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Guest of Honour

His Excellency Ahmed Shide, Minister of Finance of the Federal Democratic Republic of Ethiopia



Professor Tassew W/Hanna, President, Ethiopian Economics Association

Welcoming and Presidential Address to the 23rd International Conference of the Ethiopian Economics Association Professor Tassew Woldehanna, Friday, 17 July 2026

- Your Excellency Ahmed Shide, Minister of Finance of the Federal Democratic Republic of Ethiopia and our Guest of Honour;
- Excellencies;
- Advisory board of EEA,
- distinguished representatives of government institutions;
- members of the diplomatic community;
- representatives of development organisations;
- respected scholars and researchers;
- members of the Ethiopian Economics Association;
- invited guests;
- ladies and gentlemen

It is my great honour and privilege, on behalf of the Executive Committee, members and Secretariat of the Ethiopian Economics Association, to welcome you all to this International Conference of the Ethiopian Economics Association. I extend a particularly warm welcome to our international participants who have travelled to Ethiopia to share their knowledge and experience with us. Your presence enriches this conference and demonstrates the importance of international intellectual

cooperation in addressing the complex economic challenges facing Ethiopia, Africa and the wider world.

I would like to express our sincere appreciation to His Excellency Ahmed Shide, Minister of Finance, for accepting our invitation to serve as Guest of Honour and to officially open this conference. Your Excellency, your presence is especially meaningful because the issues we will discuss are directly connected to the major economic reforms currently being designed and implemented by the Government of Ethiopia. We are grateful for your commitment to engaging with Ethiopian economists, researchers and policy professionals.

This conference is being held at a particularly important moment in Ethiopia's economic history. Our country is undertaking far-reaching macroeconomic and structural reforms while continuing to manage the consequences of domestic conflict, global economic uncertainty, climate-related shocks, high living costs, debt pressures and rapidly growing demand for employment and public services. The choices made during this period will influence the direction of the Ethiopian economy for many years to come. Our responsibility as economists is therefore not simply to observe these developments, but to analyse them carefully, assess their consequences and contribute constructively to better policy decisions.

What do Ethiopian economists do, and what should they do at a time such as this? Ethiopian economists work in universities, research institutions, government ministries, financial institutions, businesses, civil-society organisations and international agencies. They collect and analyse data, evaluate public programmes, investigate poverty and inequality, study markets and institutions, forecast economic developments and advise policymakers.

They also train future generations of economists who will inherit responsibility for managing the country's development.

However, the contribution of economists must go beyond producing technical reports. Economists must help society understand the choices and trade-offs involved in economic policymaking. We must identify not only the expected benefits of a policy, but also its costs, risks and distributional consequences. We must ask who benefits, who carries the adjustment burden, how long the transition will take and what measures are needed to protect those who are most vulnerable. We must be willing to recognise policy achievements, but we must also be prepared to identify weaknesses and propose practical alternatives.

The Ethiopian Economics Association has an important responsibility in this regard. Since its establishment, the Association has worked to strengthen economic research, encourage professional dialogue and connect evidence with policymaking. The EEA must remain an independent, credible and constructive professional institution. Independence does not mean opposing every policy, just as constructive engagement does not mean supporting every policy 4 without sufficient evidence. Our responsibility is to provide rigorous analysis, acknowledge progress where it occurs and offer honest criticism where improvement is required. Ethiopia has achieved important economic and social progress over the past decades. The country has expanded infrastructure, electricity generation, telecommunications, roads and access to education and health services. Earlier periods of sustained growth contributed to improvements in living standards and reductions in poverty, although some of those gains were later weakened by conflict, inflation and other shocks. The Grand Ethiopian Renaissance Dam, officially inaugurated in September 2025, represents an especially significant national achievement. Built largely through the contribution and commitment of Ethiopians, it is a symbol of national determination, African self-reliance and the potential of renewable energy to support industrialisation and regional economic integration.

More recently, Ethiopia has undertaken major macroeconomic reforms. Since July 2024, the country has moved towards a market-determined foreign-exchange system, introduced an interest rate-based monetary policy framework, strengthened fiscal discipline, modernised tax administration and expanded the role of the private sector. The Government has also refrained from relying on direct central-bank advances to finance the budget, while reforms in the foreign exchange and financial markets have sought to improve transparency, competitiveness and access to foreign currency.

The latest official indicators demonstrate that these reforms have produced notable gains. The National Bank of Ethiopia reports real economic growth of 9.2 per cent during the 2024/25 fiscal year and projects growth of 10.2 per cent for 2025/26. Export earnings, government revenue and foreign-exchange reserves have improved, while the external position has strengthened. The completion of the fifth review of Ethiopia's programme by the IMF Executive Board on 1 July 2026 also indicates continuing progress in meeting major programme commitments. These are important achievements that should be recognised.

At the same time, we must recognise that macroeconomic progress remains vulnerable. Inflation, which had declined substantially (to 9%), rose again to 13.4

per cent in May 2026, partly because of increases in fuel, transport and other import costs associated with international instability. High prices continue to affect household purchasing power, particularly among low-income families whose expenditure is concentrated on food, transport, housing and other basic necessities. Ethiopia also continues to face external debt challenges, foreign-exchange market imperfections and exposure to global commodity-price movements.

Economic growth alone is not sufficient if it does not improve the lives of ordinary citizens. Macroeconomic stability is essential, but it must ultimately be judged by whether it creates productive employment, raises real household incomes, reduces poverty and improves the quality of public services. Ethiopia has a young and rapidly expanding labour force, with roughly two million people reaching the working age each year. Creating sufficient employment for these young people is not only an economic necessity; it is also essential for social stability, national confidence and the country's long-term development.

The central challenge is therefore to transform economic growth into structural transformation and shared prosperity. Agriculture must become more productive, climate-resilient and commercially connected to industry and markets. Manufacturing must expand beyond protected domestic production and become more competitive in regional and international markets. The services sector must create more productive employment rather than being dominated by low income and informal activities. Small and medium-sized enterprises must receive better access to finance, technology, markets and reliable infrastructure. Women and young people must be able to participate fully in the opportunities created by economic reform.

These concerns explain the importance of the main theme of this conference: evaluating the design, implementation and effectiveness of macroeconomic reform in achieving sustainable economic transformation. Policy design must begin with a correct diagnosis of the problems facing the economy. Reform measures must be internally consistent, appropriately sequenced and supported by realistic assumptions regarding institutional capacity and the behaviour of households, firms and markets.

Implementation is equally important. A well-designed policy can fail when institutions lack capacity, responsibilities are unclear, communication is weak or different government agencies pursue inconsistent objectives. Successful reform therefore requires effective coordination between fiscal, monetary, trade, investment, social and sectoral policies. It also requires cooperation between federal and regional

institutions, reliable data, transparent communication and regular monitoring of results.

Effectiveness should be measured by outcomes rather than announcements. We must examine whether reform is reducing inflation sustainably, improving foreign-exchange availability, increasing exports, attracting productive investment and strengthening the financial system. More importantly, we must evaluate whether it is generating decent employment, reducing poverty, improving food security and narrowing inequalities between women and men, rural and urban populations, regions and different income groups.

Investigating the social-welfare impacts of economic policies is therefore another fundamental objective of this conference. Every major economic policy has distributional consequences. Exchange-rate reform may improve competitiveness and encourage exports, but it can also raise the domestic price of imported fuel, medicine, fertiliser and industrial inputs. Tight monetary policy can reduce inflation, but it may also increase the cost of credit for businesses. Fiscal consolidation can strengthen debt sustainability, but poorly designed expenditure reductions may weaken education, health, infrastructure and social protection. Tax reform can increase government revenue, but it must be fair, predictable and sensitive to the circumstances of low income households and emerging businesses.

For this reason, social protection should not be treated as an afterthought or as compensation introduced only after hardship has occurred. It must be an integral component of reform design. Targeted support should protect poor households, children, older people, persons with disabilities, displaced populations and communities affected by conflict and climate shocks. At the same time, social policy should help people build productive capabilities through education, health, nutrition, skills development and access to economic opportunities.

Looking ahead, keeping the Ethiopian economy on a sound path will require consistency and patience. Macroeconomic credibility must be maintained through disciplined fiscal and monetary policies, transparent foreign-exchange management and prudent debt restructuring. Domestic revenue must be increased fairly and efficiently, while public expenditure must be directed 10 towards programmes with high economic and social returns. Public investment decisions should be based on careful appraisal, transparency and value for money.

The country must also build a stronger environment for private investment. This requires reliable electricity and logistics, predictable regulations, an efficient tax system, access to finance, contract enforcement and effective competition. Private-sector development should not be understood simply as transferring activities from the state to private owners. It must involve creating competitive markets in which productive firms can enter, innovate, expand and employ workers. Investment in people must remain at the centre of Ethiopia's transformation. No country can sustain rapid growth with weak learning outcomes, poor health, inadequate nutrition and limited technical and managerial skills. Universities and research institutions must be strengthened, and greater attention must be given to the quality and relevance of education. Ethiopia must prepare its young people not only for today's labour market, but also for an economy increasingly shaped by digital technology, artificial intelligence, renewable energy and climate change.

Peace, institutional stability and national cooperation are equally important economic foundations. Conflict destroys productive assets, disrupts markets, displaces communities, reduces investment and diverts resources away from education, health, research and infrastructure. Sustainable economic transformation therefore requires peaceful resolution of disagreements, restoration of livelihoods in conflict-affected areas and rebuilding trust among communities and institutions.

Over the course of this conference, I encourage all presenters and participants to engage openly and respectfully. We should welcome different analytical perspectives and allow evidence to guide our conclusions. The value of an academic conference does not lie in everyone reaching the same opinion. Its value lies in improving our understanding, questioning unsupported assumptions and identifying policy options that are both economically sound and socially responsible. I hope that the discussions during this conference will produce practical recommendations for government, the private sector, development partners, researchers and civil society. I also hope that they will create new research partnerships, encourage younger economists and strengthen the contribution of Ethiopian scholarship to national and international economic debates.

Before concluding, I would like to thank the members of the Conference Organising Committee, the EEA Secretariat, our partners, sponsors, presenters, reviewers and everyone who has worked to make this conference possible. I also thank all participants for joining us and for contributing your valuable time, knowledge and experience.

Your Excellency Ahmed Shide, the Ethiopian Economics Association deeply appreciates your participation as our Guest of Honour. We look forward to hearing your reflections on the progress of the reform programme, the challenges that remain and the Government's vision for Ethiopia's sustainable economic transformation.

I also would like to express the Ethiopian Economics Association's sincere appreciation to the institutions whose generous financial, technical and institutional support has made the 23rd International Conference of the EEA possible. We gratefully acknowledge the Ministry of Finance; Friedrich Ebert Stiftung; the United Nations Economic Commission for Africa; the International Food Policy Research Institute; the Centre for Tax Analysis in Developing Countries, TaxDev; Bahir Dar University; the University of Gondar; and the Policy Studies Institute. Their partnership reflects a shared commitment to strengthening economic research, encouraging evidence-based policymaking and creating a platform for informed discussion on Ethiopia's development. On behalf of the Ethiopian Economics Association, I extend our profound gratitude to all our sponsors and partners for their confidence in the Association and their invaluable contribution to the success of this conference. I kindly invite all participants to join me in acknowledging them with a warm round of applause.

Distinguished guests, ladies and gentlemen, once again, I warmly welcome you to the International Conference of the Ethiopian Economics Association. I wish all of you productive deliberations, meaningful professional exchanges and a successful conference.

It is now my great honour to invite His Excellency Ahmed Shide, Minister of Finance of the Federal Democratic Republic of Ethiopia, to deliver his address and officially open the conference.

Thank you very much for listening. Amesegenalehu

Whither Ethiopia (Vision 2020): Revisiting Prof. Mesfin Woldemariam's Prophecy

Amdissa Teshome[1]

Abstract

The paper revisits the late Prof. Mesfin Woldemariam's prophecy that by 2020 E.C. Ethiopians will be more worried about their survival than poverty and famine. We are at that point in history when peace and security have preoccupied the people and Government of Ethiopia. Despite numerous attempts, both constitutionally and traditionally, to resolve conflicts, we are still far from ensuring lasting peace.

The study is qualitative involving a careful analysis of Prof. Mesfin's prophecy; comprehensive review of relevant literature and formal and informal interaction with concerned professionals.

Underpinning Prof. Mesfin's belief that Ethiopian's, despite their diversity, have a longstanding culture of peaceful co-existence, the paper examines the extent of diversity, traditional and constitutional mechanisms for conflict resolution and peacebuilding. It is found that Ethiopia is certainly diverse but by no means the most diverse country in the world. There are more diverse countries than Ethiopia that are not necessarily in conflict and countries that are less diverse but have suffered from conflict. Therefore, being diverse is not necessarily cause for conflict. Individually, there is no single identity that determines our destiny but the multiple identities we acquire throughout our lives that shape our future.

I also find that the traditional mechanisms have focused on conflict resolution – after the damage is done! And the constitutional initiatives have largely been top down. It is therefore recommended that we shift the mindset from conflict 'resolution' to 'prevention'; constitutional efforts should also shift from top down to bottom up giving sufficient space and recognition to the traditional mechanisms and prepare for a hybrid peacebuilding process supported by peace education, conflict early working and appropriate technologies.

Key words/phrases: conflict, prevalence, prevention, resolution, constitution, diversity, hybrid peace process, peace curricula.

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[1] *Independent Consultant & Social Science Researcher (ICSSR)*

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1. Introduction

In the evening of 28 November 2003, the late Prof. Mesfin Woldemariam took the stage to deliver his much anticipated Vison 2020 speech - "Whither Ethiopia", which many found intriguing. His 'prophecy' that in 25 years, Ethiopians will be more concerned about their survival than poverty and famine (Woldemariam, 2003:19) was even more intriguing and puzzling.[2] Desalegn Rahmato, commenting on the vision, described it as "biblical". Dr. Assefa Bequele called it "insufferable and terrifying". This perceptions by our teachers and mentors have encouraged me to describe the vision as a 'prophecy' that should inspire generations to seek lasting solutions to conflict, no matter what the causes are. In a survey of EEA members on the extent to which the 2020 visions were realised, Prof. Mesfin's 'Whither Ethiopia' was ranked in the top five indicating its continued relevance to contemporary Ethiopia (Teshome, 2024).

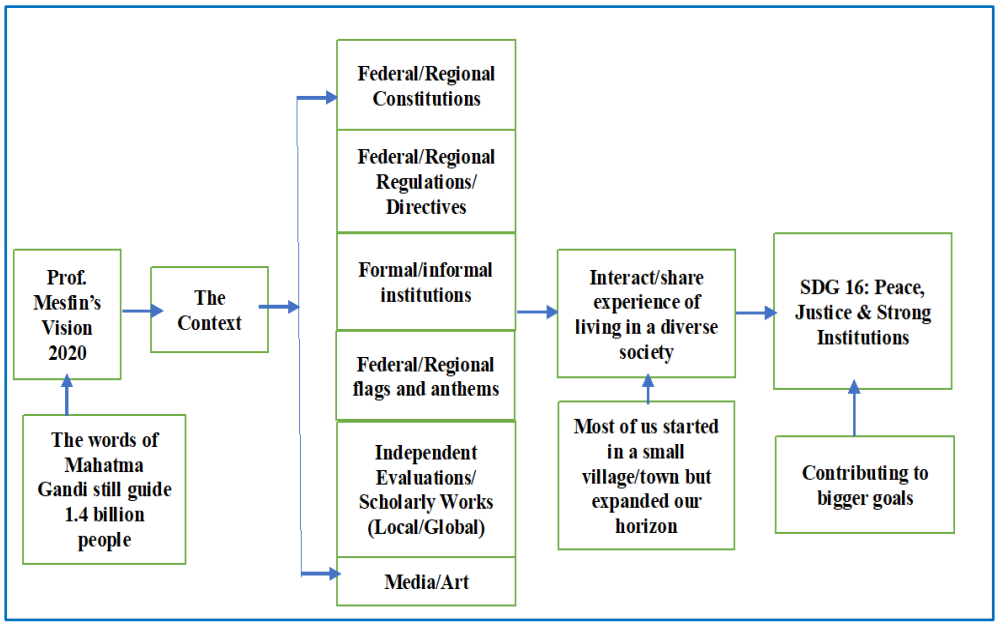
The general objective of the paper is to contribute to the culture of celebrating (or critiquing as appropriate) Ethiopian thinkers – past and present – and motivate future thinkers to come forward.[3] Specific objectives are to (i) provide a synopsis of Prof. Mesfin's 'prophecy' and explain its continued relevance; (ii) build on Prof. Mesfin's belief that diversity is not the root cause of conflict; (iii) examine the constitutional and traditional efforts to resolve conflicts and bring about lasting peace; (iv) identify the gaps in these efforts and finally, (v) propose a bottom up process of preventing conflict and promoting peaceful co-existence.

Revisiting a thinker's idea is typically done through qualitative approach that entails text analysis, interpretation, and judging relevance to contemporary situation. Accordingly, the paper draws on a synopsis of the prophecy, a review of federal and regional constitutions, various regulations and directives issued to establish conflict resolution institutions. Independent evaluations of these mechanisms and global databases on conflict prevalence are also used. Formal and informal dialogue with concerned citizens and non-citizens have also been beneficial to test the continued relevance of the prophecy (Figure 1).

[2] Prof. Mesfin, more than anybody, knew that 'poverty and famine' are themselves questions of survival but at the time of his talk and now, peace has truly become an overriding concern.
[3] In a similar tone, Alemayehu Geda (2015) celebrates the works of Gebrehiwot Baykedagne who he describes as "the pioneer African Macroeconomist". Prof. Bahiru Zewde's "Pioneers of Change" also paved the way for celebrating Ethiopian thinkers.

Following this introduction, Sections 2 and 3 present a brief biography of Prof. Mesfin and his prophecy. Section 4 discusses diversity and conflict. It explains how diversity is measured and highlights the importance of celebrating diversity without magnifying differences. Section 5 discusses the continued importance of traditional conflict resolution (rarely prevention) mechanisms and explores how they can collaborate with the formal system to deliver peace and security. Sectio 6 concludes the chapter by linking the findings and recommendations to SDG 16 – peace, justice and strong institutions.

Figure 1: Roadmap for the revisit



2. Prof. Mesfin's Woldemariam: A Man Ahead of His Time

Prof. Mesfin Woldemariam was born on 23 April 1930 in Addis Ababa, Ethiopia. He received his early education at Teferi Mekonnen School; his BA from Punjab University, Chandigarh in 1955 and his MA and Ph.D. from Clark University in 1977.

A defining feature of Prof. Mesfin is that he always maintained that nonviolence struggle should be the means to achieve political goals. One of the earliest example of this lifelong motto was when the university college students demonstrated in support of the aborted *coup d'état* led by the two brothers, Brigadier General

Mengistu Neway[4] and Germame Neway, an intellectual, political activist and provincial Governor. Mesfin was the only faculty member who accompanied the demonstrators from *Arat Kilo* to *La Garre* tendering advice to the young demonstrators that they should avoid confrontation with the policy who were read to shoot and kill. At the end of the day, he saved the student demonstrators from a certain massacre by warning them not to disobey the orders of the pro-monarchist soldiers (Milkias, 2020).[5]

During the most dreadful famine of the imperial era, he established the first ever famine relief committee at Haileselasseie I University (now Addis Ababa University); at a time when the feudal regime not only denied the existence of famine but also incarcerated the hungry people who migrated from Northern Ethiopia in Shola Camps in Addis Ababa.[6]

In 1977, when the Somalia army invaded Ethiopia, Professor Mesfin wrote a highly acclaimed and yet controversial book, *Somalia: the problem child of Africa*, in which he argued that the dream of Greater Somali was not the desire of the Somali people but orchestrated by colonialists and neo-colonialists (Cochrane, 2018) and he foresaw that this would ultimately lead to disintegration of Somalia. Prof. Samatar (2005), a prominent Somalia scholar, having previously criticised Prof. Mesfin for being too nationalistic, later issued an apology:

> *"…. Twenty years later and the sinking of Somalia into the sand dunes of the Horn, I write this expressly to apologize to Professor Mesfin whose judgement of the Somalis as a nation turned out to be remarkably prescient and to the point. Somalia did indeed prove to be the problem child of Africa. Professor Mesfin can take little comfort from this, though, for Ethiopia itself today, riven by ethnic conflict and regional antagonism, seems to be lurching heedlessly towards Somalia's fate."*

Prof. Mesfin was also co-founder of the first independent Ethiopian Human Rights Council in 1991 which was established to help the transitional government ensure human rights as stipulated in the Transitional Charter and later the Constitution.

---

[4] Mengistu also served as the Commander of the Ethiopian Imperial Guard (*Kibur Zebegna*) during the reign of Emperor Haile Selassie.

[5] What makes Prof. Mesfin truly a man ahead of his time is the fact that nonviolence, pioneered by Mahatam Gandhi in the modern times, became global phenomenon in the last 25 years due to the proliferation of media outlets (Chenoweth, 2020:70-1).

[6] Based on Tsehayou (2024) and Milkias (2020).

His extensive scholarly work and advocacy for human rights have earned him several nominations and awards, and anger from successive governments at home. Prof. Mesfin is the 2006 recipient of the Heinz Pagel Human Rights Award from the New York Academy of Sciences. He died on 29 September 2022 at the age of 90.

3. Synopsys of the Prophecy

"Whither Ethiopia?" captures a deep anxiety about peace and security shared by the people and Government of Ethiopia. Very few have articulated this anxiety more persistently and courageously than Prof. Mesfin Woldemariam.[7] Vision 2020 platform was simply the climax of this journey. Following a review of the global situation at the time, he posed four fundamental questions that guided his talk: (i) Where did we start to get to where we are now? (ii) What is our current predicament? (iii) Where will the present path take us? (iv) What should we do to thwart the disaster? I will not do any justice (or it is not desirable) to summarise the whole talk here but focus on what he said about our predicament and on what should be done. Prof. Mesfin described Ethiopians as:

> *"... peaceful with the capacity to endure suffering. There is no people that is as innocent and as patient as we are. We do not get angered when robbed; we do not complain about the injustices we suffer; we do not lose our temper over the violation of laws; we are insensitive to the agonies and the cries of the poor and the unemployed. We are all governed by the day-to-day necessities for survival without being engaged in the pain of thinking. We live in a situation in which the educated and the uneducated mutually denigrate each other; a situation in which the youth and the elderly, the rich and the poor, the rural dweller and the urbanite each blames the other for its predicament; ..." (Woldemariam, 2003:17)*

One would not expect attributes nurtured over centuries to change in just two decades. Ethiopians are still tolerant in many areas of everyday life: queuing long hours to board public transports and access other public and private services; to pay tax; tolerate crowded buses and taxis. If one travels on public transport, as I often do, it is common to see a notice "ሞላ የሰው ስም ነው፤ ጠጋ በሉ" ("Mola is a name; move and

[7] Not all predictions or prophecies come true. In "How to Expect the Unexpected", Kit Yetes chronicles prophecies that scientists, politicians, and evangelical preachers, to name but a few, have been making and getting it wrong. Despite the dangers of predicting the future, predict it we must Yates (2023: 2-4).

let the extra person sit". 'Mola' also means the taxi is full). The passengers, including myself, often abide and carry the extra person on our lap.

Of course, Prof. Mesfin's core message was not about the demand and supply of services. It was about the degree of "tolerance" built into Ethiopian culture that should have been the foundation for peaceful co-existence but is either been misinterpreted, misunderstood or misused.

His message was also symptomatic of the history of top down governance. Prof. Mesfin told a story about an ancient manuscript he received from a fellow scholar, which was about how Ethiopian leaders at the beginning of the 15th century did not tolerate differences of opinions. Prof. Mesfin found it "both tragic and surprising" that past and present leaders persecuted those with different opinions using a variety of methods which have not changed to this day!

This is by no means to suggest that Ethiopians have not risen against oppression and aggression – external or internal. Again Prof. Mesfin knows more than anybody else. On the contrary! It is widely acknowledged that Ethiopians are the only Africans to fend off colonialism. Internally, there has been resistance of various kinds - from the village *shifts* (rebels) who rose against the local landlords to the organised armed groups that attempted, some succeeded; others failed, to oust the monarchy and then the military junta that replaced it. Ethiopian youth have played a historic role in the most recent changes that forced EPRDF to reform or die.

However, these sporadic efforts have failed to bring about a democratic and peaceful system. As a matter of fact, there is little evidence, particularly in Africa, of armed groups that seized power by force transforming into democratic entities (Avis, 2021).[8] As Prof. Mesfin remarked, "We [Ethiopians] are now in 1996 (2003 Gregorian) without learning to institutionalize power. Institutionalizing power is the mark of a civilized community" (Woldemariam, 2003:21).

Prof. Mesfin's central theme, which this paper examines at some length, was that diversity is no reason for conflict. It is the misuse of diversity for political ends that has made the country conflict prone (see also Geda, 2015:622). This must change! How? Prof. Mesfin offered a number of solutions.

[8] Chenoweth (2020) gives several reasons for the dominance of civil resistance including new information technology, increasing youth populations and, more to the point, the market for violence is drying up perhaps discouraged by the armed groups inability to transition to democracy.

First and foremost, Ethiopians must learn to demonstrate the zeal for a peaceful struggle for democracy as much as they do to defend their country. It should be an age of peaceful, intellectual engagement based on reasoning. This very much resonates with Ghandi's peaceful struggle against apartheid in South Africa and later colonialism in India.

Second, formal and informal institutions including the media should be free and operate within, what Prof. Mesfin calls, "the law of reason". Third, Prof. Mesfin contended that since the conflict between us [Ethiopians] is one of mutual mistrust and fear of each other created by politicians, we have to seek a way that would enable us to trust each other as individuals or groups. Afterall, as Sent (2006) put it, there is no single identity that determines our future but *context*, *reason* and *choice* determine which of the multiple identifies we acquire shape our future. Prof. Mesfin said, "Let our ideas [not our ethnicity] clash and jostle and build our country with the spark from the clash of our ideas as the blaze that lights the trail we follow" (Woldemarian, 2003:23). Can anyone be more prophetic than this? It is no wonder, Milkias (2020) described Prof. Mesfin as "an indefatigable Ethiopian nationalist".

Prof. Mesfin reminded us that Ethiopians have strong tradition of *irq* [conciliation] at individual, family and community levels. In the rest of the paper, I will develop this idea and show how it can be scaled up to national level to bring lasting peace. But first, how diverse is Ethiopia and should diversity be the reason for conflict?

4. Diversity and Conflict

In spite of (or because of) increasing ethnic and religious violence around the world, there has been a growing recognition and acceptance of ethnic and cultural diversities. Societies may be divided into two depending on how they treat diversity: plural or multicultural. A plural society may choose to play down its ethnic diversity and to emphasise cultural uniformity and homogeneity. A multicultural society, on the other hand, publicly acknowledges and cherishes this diversity and allows sufficient autonomous space to different ethnic groups and cultural communities (Amon, 2022).

Ethiopia has exhibited both characteristics. During the Imperial era, Ethiopia was a plural society but did not give any recognition to its diversity focusing on homogeneity. Article 1 of the 1955 revised constitutions stated "All Ethiopian subjects, whether living within or without the Empire, constitute the Ethiopian people".

The 1987 *Derg* Constitution gave a moderate recognition to Ethiopia's nationalities and diverse communities but underlined "Ethiopia is a unitary state" (Article 2-1). The Derg went further and established the Institute for the Study of Ethiopian Nationalities (ISEN) in 1983 which produced substantial data on ethnic diversity which became the foundation for EPRDF to create the new ethnic-based map of Ethiopia. Many now believe that EPRDF took ethnic diversity to the extreme by reorganising the country along ethnic and language lines as enshrined in Article 46 (1 and 2) of the 1994 Constitution.[9] Therefore, Ethiopia moved from **no recognition** for diversity to **moderate recognition** and ultimately to being **re-configured** along ethnic and language lines.

4.1. Measuring Diversity

Is Ethiopia as diverse as it claims? Diversity is measured by the probability that two randomly picked persons from a given country belong to different ethnolinguistics and religious groups, which Easterly and Levine (1997) labelled as "fractionalization". The higher the fraction or percentage (closer to 1 or 100), the greater the diversity; the lower the fraction or percentage (closer to 0) the lower the diversity. Table 1 compares Ethiopia's diversity with its neighbouring IGAD countries and some non-IGAD countries. Accordingly, it stands 3rd compared to its IGAD neighbours; is above the IGAD average and close to the SSA average.[10] Somalia has the lowest fraction in all dimension but, as commonly known, highly fractionalised along clan lines.

Among the non-IGAD group, Tanzania and Indonesia are the most diverse; Egypt has the lowest ethnic and language fractions; while Rwanda's ethnic fraction is lower than its religious fraction. China's ethnic and language fractions are lower than its religious fraction. The key takeaway from this data is that countries with higher

[9] It is worth noting in passing that ways and means of ratifying Constitutions is a heated debate among political scientists (Qvortrup and Trueblood, 2023; Beckman, 2018). Although not a global standard it has become common practice to hold referendums to ratify constitutions and other foundational laws. This is particularly true in emerging democracies. When law makers ratify constitutions, they are determining their own mandates thereby creating conflict of interest. The people should give the mandate to elected bodies to govern the country. This process should of course be supported by a vibrant civil society and independent media.

[10] https://worldpopulationreview.com/country-rankings/most-racially-diverse-countries (accessed 11.10.25). The complete dataset can be found here https://cadmus.eui.eu/server/api/core/bitstreams/7be7a218-4039-5564-8b40-8dcc9e921e8c/content.

diversity are not necessarily at war with themselves; or countries with lower diversity are not necessarily at peace with themselves. So, what is driving conflict? I shall come back to this question in Section 4.2.

Table 1: Diversity among IGAD and selected non-IGAD countries

Country	Ethnic fraction (%)	Language fraction (%)	Religious fraction (%)	Average fraction	Rank[11]
IGAD countries					
Djibouti	64.9	65.6	4.4	45.0	6
Eritrea	65.9	65.3	42.5	57.9	5
Ethiopia	**78.3**	**80.7**	**62.5**	**73.8**	**3**
Kenya	85.5	88.6	77.7	83.9	1
Somalia	22.2	3.3	0.3	8.6	7
Sudan	74.6	71.9	43.1	63.2	4
Uganda	88.3	92.3	63.3	81.3	2
IGAD Average	68.5	66.8	42.0	59.1	-
Selected SSA average	78.7	78.9	54.7	71.4	
Non-IGAD countries					
China	19	13.3	66.4	32.9	4
Egypt	4.1	2.4	19.8	8.8	5
Indonesia	80.3	76.8	23.4	60.2	2
Rwanda	28	N/A	50.1	39.1	3
Tanzania	59.1	89.83	63.34	70.8	1

Source: see footnote 3 (rounded to one decimal place).

Inter-ethnic-religion marriage is generally viewed as an important indicator of peaceful co-existence, reconciliation and celebrating diversity.[12] Unfortunately, nationally representative data on this indicator are rare not only in Ethiopia but in sub-Saharan Africa (SSA). Two studies stand out in SSA. Bandyopadhyay and Green (2021) and Crespin-Boucaud (2020) used national DHS and found that 19.4 percent and 20.4 percent, respectively, of their sampled households were in inter-ethnic

[11] Averages and ranks are author's computation.

[12] These perceptions and the associated research are mainly in the highlands of Ethiopia. In the lowland pastoral communities, there is a general tendency to marry within clan and religion. Marriage between different clans are less common and between different religions is almost non-existent.

marriage. Crespin-Boucaud (2020) did a separate analysis for interfaith marriages and found that it accounted for 9.7 percent.

In Ethiopia, such marriages are believed to be common. They ae considered indicators of high level of "societal assimilation" (Woldegebreal, 2010). In more recent times, investigating these variables have become too sensitivity. The 1984 census is the only time direct questions were asked about ethnicity and inter-ethnic marriages (Belachew, 2021).

Current available data are limited to academic studies whose samples are often small but the methods are rigorous. For example, Woldegebreal (2010) surveyed about 1000 households in Addis Ababa (the most diverse in Ethiopia) and found that nearly 40 percent were ethnically inter-married. The average annual growth rate in ethnic inter-marriage was about 0.3% during the timeframe for the study (1984–2010 E.C.). Woldegebreal's study also revealed that the likelihood of being ethnically inter-married, within his sample, is higher among the Oromos and Gurages; Catholic Christians and Protestants. Travelling and urbanisation are key contributors to inter-ethnic marriages.

A similar (but qualitative) study in Oromia region found that inter-ethnic marriage plays an immense role in the development of trust, tolerance, culture of mutual understanding and peaceful co-existence among different ethnic groups. However, unpredictable and polarized views and interests among political elites of different ethnic groups may influence the practice of inter-ethnic marriage (Belay, 2021).

Evidence on inter-religion marriage is even harder to come by. In Wollo, where such marriages have been practiced for centuries, Tilahun, et.al. (2025) state that the history of Wollo represents a unique model of religious coexistence where Christians and Muslims have prioritised tolerance, shared traditions, and mutual respect over doctrinal differences. Finally, they concluded that creating interfaith forums and discussion groups, organizing collaborative cultural and religious festivals, facilitating adaptive religious practices, preparing continuous cultural exchange and experience-sharing programmes would produce positive results.

Inter-ethnic-religion marriages have significance not only for the couples but also for the next generation - their children. It is hoped that these children would grow up with a diversity mindset that should form the foundation for peaceful co-existence, but this is by no means given. Neither conflict nor peace are in the blood – they are cultivated! A 'culture of peace' must be cultivated through dedicated and sustained peace education (more on this later).

4.2. Celebrating Diversity Without Magnifying Differences

How is diversity celebrated?

Recognising and celebrating diversity is an important step in nation building. To facilitate and encourage this process, UNESCO dedicated May 21st as the World Day for Cultural Diversity for Dialogue and Development. Scholarls (e.g. Yahiya, 2015) also value celebrating diversity and it can be done through everyday activities such as visiting exhibitions and museums dedicated to other cultures; learn about another religion[13] and language; listen to music, watch documentaries about a different culture; and volunteer with an organisation working for diversity and inclusion.

Ethiopians do more than these. Nations, Nationalities and People's day has been celebrated since 2006. While each region celebrates the day locally, regions/cities take turns to host the main event (the climax) where representatives of each region show case their cultures. This is aimed at enhancing awareness of each ethnic group and strengthen ties among them. The importance of the event is such that, more often than not, it is attended by high level government officials and representatives of the diplomatic cor.

Flag day is celebrated every year as per the Proclamation No. 654/2009. The Proclamation states that the flag symbolizes the sovereignty of the nation and the unity of its peoples. Flags are also political instruments (Tefera and Castro, 2016) and used for mobilizing citizens around a common vision or challenges such as invasions.

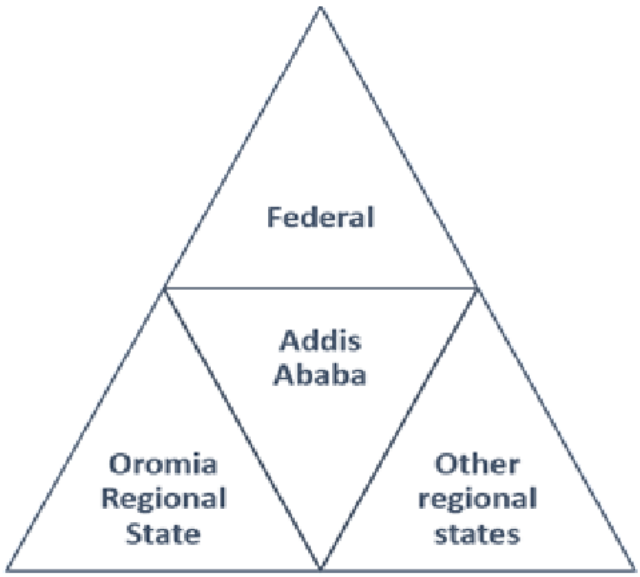
Ethnic groups in Ethiopia also celebrate various events that are specific to their culture and beliefs dating back centuries but hidden away from the public eye due to the pluralist (not multi-culturalist) ideology of the imperial era. Constitutional recognitions of diversity meant that ethnic groups are able to celebrate their cultural events and some are recognized as Intangible Cultural Heritage of Humanity by UNESCO.

How are differences magnified?

Although the Federal Constitutions is said to be the highest law of the land, in practice, it has opened doors for regional states to enact their own constitutions that

[13] Writing for the New York times, the Dalai Lama said 'finding common ground among faiths can help us bridge needless divides, at a time when unified action is more crucial than ever.'

are markedly different from the federal constitution and in some cases contradictory to it. This is particularly the case with the Addis Ababa question where a three way tension has been rocking the nation since the federal system was in place (Figure 2).[14]



Source: Author's synthesis of the Constitutions and other relevant literature

The tension between the Federal Government and the Oromia Regional State over Addis Ababa has been the most intense. During the transition period, Addis Ababa was designated as one of the regions (Region 14) and the Oromia Regional constitutions designated Adama, 100 km East of Addis Ababa, as its capital. When the Federal Constitution was adopted in 1995, Addis Ababa became self-governing Chartered City. This prompted or angered the Oromia Regional State to declare Finfine/Addis Ababa as its capital. This declaration was affirmed in the aftermath of the 2005 election when the late Prime Minister Meles Zenawi openly invited the Oromia Regional State to return to Addis Ababa by way of stopping the opposition from taking over the city.

[14] Apparently, the scramble for a Capital is by no means unique to Ethiopia. Goodfellow and Jackman (2023) document research from various parts of the world, including Ethiopia, where the struggle for "controlling the capital" is intense. See the Ethiopia case, see Gebremariam (2023: 86-117). Readers may also find Kebour Ghenna's 'Who Gets Addis Ababa' article in *Ethiopia Today*, August 15, 2026.

Other regions also claim to have a stake in the Capital. Chief amongst them is Amhara, which historically held the view that Addis Ababa belongs to all Ethiopians. More recently, however, it has laid claim that prior to the Oromo migration of the 16th century, the area now known as Addis Ababa was occupied by several non-Oromo ethnic groups (Seyoum, 2018/19, Amharic) thereby fueling the tension.

The role of media and the arts in celebrating or magnifying differences

Media (both public and private) play an important role in celebrating diversity. Media is the most cost effective way to get to know all the ethnic groups from around the country, their culture, music and dance. Diverse media (print, audio, visual, and digital) and the introduction of regional media have created immense opportunities for exposure.

However, there are concerns that the "ethnification" of the media in Ethiopian has contributed to polarisation and parts of the media are being blamed for magnifying the differences (Dessie, et. al. 2023; Skjerdal and Moges, 2021). While the activities of the 'mainstream media' (for example, print, radio, television) can be monitored, the social media are more difficult to monitor and that is where most of magnifying differences happens.

The role played by private and public media in this process differs. For example, the state media portrays the Nations, Nationalities and Peoples' Day event as a day of celebration, whereas some private media question the purpose of the celebrations suggesting that it magnifies difference and jeopardizes unity (Dessalegn, 2015; Hailu, 2015 cited in Skjerdal and Moges, 2021:11).

Although Dessie, et. al. (2023) attributed this media behaviours to the absence of media law, the media law has been in place since 2021 and amended in 2025 (Proclamation No. 1374/2025). It governs all kinds of media both within and outside the country. Article 2 (34) of the media proclamation makes provisions for "self-regulation" that entails, among others, developing professional ethics and Codes of Conduct. The authors also identified weak media leadership and poor media ethics as factors for poor media behaviour.

The arts (for example, theatre, cinema, music, poetry) are the principal instruments of celebrating diversity. They can also magnify difference if care is not exercised. More recently, much of these media behaviours have moved to social media where monitoring has proven difficult, but not impossible.

It is evident that media plays multiple roles (both positive and negative). Positively, it celebrates diversity and creates awareness about different cultures. Negatively, media spreads misinformation, disinformation, and hate speech. How best could these negative aspects be countered? Positive peace messaging is the most effective instrument as practiced by some NGOs.[15] However, these instruments remain top down and some questions remain unanswered - who designs the messages? How participatory can the process be? Furthermore, media themselves are so diverse it is not clear which messages should be direct to which media - state media vs private media; mainstream media vs social media, and global media vs local media.

Diversity and the SDGs

In order to encourage not only celebrating diversity but make tangible contribution to maintaining peace and security for all citizens, the United Nations dedicated Goal 16 of the SDGs to peace, justice and strong institutions). The goal has 10 indicators and local efforts can contribute to at least four key indicators Goal 16.1 reduce all forms of violence and related death rates everywhere; Goal 16.6 develop effective, accountable and transparent institutions at all levels; Goal 16.7 ensure responsive, inclusive, participatory and representative decision-making at all levels; and Goal 16A strengthen relevant national institutions [both formal and traditional], build capacity at all levels and prevent violence.

5. Conflict Prevalence, Prevention and Resolution

5.1. Conflict Prevalence

Conflict prevalence is the frequency and extent of disagreements, disputes, or violent actions within a workplace, community, nationally or globally at a given time. It can be measured into ways (i) actual conflict occurrence; and (ii) research interest in conflict which can go up and down more or less in line with the actual occurrence. The EEA (2025) annual report has covered frequency of conflict events by region; causes and adverse effects of conflict. The regional distribution shows that Amhara and Oromia hosted almost 81 percent of the conflict that were going on at the time of the reporting (Figure 3). A survey of expert perceptions indicated that 90.7 percent perceived 'governance problem' as the major cause of conflict; and 89.5 percent identified 'increased macroeconomic instability' as adverse effect of conflict.

[15] https://ppeth.org/programs/ (accessed 27.03.36) and complemented by interview with the founder manager.

Conflict had been, and continues to be, one of the most studied/researched topics over the last half century. In order to substantiate this claim, I searched Google Scholar using four variable: (i) all conflict, (ii) ethnic conflict, (iii) ethnic conflict in Ethiopia, and (iv) time.

Figure 4 shows research interest in conflict has certainly spiked since 1991 more generally and especially in Ethiopia. Ethiopia's ethnic conflict research as percent of global ethnic conflict research increased from 25 percent during 1991-2000 to 40 percent during 2021-2025.

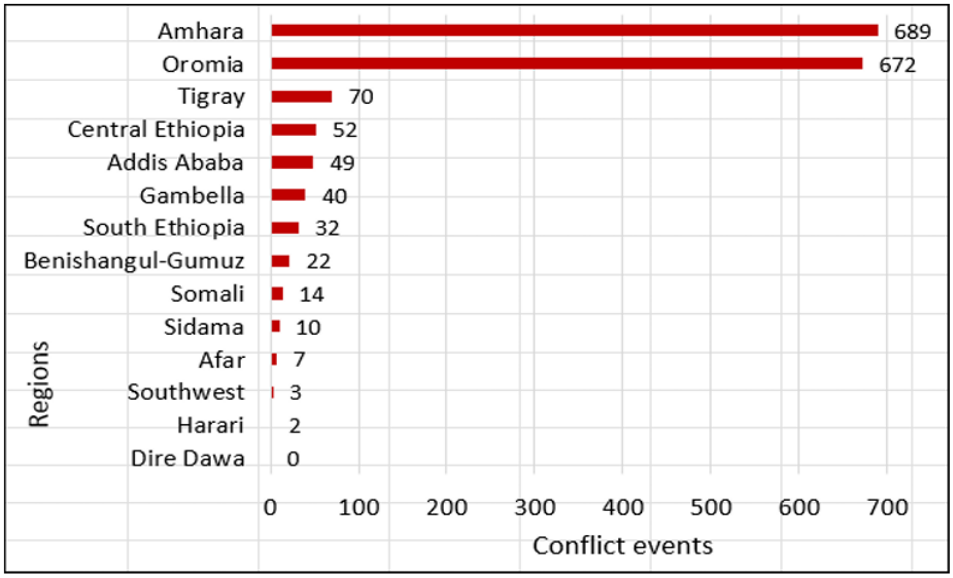


Figure 2: Regional distribution of conflict occurrences
Source: EEA (2025)

The fact that Ethiopia's conflict escalated following the institutionalization of ethnic federalism confirms the view expressed earlier that it is more the politicisation of diversity that leads to conflict than diversity *per se*. In his seminal book *Identity and Violence: the illusion of destiny*, Amartya Sen, argues that no single identity (language, ethnic or religion) defines our destiny. Instead *reasoning and choice* define our destiny. There are a great variety of categories to which people simultaneously belong. For example, Sen (2006:19) describes himself as an Asian, an Indian citizen, a Bengali with Bangladesh ancestry, an American or British residency, an economist who identifies with a group of economists; an author who identifies with a group authors; and so on. He does not put these identifies in any

order of priority. Depending on context, one identify could be dominant at some point in time and then replaced by another identify. There should be no tension between these identifies.

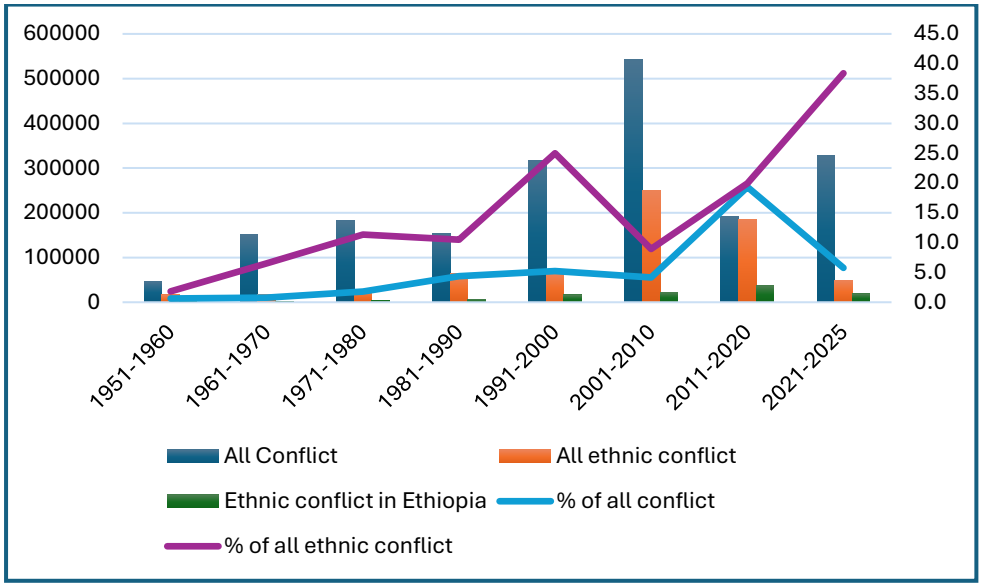


Figure 3: Research interest in conflict

Source: compiled by the author from Google Scholar (12.12.2025)

One of the key sources of tension in Ethiopia is the notion of which comes first – being an Ethiopian or the ethnic identity that one was born into? Skjerdal and Moges (2021:13) reported that when a group of Ethiopian journalism students were asked about their ethnicity, they found it distasteful to be asked and were unable to put Ethiopia first or their ethnic origin first thereby demonstrating competition between identities. When identifies compete for attention and priority over each other, the person has to decide on the relative importance of the respective identities often under political pressure. However, according to Sen (2006), "the importance given to one identify need not obliterate the importance of others". In the Ethiopian case, this means, being an Oromo or Amhara or Sidama need not negate the person being an Ethiopian; or being an Ethiopian need not negate being an Oromo or Amhara or Tigre or Somali, Gurage or Sidama, or Wolaita, and so on.

Whatever the cause, at best conflict must be prevented before the damage is done; if it happens, it must be resolved in the quickest time possible to minimise the damage and build peaceful coexistence thereafter. That is where we are heading now.

5.2. Conflict Prevention and Resolution Mechanisms

5.2.1. Traditional Mechanisms

Among the IGAD member states, Kenya has multiple layers of informal Councils of Elders that continue to serve as alternative dispute resolution mechanisms (Nyamweru and Chidongo, 2018). However, not all Kenyan elders or their Councils are non-partisan. During the 2022 presidential election, the Kikuyu Council of Elders endorsed Martha Karua as the running mate to the late Raula Odinga, declaring that she deserves to be the running mate to empower women leaders in the country.[16] The Ugandan Council of Elders is affiliated with Lutheran Church of Uganda and is composed of seasoned men and women who had served the church in various capacities. These men and women counsel, arbitrate and mitigate conflict.[17]

Rwanda (non-IGAD country) has established the Rwandan Elders Advisory Forum by law. The law defines elders as "wise men and women of irreproachable moral and social values, aged at least fifty years with experience and expertise in the leadership of the Country or other institutions." The elders forum advises the Government on national topical issues, national political orientation and challenges pertaining to good governance, justice, economy and social welfare. It submits action plan and activity report to the Office of the President (Laws Africa, 2013). Although this is not a complete comparative analysis, the common features are that elders are respected for their experience and wisdom and have a lot to offer even when not active in official or unofficial positions.

Ethiopia's diverse societies have long relied on traditional mechanisms of mediation and moral authority (Pankhurst and Assefa, 2008). Clan leaders and religious leaders are called upon to resolve a wide range of conflicts among families, neighbours and communities or clans. These traditional mechanisms serve not only as mediators but also to some degree as channels through which indigenous knowledge and wisdom are transferred to the next generation by way of informal coaching and mentoring.
The Ministry of Peace (2021/22) has compiled traditional mechanisms that fall into three categories, namely, mechanisms for (i) social integration and communication (conflict prevention); (ii) conflict resolution and (iii) cross-border conflict prevention and resolution mechanisms. As shown in Figures 5 and 6, the majority of these

[16] Dauti Kahura wrote for https://thisisafrica.me/politics-and-society/, July 13, 2022.
[17] https://lcu.ug/structure/council-of-elders/

mechanisms fall under conflict 'mediation' or 'resolution' rather than proactively working to prevent conflict.

These traditional systems are by and large functional but not all are as active as they used to be. Based on a study of traditional mechanisms in Gedeo Zone, Gamtessa (2024) concluded that in contemporary Ethiopia and across Africa, the effectiveness of indigenous conflict resolution mechanisms is facing unprecedented challenges due to globalization, modernity, and the decentralization of state power. This review has also shown that that Ethiopian regions with the highest occurrence of conflict (Amhara and Oromia) are also regions with the highest number of traditional conflict resolution mechanisms (cf. Figure 3 and Figure 5) indicating that either they are not trying to prevent or resolve the conflicts or they are rebuffed (not listened to).

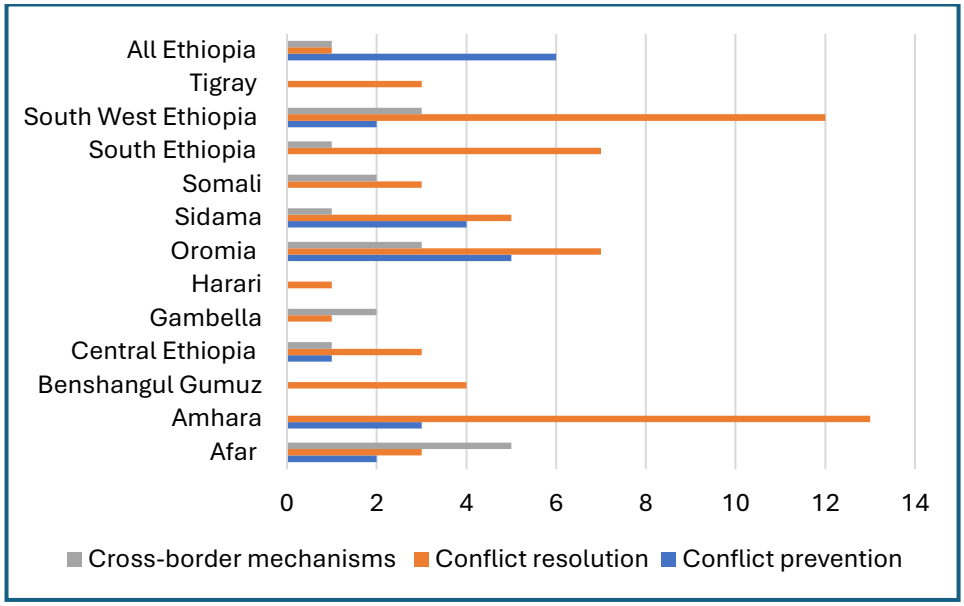


Figure 4: Traditional conflict management mechanisms by region

Source: based on data compiled by the Ministry of Peace, 2021/2022

Efforts to resolve the most recent conflicts in northern Ethiopia demonstrated that elders were sometimes invited by the government; and other times they took their own initiatives. It is safe to state that they have had little success. At worst, they have been rebuffed (Gardner, 2024). However, despite these challenges, traditional systems will continue to prevail and increasingly work with the formal/constitutional systems to deliver peace for Ethiopia.

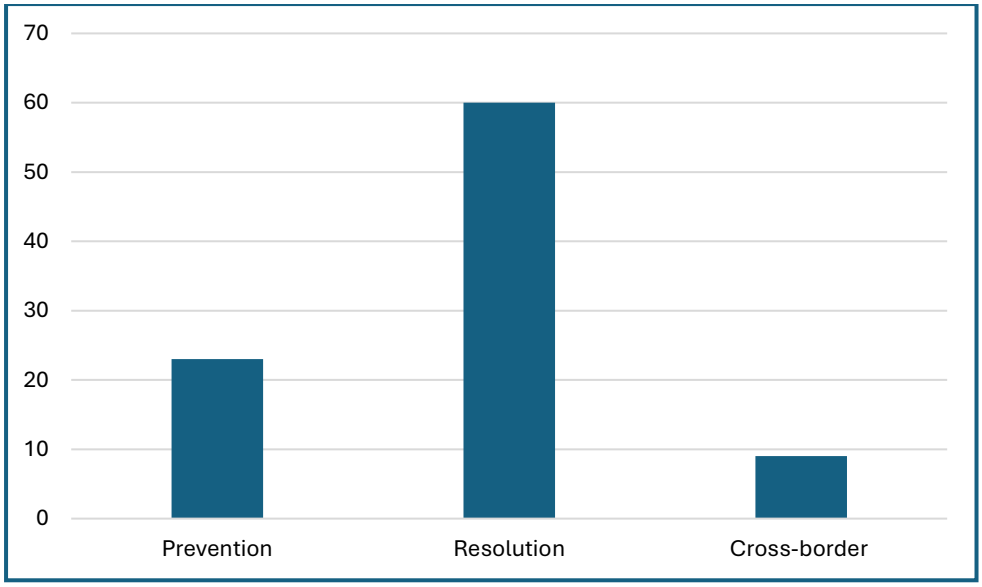


Figure 5: Summary of traditional conflict management mechanisms
Source: Based on Figure 5

5.2.2. Constitutional Mechanisms

Article 9:1 of the 1995 FDRE Constitutions states that the Constitution is the supreme law of the land and any law, customary practice or a decision of an organ of state or a public official which contravenes this Constitution shall be of no effect. On the other hand, Article 34:4 recognises marriages concluded under religious or customary laws; and adjudication of disputes relating to personal and family laws in accordance with religious or customary laws. More significantly, the Constitution mandates the House of Peoples' Representatives and Regional State Councils to enact laws that establish or give official recognition to religious and customary courts (Article 34:5).

In order to meet its Constitutional mandate of delivering peace and security, the Government established several institution including the Ministry of Peace, which many have proclaimed as being the first of its kind in Africa (Ura, K. et.al., 2023); Ethiopia Human Rights Commission; the Institute of the Ombudsman; Ethiopian Reconciliation Commission; Administrative Boundary and Identity Issues Commission; the Ethiopian National Dialogue Commission (ENDC), and others.

One of the problems of establishing a plethora of institutions is that sometimes there is no clear boundary between them either in the eyes of the public or critical observers. New institutions are established in haste without clarity on the status of the previously established institutions. This situation prompted Metekia (2025) of the Institute of Security Studies (ISS) to ponder "*Ethiopia's national dialogue and transitional justice: competition or complementarity*?". Although Metekia is optimistic that the dual peacebuilding processes are equally important and can run simultaneously through coordination and sequencing, he acknowledges that from the outset, tensions have surrounded the coexistence of these two processes, with stakeholders expressing concern that one may steal the spotlight or undermine the urgency and relevance of the other. Transitional justice actors feared the national dialogue would monopolise institutional and political attention. Proponents of Ethiopian National Dialogue Commission (ENDC) viewed the transitional justice, with its rapid process and victim-centred agenda, as potentially polarising and ill-timed. In my view, such an open dialogue between rival institutions is unprecedented and is to be encouraged but consensus has to be reached as which takes precedence.

The ENDC is the most active at the time of writing. It is established based on lessons drawn from the South Africa Truth and Reconciliation Commission (1995); and Rwanda National Unity and Reconciliation Commission (1999). Both were established immediately following the end of their respective domestic predicaments – end of apartheid in South Africa and genocide in Rwanda. Their legal basis were the interim or transitional constitutions and peace accords (see Table 2). Ethiopia on the other hand delayed the process for almost thirty years after the end of the civil war that obliterated the entire northern part of the country and was about to ingulf the entire nation before the TPLF led coalition took over. The Transitional Charter should have triggered the process of reconciliation. That was a missed opportunity!

But it is never too late! As per its mandate outlined in Proclamation No.1265/2021, the ENDC has completed agenda collection and 4000 delegates have converged on Addis Ababa to deliberated on the agendas and reach consensus on behalf of the Ethiopian people. Eight major agendas (see Figure 7) with 80-90 sub-agendas were identified. Some of the issues raised in this paper have been captured by the agendas. For example, nation-building and diversity management (Sub-agenda 1.4); constitutional interpretation and amendment procedures (sub-agenda 2.1.8 and 2.1.9); Addis Ababa and Dire Dawa issues (Agenda 3); religious affairs (Agenda Item 4) and root causes of conflict; traditional conflict resolution mechanisms (Sub-agenda 8.1, 8.3 and 8.4). Ideally, such processes should take place under relatively

stable political environment, not while conflict is raging here and there which has led to claims and counterclaims of inclusion/exclusion.



Figure 6: Major Agendas of the National Dialogue[18]

Source: https://ethiondc.org.et/en/major-agenda-pillars/ (accessed 13.07.26)

[18] Key: Agenda 1 (Nation building); Agenda 2 (Government structure, political system, representation and elections); Agenda 3 (Federal cities - Addis Ababa and Dire Dawa); Agenda 4 (Religious affairs, historical grievances and reconciliation); Agenda 5 (Institution building, rule of law and human rights); Agenda 6 (Social, economic, farmers and pastoralists affairs); Agenda 7 (Corruption and good governance); and Agenda 8 (Peace building).

Table 2: Ethiopia's National Dialogue Commission: Comparison with South Africa and Rwanda

Dimension	Ethiopia	South Africa	Rwanda
Name	National Dialogue Commission (NDC)	Truth and Reconciliation Commission (TRC)	National Unity and Reconciliation Commission (NURC)
Legal basis	Proclamation No.1265/2021	Interim Constitution of 1993 (Act No. 200 of 1993); National Unity and Reconciliation Act (Act No. 34 of 1995)	The Arusha Peace Accords (1993); Law No 03/99 of 12/03/1999
Year Established	2021	1995	1999
Focus	Diversity, Identify, Political Pluralism	Truth, Justice, Reconciliation	Unity, Reconciliation, Nation-building
Justice Model	Dialogue-based	Restorative justice	Retributive and restorative justice
Consultation model	Managed/guided/facilitated consultations	Extensive public hearings	Community participation
Amnesty	No	Yes (conditional)	No
Judicial Function	No	Partial	Separate courts handled prosecutions
Main Outcome	Inclusive and transparent dialogue; complete documentation of the process and outcome of the dialogue	Peaceful democratic transition	Long-term national stability and reconciliation
Exit strategy	Finalise consultation; document and report to HPR; support the implementation of the recommendations. However, the official mandate expires in Oct, 2026	Completed investigation of human rights violations during apartheid in 2003; there is a TRC Unit within is the Department of Justice to deal with outstanding reparations.	The Ministry of National Unity and Civic Engagement evolved from the original National Unity and Reconciliation Commission (NURC)

By way of summary, Ethiopia has sufficient traditional and constitutional mechanisms to prevent conflict and build lasting peace. What is required is to create a new mindset - from conflict resolution to prevention; from top own to bottom up approach to peace building. This is where we turn our attention to.

5.2.3. The Case for a Hybrid Peace Process

Prof. Mesfin Woldemariam ended his prophecy by reminding us that Ethiopians have strong tradition of *irq* (conciliation). In this paper, I have shown that these traditions still exist and functional but their effectiveness and capability to operate at scale (beyond individual/family and community) has been questioned. On the government side, despite putting in place various constitutional mechanisms including establishment of a Ministry for Peace, the much needed peace and security is yet to be delivered.

The traditional mechanisms enjoyed centuries of respect and acceptance because of social capital (Ali, 2012) which as society modernises, traditional institutions either have to adapt to the changing environment or left behind.[19] We have also seen that the majority of traditional mechanisms focus on conflict resolution – after the damage is done – and the constitutional mechanisms are generally top down; established when the government wants them; abolished when the government does not want them; regardless of their success or failure.

The 23rd anniversary of Prof. Mesfin's prophecy is a historic opportunity to rethink our approach to conflict management – shift from conflict resolution to prevention; from top down to bottom up. The goal should not be only to solve immediate problems but institutionalise sustainable peace. There is a need for a Hybrid Peace Process (HPP) that is rooted in traditional mechanisms and values and has constitutional backing as illustrated in Figure 8.

There are several cases when elders (men and women) and religious leaders took the initiative to resolve conflict but were rebuffed by one side or the other. There are also times when these elders were invited by one side of the conflict but rejected by the other (Gardner, 2024). As reported in Addis Standard (18 July 2025),[20] the Prime

[19] In a separate research, the author asked survey participants what would be the fate of traditional institutions in a transformed Ethiopia, 52% (n=89) said some traditional institutions will adapt others will wither; 44% said all traditional institutions will adapt to the changing environment (see Teshome, forthcoming) .

[20] https://addisstandard.com/pm-abiy-tells-religious-leaders-stakeholders-to-act-now-to-prevent-war-in-tigray-warns-it-will-be-worthless-after-conflict-begins/

Minister, Abiy Ahmed, called on religious leaders and elders "to act now to prevent war in Tigray and warns it will be too late after conflict begins". He held discussion with the elders after their visit to Tigray and described the talks as fruitful.

On 30 July 2025, Fana Broadcasting Corporation reported that the elders group also held discussion with the Ministry of Peace which praised the initiative and emphasised that the government has taken steps to ensure economic and social development activities in the region.[21] These two examples indicate the government's openness to the use of traditional mechanism to resolve conflict.

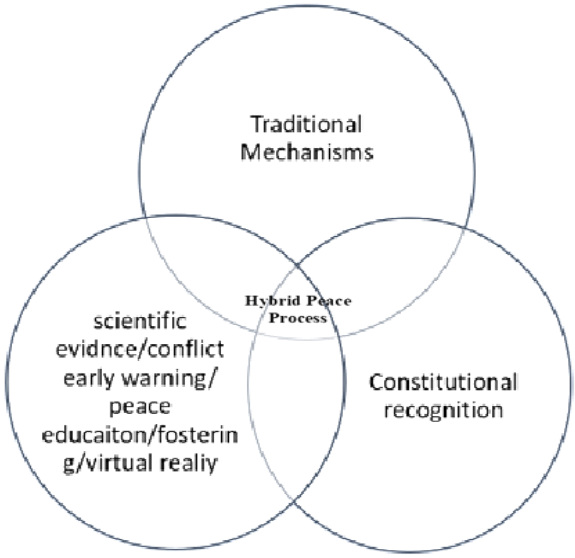


Figure 7: A simple model for formalised Hybrid Peace Process

There were also examples of the Government not as receptive to initiatives by elders. Gardner (2024:198) reported that a delegation of Oromo leaders and activists came to Addis Ababa and camped in the grounds of the palace in the hope of getting an audience with the Prime Minister but they were "rebuffed". A similar attempts by the Council of Abba Gadda to engage in dialogue with the government "hit a brick wall". Gardner (2024:153) also reported that at the peak of the Gedeo-Guji conflict, there were strings of petitions and desperate pilgrimages made by Gedeo elders and activists to the regional and central governments but failed to get an audience.

[21] https://www.fanamc.com/english/elders-who-visited-tigray-in-response-to-pm-abiys-peace-call-hold-talks-with-ministry-of-peace/?utm_source=chatgpt.com (accessed 03.11.25)

These cases may give the impression that the proposed HPP may not succeed where others have failed. One should not despair! Prof. Mesfin never despaired! The Constitution gives some recognition to traditional mechanisms and has mandated the federal parliament and regional councils to enact laws that establish or give official recognition to religious and customary courts. The proposed HPP will have *constitutional backing*, will be *non-executive* and *non-partisan*. Either side of the conflict will have no grounds to rebuff it!

The HPP will be supported by local peace education initiatives and an independent secretariat that will provide the necessary technical back up. The data and information (print, audio, video, pictures) collected by the ENDC will be an invaluable resource for the HPP and should be documented and handed over.

It is now clear from this review and others that the traditional media (state, private, social media) are insufficient to bring about lasting peace mainly because of their dual role - positive and negative. What is required is going beyond celebrating diversity and creating an environment in which one ethnic group immerses itself in another culture to see for itself and unlearn the misinformation, disinformation and the hate speech it has been listening to about others. Two instruments have recently evolved to create such an environment.

Foster Family Initiative, pioneered by Gonder University in collaboration with Gondar City Administration, is a scheme whereby first year students from various parts of the country are voluntarily allocated to families in and around the City of Gonder. By interacting with cultures outside of their own, students unlearn the misinformation, disinformation and hate speech they have been listening to before joining the university. The scheme is in the process of being scaled up to the rest of public universities.[22]

Virtual Reality technologies are environments in which we can immerse ourselves in a real situation without actually being there. This artificial intelligence based technology evolved over a long time first in a form games and military applications and then scaled up to a variety of economic and social environments. Its use in peace promotion is a recent phenomenon (Hasler, et.al. 2021). In Ethiopia, US Embassy introduced it as an initiative to encourage youth in peacebuilding allowing them to *immerse* themselves into a given culture (without actually being there). It is early

[22] Based on https://uog.edu.et/gondar-family-project/, an interview with the Project Coordinator and a PowerPoint Presentation prepared for national experience sharing (University of Gondar, 2024/25).

days but there are indications that it can be the most effective way of combating misinformation, disinformation and hate speech (Tezera, 2026).

5.3. State Capture Concerns

State capture is a major concern in any attempt to use traditional mechanisms for conflict prevention and resolution; and Ethiopia is no exception. A study on the interplay between the traditional dispute resolution institutions and the formal justice system in Arsi of Ethiopia (Roba, 2024) found that there is a "shared interest" in some cases; and "competition" in other cases between the two systems. More importantly, there is mutual recognition which is an opportunity for the traditional systems to maintain their influence and relevance.

However, one should not be complacent. Examples cited from Kenya, Rwanda and Uganda indicate that affiliation with government, political party or religious organisations can influence traditional conflict resolution structures positively or negatively. This also brings to the fore the age-old debate about 'autonomy' or 'independence'. If they choose to be 'autonomous', by definition, traditional structures should have the internal capacity for self-governance and act according to their own rules, even while relying on others. If they choose to be 'independent', again by definition, they should be able to act without needing or accepting help, resources, or supervision from others. While state capture (or capture by other entities) is present, that should not deter the advocates from creating innovative ways of helping traditional conflict prevention to continue to be relevant.

6. Conclusions and Call to Action

The Ethiopian people have suffered an extraordinary level of conflict and violence despite having a rich traditional conflict management structures. These systems focus on resolving conflicts – after the damage is done – rather than proactively preventing conflict. More worryingly, when they tried to prevent or resolve conflict, their efforts have been undermined by one side of the conflict or the other because they do not have legal backing. The country also has a variety of formal institutions with a mission to identify and address the causes of conflict. However, these efforts have largely been top down; and their mandates have been overlapping.

In view of these, a genuinely bottom up process that intentionally works on conflict prevention and peace building is required. A Hybrid Peace Process that has constitutional recognition but no executive power or political affiliation is proposed. It will be built from ground up and have a legally established Permanent Secretariat

that is autonomous, multi-disciplinary and operates more like a think tank than a bureaucratic institution. The Hybrid Process will be supported by peace education at all levels. Establishing the Process is only the start. In order to make it effective, the following measures should be taken:

- Harmonise constitutional instruments/mechanisms for expressing aspirations. These include but are not limited to anthems and flags. All children should be proud of their roots but have a common/national vision.
- Mainstream peace education into the curriculum. Establishing peace clubs at secondary schools and universities is fine but the peace movement should start from early childhood, primary in particular.
- Coaching and mentoring should be an integral part of peace education.
- The national dialogue process has generated unprecedented (perhaps equivalent to Derg's Institute for the Study of Ethiopian Nationalities) amount information on peace and development issues. These must be documented and the dialogue process evaluated to form the knowledge base for developing peace education curriculum and promoting the peace-development nexus.
- Monitor contributions to Goal 16 of the Sustainable Development Goals which is about promoting peaceful and inclusive societies, providing access to justice for all and building effective, accountable and inclusive institutions at all levels. People everywhere should be free of fear from all forms of violence and feel safe as they go about their lives whatever their ethnicity, faith or language.
- All media outlets should establish a common platform where they evaluate their own contribution to peacebuilding on a regular basis.
- Finally, all key recommendations from the national dialogue should be ratified by the people of Ethiopia, going as far as a referendum, depending on the weight of the recommendations.

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The Essence of Transformation in Ethiopia: An Exploratory Research

Amdissa Teshome[1]

Abstract

Ethiopia has been implementing policies and strategies aimed at ending poverty and transforming the economy since the early 1990s. As a result, growth rates of at least 10 percent were recorded 10 years prior to Covid-19. However, the essence of ***transformation*** *is not clear and the concept is used rather loosely (often casually) in policy documents and public discourse. The research aims to contribute to deeper debate on economic and social transformation. Expert opinions were solicited using an electronic Google form complemented by comprehensive desk review of transformation research over the last 30 years.*

The findings suggest that perception of economic transformation is more or less in line with the classic definition of moving labour from low productive agriculture to manufacturing/industry with emphasis on poverty reduction, women empowerment and livelihood improvement. This clearly indicated the imperativeness of social transformation.

Surprisingly, the importance given to regional integration/ interdependence was rather weak. The majority indicated that Ethiopia is either less dependent on its neighbours or can transform irrespective of what is happening there. Ethiopia's transformation readiness, as measured by respondents scoring of transformation indicators, is also found to be low.

Benchmark countries for Ethiopia were identified and the top five are South Korea, Vietnam, China, Rwanda and Singapore. This is a major shift for a country that had been obsessed with Japanese for decades.
In order to deepen the dialogue on transformation, it is recommended that the government formulate a 25-30 year Transformation Roadmap; and the Alliance of Professional Associations should advance the transformation agenda and support the government's transformation roadmap.

Key words: transformation, economic, social, indicators, Eurocentric, transformation index.

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1. Introduction

1.1. Rationale and objective

Ethiopia has been registering growth rates at an average 10 percent[2] ten years prior to COVID-19 and as a result cut poverty rates to less than 25 percent in 2016 (Dirba and Man, 2019). However, multidimensional poverty, a broader measure of well-being encompassing income, education and health, has increased from 68 percent in 2019 to 72 percent in 2024 (World Bank, 2025).

The growth rates achieved pre-COVID-19 have been endorsed by development partners who attributed them to public sector investment in infrastructure. The government has indeed implemented policies and strategies aimed at ending poverty and transforming the economy.[3] The most recent initiatives such as the *Lemat Tirufat, cluster farming and the Green Legacy* are all geared towards transforming agriculture and the food system. However, the essence of ***transformation*** as used in policy documents and policy dialogue forums is not deep enough; past and present research on transformation are not holistic enough focusing only change in economic structure and almost entirely neglecting social transformation perhaps under the presumption that social transformation will follow economic transformation.

The broad aim of the research is to deepen the debate on transformation. The specific objectives are to (i) explore how economic and social transformation are perceived; (ii) identify enablers and obstacles to economic and social transformation; (iii) solicit strategies to overcome the obstacles; and (iv) introduce the concept of 'transformation index' and make a preliminary calculation for Ethiopia.

1.2. Challenges and limitations

Administering online surveys is very challenging. First, the target audiences' access and familiarity with the online tool; change of email addresses, protection mechanism built into institutional emails, have affected the timeliness of the response.[4]

[2] I personally do not like the expression 'double digit' as this can be anywhere between 10 and 99. Politicians can be forgiven for using it as a mobilising phrase but experts should, wherever possible, use percentages or ranges.

[3] For a comprehensive review of government policies and strategies in highland and low land pastoral areas, see Chanyalew (2017).

[4] Having said this, I would like to thank all my respondents for enduring overcoming the challenges. Even those who were unable to submit their responses were supportive of the research and encouraged me to tackle the transformation agenda which they felt is timely.

Second, as an exploratory research, the conclusions and recommendations should be treated with caution. A larger sample is also required to do disaggregated analysis. Having said this, the research process and indicators of transformation are replicable and a foundation for a larger survey has been formed.

1.3. Features of the research and methodology

This is a *real time, exploratory research* based on *perception*. It is *real time* in the sense that the first response was received on 08 December 2025 and the survey was closed a day before the presentation on July 18, 2026. *Exploratory research* is one of three typologies of research[5] used to investigate a problem that has not yet been clearly defined; or look for a better understanding of existing problems and provide indicative but not necessarily conclusive results which can then form the basis for formulating specific research questions or hypotheses to conduct an in-depth research. Although research in transformation is not new, most past and present research focus on sectoral transformation (for example, agriculture, manufacturing). Very few, if any, have investigated transformation in a holistic manner and the social dimension in particular has not been addressed.

What is perception surveys? Perception survey assess what respondents believe, think or feel about the issues under investigation (in the present case, Ethiopia's transformation) based on their existing knowledge and experience. There is no direct measurement of the variables under investigation (for example, productivity). Perception surveys have been commonly used in many countries – both developed and developing – and by donors and international development agencies since at the 1980s (Hilker & Kangas 2011 cited in Herbert, 2013). For example, the Pew Research Center[6], extensively uses perception surveys and public opinion polling to understand social issues, trends, and views. The EEA frequently uses perception surveys of its members about national development issues and its own performance (EEA, 2025; EEA, 2024; Goshu, et. al., 2024). The World Bank (2023) used perception survey to monitor the effects of Home Grown Economic Reforms. The Demographic and Health Survey commonly asks respondents how they perceive their economic and health status.

How was the sample selected? The sample of experts for the study were selected purposely but systematically (non-probabilistic) for their professional journey in the

[5] The other two typologies are experimental and hypothesis testing (Phillips and Pugh, 1987).
[6] See https://www.pewresearch.org/about/

transformation process. First, a list of participants in various networks or platforms was compiled (see Figure 1). The networks or platforms included humanitarian, food security/PSNP, social protection, and mechanization. In order to increase inclusivity, 'development veterans' outside networks or not in active service were also sought to get their insights. Attempts were also made to identify and reach out to people in policy circles, with limited success. Based on this, about 500 potential respondents received an invitation to participate in the survey.

Second, the survey tool was developed using Google Form, piloted and distributed to 160 who expressed interest of which 89 responded which is the effective sample size. This represented 11.6 percent of the invitees and 55 percent of those who expressed interest. According to Graglia (*n.d*), for an online survey such as this, a "good" survey response rate is between 10 percent and 30 percent of those invited to the survey which is an indication that the current research meets the standard of sampling. However, where the sample size is not a multiple of 100, it is recommended to minimise the use of percentages when reporting numerical data. Where necessary, they should be accompanied by absolute numbers (frequencies). Researchers are also advised not to generalise to the entire population.

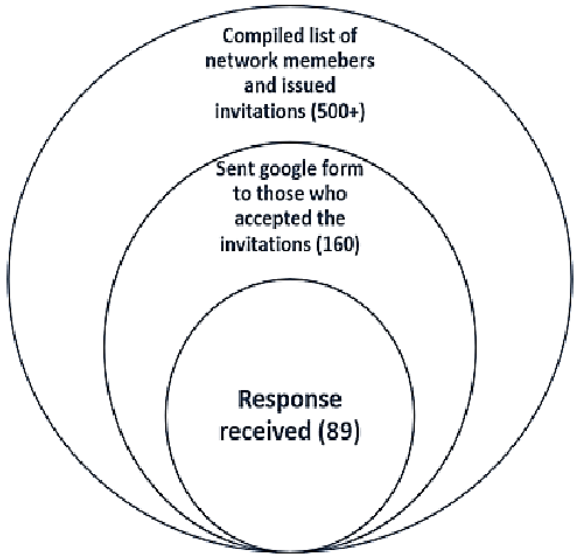


Figure 1: Sample selection process

A mix of open ended and closed questions were used. On issues like perception of economic and social transformation, enablers and obstacles to transformation, open-ended questions with "Ethiopian context" were asked. Multiple choice and multiple

choice grids were used as closed questions. A total of 19 indicators (9 for economic, 6 for social and 4 for Eurocentric) were derived from review of literature and respondents scored their perception using the conventional Likert scale. Figure 2 shows the three dimensions of transformation with the broad indicators. Annex 1 gives the full description of the indicators.

The survey results were analysed using simple arithmetic descriptions and the text was analysed using Word Cloud/Word Stat that made tallying of key words and phrases used by respondents.

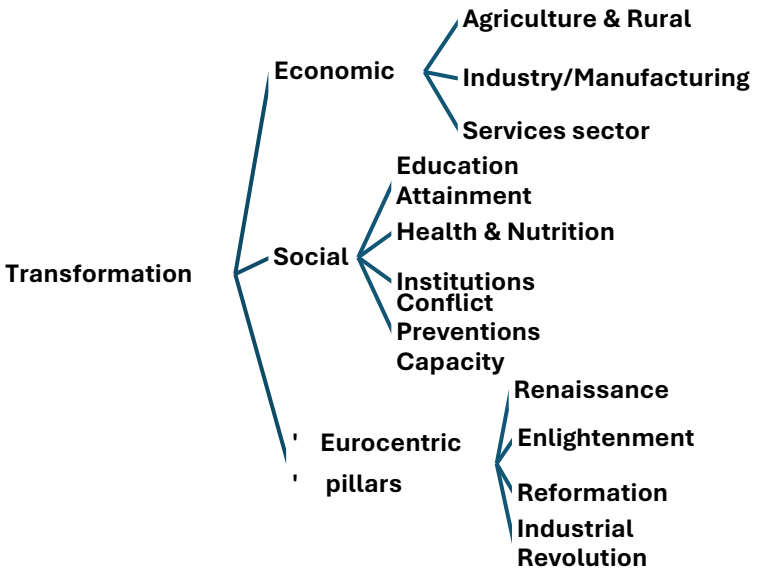


Figure 2: Dimensions of transformation

2. Review of the Literature

2.1 What is transformation?

In simple terms, transformation is change and there are different types and drivers of change (Price, 2009) but not always easy to measure. Growth, the rate at which something expands (for example, physically), is a widely understood concept and relatively easy to measure. Economic growth which is measured by the gross domestic product (GDP) has been subjected to several criticisms because it neglects distributional issues and undercounting of informal, especially domestic, activities (Boot, 2026).

Of transformation, there is no single straightforward definition – there are plenty. An important feature is that transformation should be an all-encompassing and multi-dimensional. For example, ECA (2019) defines transformation as a fundamental reconfiguration of how a society produces and distributes wealth, governs itself, organizes social relations, thinks, behaves, and adapts. It is a deep, systemic, generational and irreversible change. McMillan et al. (2017) cited in Lemma (2021) define economic transformation, as 'the continuous process of (a) moving labour and other resources from lower- to higher-productivity sectors (structural change) and (b) raising within-sector productivity growth'.

Many African economies, including Ethiopia, have registered growth but not yet exhibited such a comprehensive transformative characteristics. According to the African Center for Economic Transformation (ACET, 2025), economic growth alone is not sufficient to address Africa's long-term sustainable development challenges because African growth is driven mainly by extractives and primary commodity exports, it is vulnerable to external shocks, does not create enough decent jobs, and has little to no impact on human well-being. This conclusion is also in line with the Ethiopian Governments' assessment that Ethiopia's long term growth lacked "quality" which was the foundation for the Ten Year Development Plan (TYPD).

ACET defines economic transformation as "Growth with DEPTH" which stands for *diversification*, *export* competitiveness, *productivity*, *technology* upgrading and *human well-being*. Bertelsmann Stiftung's Transformation Index (BTI, 2008, 2024) focuses on political economic and governance transformation. Based on a review of six countries[7] that have undergone economic transformation, Lemma (2021:2-3) presents three broad categories of factors: *triggers*, *enablers* and *policy environment*. The triggers are events that kick-start the transformative process such as internal and external shocks, and deliberate plans to transform. Enablers are the factors that sustain the transformative process and include but are not limited to strong government; capable civil servants, private sector engagement; and labour supply, cost and skills. Finally, conducive policies shape the transformative process.: Such categorization helps to identify and prioritise the most strategic interventions that have the potential to solve multiple problems. The "Bullseye" metaphor has recently been adopted to capture this essence (Balfour, 2014; Zandee, 2024).

[7] The countries are China, South Korea, Vietnam , Bangladesh, Mauritius and Sri Lanka. The first thee have been identified by the respondents of this research as model for Ethiopia (see Sectio 3.5).

2.2 Ethiopia's transform journey

Ethiopia's desire to transform began with Emperor Haileselassie's introduction of 'constitutional monarchy' in 1931 replacing the religious and traditional governance system of *Kebre Negest* (the Glory of the Kings) and *Feteha Negest* (the Law of Kings). Although the Emperor wanted to emulate the British or the Japanese Constitutional Monarchy, He did not go far enough. Instead, He consolidated his power rather than promoting democratic and merit-based institutions. This was perhaps the first seed of transformation that was never nurtured.

With the emergence of reformist intellectuals, the desire to transform gathered momentum. Kebede Michael, a prominent Ethiopian intellectual, is remembered for pioneering academic cooperation between Ethiopia and Japan in the 20th century. His book, "ጃፓን እንደምን ሰለጠነች" (How did Japan Civilise?), written in 1955, stands out as a reflection of his admiration for Japan's modernization model and vision for Ethiopia's development (Tran, et.al., 2025).

In *Pioneers of Change,* Bahru Zewde documented the efforts (successes and challenges) of intellectuals who came to the scene in the 1940s following the end of Italian occupation, and logically, focused on rebuilding the administration and exploring social, economic, and political changes.

The 1960s and 1970s were the times of students movement and armed rebellion demanding economic, social, and structural transformation. The 1974 revolution was a response to this pressure and fulfilled the long standing dream of "*land to the tiller*", severing the tenant-landlord exploitative relationship once and for all – it was irreversible![8] This was perhaps the second seed of transformation that was not supported by appropriate policies and strategies to bring about deeper rural transformation. The land debate still continues unabated!

Bekele (2019:31) reviewed 70 years of Imperial Ethiopia (1890s-1960s) and concluded that the economy underwent a fundamental mutation from plough-based agriculture and traditional crafts to boasting several modern sectors such as

[8] Bahru Zewde makes a comparison of the Ethiopian revolution with its predecessors such as the French, Russian and Chinese revolutions and finds that it is with the French and Russian revolutions that the Ethiopian experience has the closest parallels (Zewde, 2017). Like them, it did away with centuries old feudal system and the most famous dynasty of all 'the Solomon Dynasty'. However, resemblance with the French ends there. The French distributed/sold the land to individuals who invested on it and became capitalists. Ethiopia replaced the landlords with the state leaving the individual farmers at the mercy of it.

infrastructure, services, manufacturing and finance. In finance, Ethiopia went from bartering to where money became the main medium of exchange.

Clapham (2019) covered the imperial to EPRDF period and observed that Ethiopia is in many ways an outlier in exhibiting elements of both the sub-Saharan African countries and the rapidly developing Asian countries from which it has recently drawn inspiration. Ethiopia is crafting a response to the demands of development that draws on experience elsewhere while also trying to address internal situations that have been deeply problematic in some ways and positive in others. In the end, Clapham paints a grim picture that the underlying issues that have historically shaped Ethiopia's political economy remain unresolved and may take a long time to resolve.[9]

In the 1990s, researchers were sceptical of large increases in productivity and production given land constraints, ineffective agricultural extension, and weak input supply system. However, they ave become increasingly optimistic due to the dramatic investments in infrastructure, industrial parks and agricultural development (Dorosh and Minten, 2020; Schmidt, et.al. 2018; Dorosh and Rashid, 2012).
With regard to labour movement, in the late 1990s, rural urban migration was restricted by the tenue system that required small holders not to leave their land or lose it (Chamberlin and Schimidt, 2012:46-7). Those who migrated were youth with little or no access to land. What has become increasingly worrying for most researchers is the direction of labour movement which is not following the conventional/classic route - excess labour moving from agriculture to industry/manufacturing. They are moving to the service sector (Dorosh and Minten, 2020:9).

Several of EEA publications have covered transformation, including but not limited to, Annual Reports (EEA, 2015, 2016); Working Papers (Diriba, 2020); and Ethiopian Journal of Economics (Adem and Mehari, 2023). The 2015 Annual Report reviewed the theoretical underpinning of Ethiopia's structural transformation and concluded that despite achieving high rates of economic growth and capital accumulation driven by public investment, Ethiopia is, at best, at the preparatory stage of structural transformation. The shift of economic activities (and labour) from low productivity sectors to high productivity sectors remains far from a reality.

[9] Clapham actually says the problems "may never be resolved" (Clapham, 2019:xx). I am being more optimistic.

Interestingly, this position has not shifted in subsequent publications (EEA, 2021, 2022).

Wrako, et.al., (2019) conducted research on productivity and financing of commercial farms and manufacturing firms and found that the farms suffered from multiple challenges that affected their performance, profitability and sustainability let alone be a vehicle for transformation. The manufacturing sector also faced numerous challenges relating to workers' mindset, quality problems, policy and labour law, and logistics bottlenecks. As a result, firm productivity was far below the benchmark countries such as Kenya, China, Indonesia and Malaysia. Ethiopia's productivity was higher than Vietnam until the first decade of 21st Century but has fallen behind since then (PSI, 2020).

Development partners also formulate their own opinions based on evidence generated internally as well as externally (AfDB, 2026; UNDP, 2022; World Bank, 2022). For example, according to the World Bank (2022), over the past decade, economic growth in Ethiopia was driven by capital accumulation, while total factor productivity did not increase, and structural transformation was limited. Similarly, the AfDB (2026) concluded that despite recording average real GDP growth of about 7.2 percent between 2022 and 2024, the shift of labour from agriculture into industry, widely regarded as a central feature of structural transformation, has been slow at best. These snapshots of the transformation literature indicate that Ethiopia is a long way from 'deep transformation'.

Having said all these, the research on transformation has certain limitations. First, it is limited in scope largely dominated by measuring structural shift (from agriculture to manufacturing/industry) but 'social transformation' is hardly researched. Second, the theories and philosophies that shaped transformation in Europe, Japan and North America are completely ignored presuming that they are not suited to the Ethiopian context. This has led to the casual use of concepts like renaissance, industrialisation and transformation without deeper understanding of what they entail.[10] Although we cannot transplant these theories into Ethiopian society, we can adapt them like many countries such as Japan did. The theories were developed for humanity not for Europeans or Americans or Japanese in the same way Socrates, Adam Smith, and Karl Marx developed their philosophies and theories for humanity.

[10] For an explanation of the use and misuse of the concept of transformation in Ethiopia, see Chanyalew (2017: 189-194). The author also documented the difference between the English and Amharic versions of policy documents in the way they transformation is used.

In his seminal work "Identify and Violence", Sen (2006) argued that there is no such thing as western civilisation or theory. Every society thinks for itself as it develops and transforms through time. What the west or the west did is formalising the knowledge – experiment, implement and document for wider use. He makes the point that in India, *Buddha* stands for enlightenment. There is no doubt in my mind that within Ethiopian society there are similar thoughts and theories that can guide us if only were are openminded and looked in the right places. I leave it to future researchers to dig further.

In a nutshell, seeds of transformation have been planted well before the current policies and strategies. It is not something that comes after development. It is not "development plus change in something" as pondered by Chanyalew (2017:191). It is an ongoing continuous process (see Figure 3).

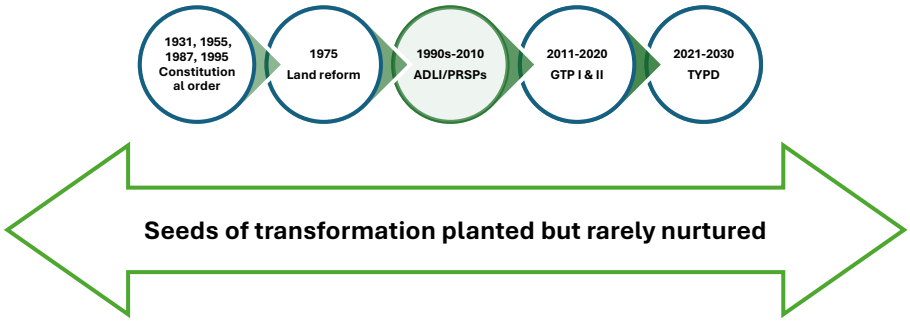


Figure 3: Transformation as a continuous process

3. Findings and Discussion

3.1 Respondents Profile

As indicated earlier, of the 160 who expressed willingness to participate in the survey, 89 responded. Public sector employees of various responsibilities (experts, directors, advisors and people in policy circles) accounted for 26 percent (21/89). The private sector (self-employed/entrepreneurs) made up 25 percent. Women respondents accounted for 15 percent (11/89). Geographically, the respondent were divided into two broad categories. Those within Ethiopia accounted for 92.0 percent (73/89), of which 77 percent (61/89) were in Addis Ababa and 15 percent from across the regional states. The remaining 8.0 percent were from outside.

3.2 Perceptions

Respondents were asked to describe economic and social transformation in the context of Ethiopia. The context was important to prevent respondents from giving generic text book definitions. The responses were summarised by distilling powerful concepts from the descriptions using Word Cloud.[11] Respondents used both the classic and contextual concepts. The classic concepts such as shift/change; low productivity, agriculture, industry/manufacturing and agro-processing feature strongly. The contextual terminologies used included, but are not limited to, livelihoods, attitude/skills, population, and policy. The key takeaway from this is that powerful terminologies we use or don't use in our communication can influence policy making and the resulting policy documents. Sample definitions are given in Box 1.

Box 1: Examples of perceptions

"..... For me, economic transformation in Ethiopia would imply a long-run shift [from] low productive and traditional rural (agricultural) economy into a more productive modern economy of industry and service, driven usually by reallocation of resources using technology and innovation." (#5)

" social transformation is about change (shift) in societal and institutional structure in the long run. This, in the Ethiopian context, would imply the shift from traditional (usually growth-hindering) rules, norms and values, and bureaucratic and inefficient institutions to modern societal values, technology-based productions and efficient institutions". (#5)

Whereas most respondents expressed their aspirations of Ethiopia's future transformation, some expressed the reality on the ground. For example,

"I would describe it [Ethiopia's economic transformation] *as movement of labour from less productive small scale agriculture to less paying/less remunerative (informal) manufacturing and service sector." (#88)*

[Ethiopia's social transformation is] *"Changes in institutions and introduction of innovative policies without strong human capital." (#88)*

[11] Before submitting the text to Word Cloud for analysis, the author cleaned words that are less powerful (for example, articles and conjunctions) and joined some words that go together using a hyphen (for example, less-developed). This is equivalent data cleaning in quantitative research.

3.3 Enablers, Hindrances and Strategies for Economic and Social Transformation

Respondents were asked to provide enablers and hindrances to economic and social transformation. Table 1 summarises the factors the enable and hinder transformation and strategies for overcoming the hinderances. Prominent enablers of economic transformation are infrastructure and energy expansion that include roads, rails, the desire to access to ports, and investment in various energy sources. Human-capital and demographic dividend[12] are also considered an enabling factors complemented by skills development. The third, important factor is private sector development. Here the dilemma is that on the one hand there is call for increased public sector investment which logically pushes out the private sector. The more appropriate enabler is therefore public-private partnership where the two negotiate who invests in what and who delivers what.

Among the hindrances are weak institutions, political instability/conflict/ethnic politics; poverty/inequality (including gender); unemployment and poor education.

Following a similar procedure, strategies for leveraging the enablers and tackling the hindrances are also identified. For economic transformation, as might be expected, modernising agriculture, market development/ enabling business environment for private sector development, and enhancing productivity/value-addition are of paramount importance. For social transformation, building social cohesion, social capital, expanding social protection and social security are pertinent.

Applying the bullseye framework, factors that are central to the transformation process occupy the top of the table and those in the periphery are listed in the bottom half of the table. These are no less important and policy makers have the opportunity to move those in the bottom to the tope or vice versa. It is not cast in stone. It is a framework for dialogue.

[12] The flip side of demographic dividend is 'demographic challenge' which was mentioned by some respondents (outliers). The speed at which the population is growing to the extent that the labour market cannot cope is indeed a demographic challenge that Ethiopia does not seem to take seriously. The population policy enacted during the transition time has not been revised. The country has not been able to conduct census since May 2007.

Table 3: Top five enablers, hindrances and strategies for transformation

Top 5 enablers	Top 5 hindrances	Top 5 strategies
Centre of the 'bullseye'		
1. Infrastructure/energy 2. Human-capital/ demographic dividend 3. Private sector development 4. Industrial parks/ industrialisation 5. Digital technology	1. Weak institutions 2. Political instability/ conflict 3. Poverty/inequality (including gender) 4. Unemployment 5. Poor education 6. Ethnic politics	1. Promote private sector development 2. Build human capital/skills 3. Build institutional capacity 4. Develop infrastructure 5. Good governance
On the periphery of the 'bullseye' still critical to the transformation process		
• Leadership • Urbanisation • Green legacy • Cluster farming • Diverse natural resources • Tourism • Strategic location • Finance/money	• Traditional norms • Corruption • Disaster risks • Landlockedness • Land policy	- Peace and security/ political stability - Manufacturing/ industrialisation - Modernise agriculture/ technology - Access to finance - Logistics

3.4 Ethiopia's Economic and Social Transformation Readiness

Although Ethiopia has been planting seeds of transformation at various stages in its history, it never nurtured them to bear the required fruit – 'deep', 'holistic' and 'irreversible' transformation. Is Ethiopia ready for this type of transformation? Respondents were presented with a grid showing the indicators of economic and social transformation (defined in Annex 1) and Likert scale ranging from 'not ready at all' to 'very high readiness'. The results are shown in Figure 4 and 5.

For economic transformation, as depicted in Figure 4, the majority of respondents, as measured by the size of the radar, indicated that Ethiopia is in 'low readiness' with respect to three key indicators, namely agricultural and industrial productivity, and high value addition. Ethiopia is 'medium ready' with respect to infrastructure and connectivity, technology adoption and sector diversification. The radars close to the centre represent 'very high readiness' and 'high readiness' implying that Ethiopia has

not yet reached this scale. These are consistent with the evidence available in the economic transformation literature.

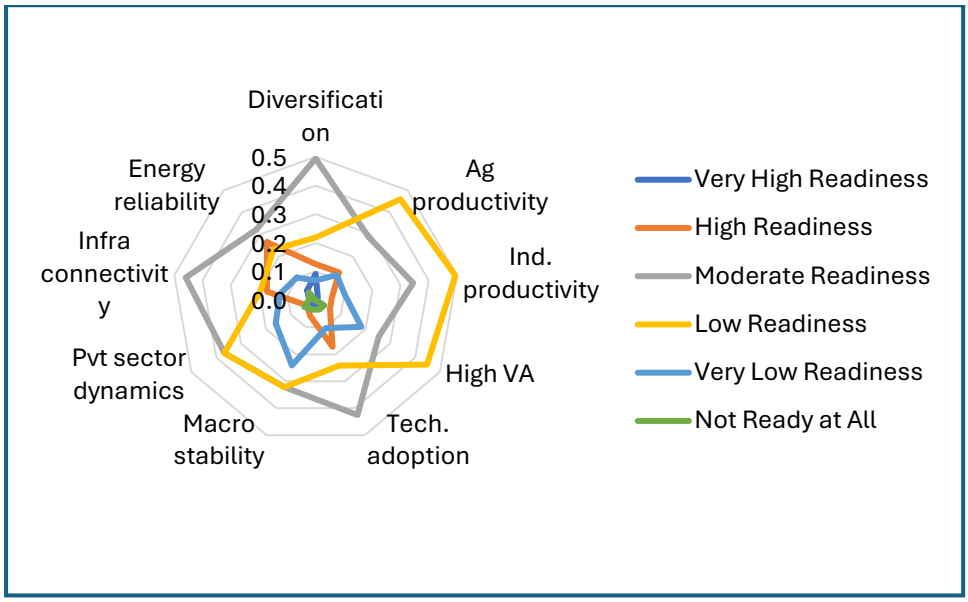


Figure 4: Ethiopia's economic transformation readiness (n=89)

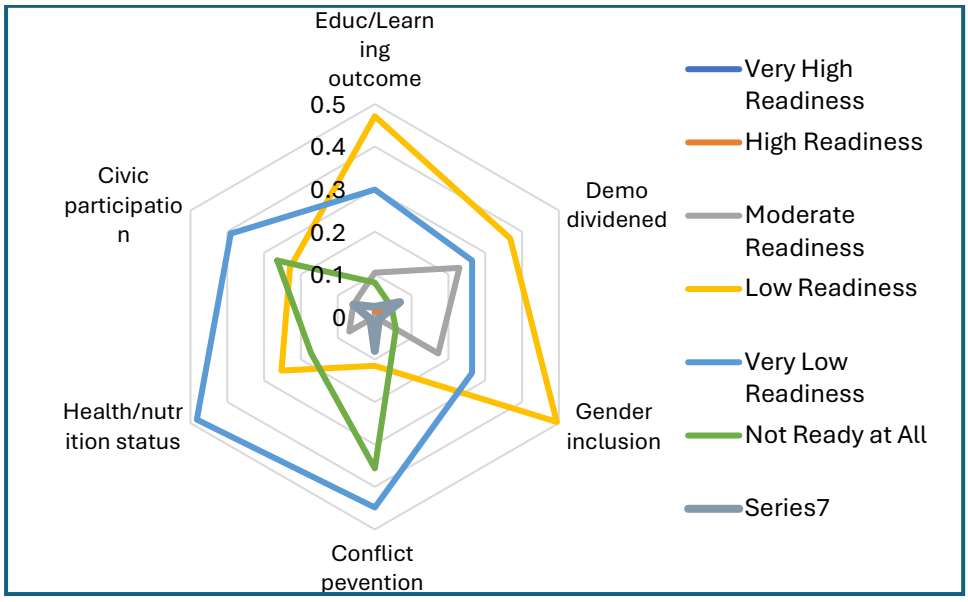


Figure 5: Ethiopia's social transformation readiness (n=*89*)

For social transformation, among the six indicators, health and nutrition status, conflict prevention, and civic participation are rated 'very low readiness'. Gender inclusion, educational outcome and demographic dividend are rated 'low readiness' (Figure 5).

Finaly, respondents were asked to rate the extent to which Ethiopia has been exhibiting the elements of the Eurocentric pillars, namely renaissance, enlightenment, reformation and industrialisation (for description of elements of these see Annex 1). Accordingly, the majority of respondents rated Ethiopia's exhibition of elements of enlightenment, industrialisation, reformation and renaissance as 'to a lesser extent' (Figure 6). Respondents had reservations about the appropriateness of these 19th century pillars to present day Ethiopia and other developing nations. For example, a respondent stated:

> *"The [Eurocentric] pillars were during the context they existed but currently, things within those pillars have significantly changed. For example, invention of internet technologies, AI, etc… and using these effectively to connect globally and learn and adapt in each of this pillar" (# 79).*



Figure 6: Appropriateness of the Eurocentric pillars (n=89)

Some respondents (for example, respondent #67) agreed with the pillars but found it difficult to judge whether or not Ethiopia's practices have been in adherence with the pillars:

> *"I agree with the pillars even though it looks difficult to judge whether or not Ethiopia's practices have been in adherence with the stated pillars. Ethiopia's practices look rudimentary and not holistic as well; and more of geared to structural reform that is not transformation intended to bring about fundamental change in strict sense. In my view a pillar that would help assess Ethiopia's readiness to transform in terms of stability, peace & security would make sense."* (#67)

A respondent expressed reservations about the relevance of one particular pillar - reformation:

> *"... Reformation is less relevant for Ethiopia, given its long-standing religious heritage and diversity, making it a limited driver of national transformation." (#10)*

These reservations notwithstanding, the philosophers that crafted these pillars did not limit themselves to European situation. They crafted them for humanity the same way Socrates, Adam Smith, and Karl Marx, to name but a few, developed their philosophies and theories for humanity and we continue to refer to them. It is up to us to adapt them to our context the same way Japan and other countries have done. In line with this, a respondent commented:

> *"The pillars are okay but need to be redefined/adapted based on the Ethiopian context." (#26)*

As a matter of fact, looking at the elements of the pillars in Annex 1, we find that several of the economic and social transformation indicators are embedded in these pillars making them relevant to the present day Ethiopia.

An overall transformation readiness is computed using simple arithmetic mean as shown in Figure 7. The mean score for economic transformation is 2.5; social transformation, 2.3 and the Eurocentric pillars scored 2.0 and overall mean is 2.3. Given that the indicators were measured using a scale of 0-5, these scores are rather on the low side.

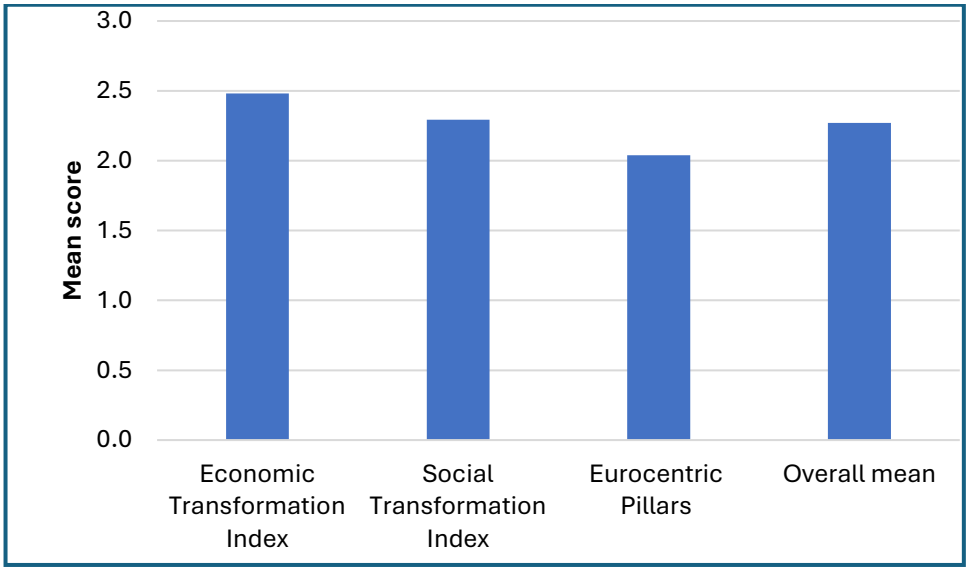


Figure 7: Overall transformation readiness (n=89)

3.5 Balancing Social and Economic Transformation

For this exercise, respondents were asked to imagine a scale and indicate if transformation efforts should lean on economic or social transformation or they should be balanced. Fifty-one percent (45/89) of the respondents indicated that economic and social transformation should be balanced whereas 33 percent (27/89) went as far as suggesting that economic transformation cannot happen without social transformation and vice versa. Only 17 percent (15/89) indicated transformation should either lean on economic or social transformation (see Figure 8).

From strategic point of this is an important issue to address. Governments often get carried away with successes in economic growth to the extent that they neglect the social dimensions (remnants of the trickledown theory). Economic growth could have negative social and environmental consequences unless mitigating measures are put in place. In the case of Ethiopia, social protection programs are implemented to mitigate against any shocks including economic growth. The safety nets and humanitarian assistance address the needs of chronic and acute food insecure in rural and urban households and the Community Based Health Insurance (CBHI) also prevents households in the informal economy, rural and urban, from the shocks of out-of-pocket health expenses. Respondents provided reasons for their positions as follows:

Box 2: Balancing social and economic transformation example responses

"Balancing economic and social transformation is essential because they are two sides of the same coin." (#77).

"Ethiopia needs both to move together to achieve sustainable transformation". (#73)

"Ideally, both are complementary and should be approached in a balanced manner. But under the current Ethiopian context (…), where conflict, ethnic polarization, … have resulted in endless and devastating cycles of conflicts, wars, and displacements … whatever economic gains are achieved cannot translate to inclusive and equitable growth of the country. In my opinion, the country has to reach a political settlement and come out of the current cycle of conflicts to make meaningful strides in economic growth and development." (#21)

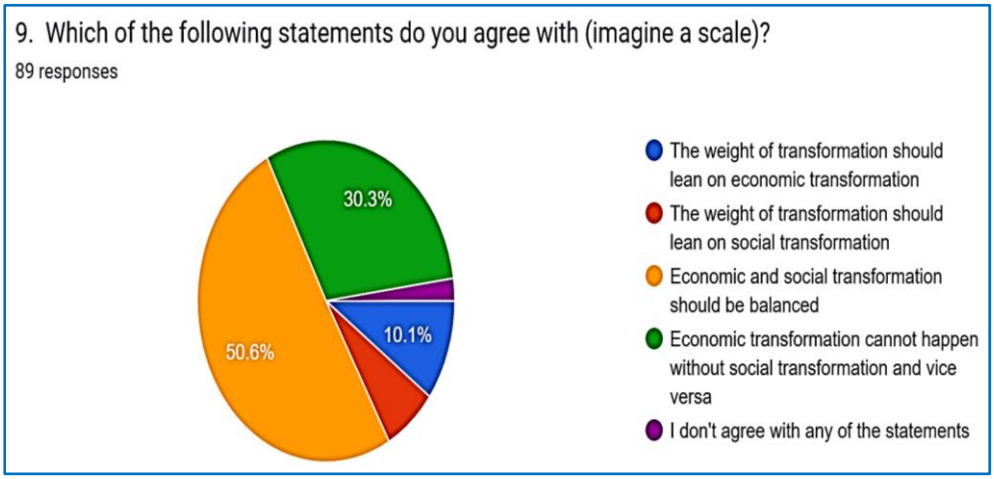


Figure 8: Balancing economic and social transformation (percent) n=89

Figure 9 plots the entire observation along X-Y axis and clearly shows the balancing of social and economic transformation.

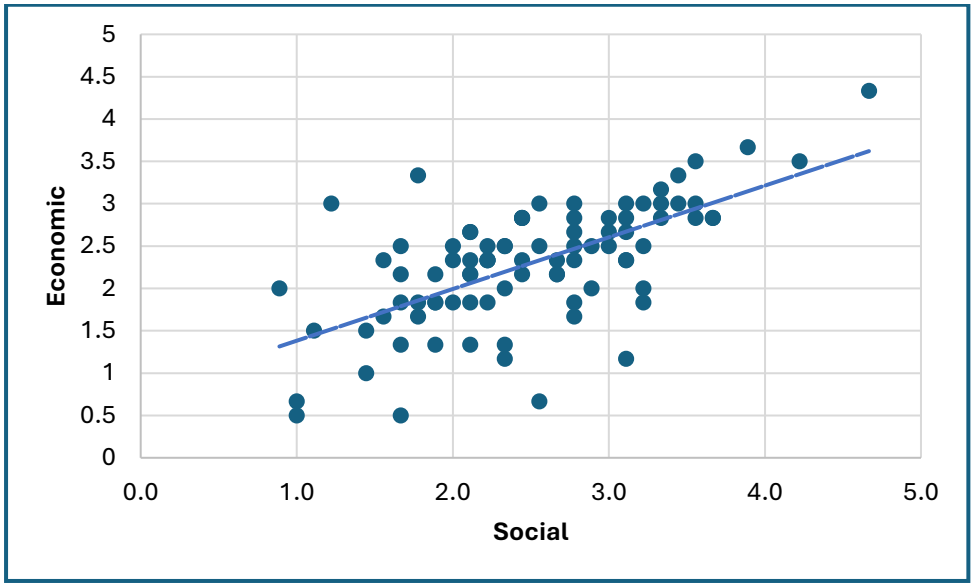


Figure 9: Overall distribution of the split between social and economic transformation (n=89)

In an effort to explore further on social issues, respondents were asked what would be the fate of social institutions in a transformed Ethiopia? Fifty-two percent (46/89) indicated some social institutions will adapt to the new context others will wither. This requires a deeper analysis of as to which institutions will wither and which will prevail. But from experience, we know that, *Idirs* have indeed been adapting to social and economic changes since the Imperial times; the Oromo Aba Gadas and other similar institutions in various parts of Ethiopia have found a new lease of life under the federal system.[13] On the other hand, traditional labour mobilisation systems such as *Jigi* and *Debo* in Oromia have indeed weakened.

[13] See Teshome's paper on traditional conflict resolution mechanisms in this proceedings.

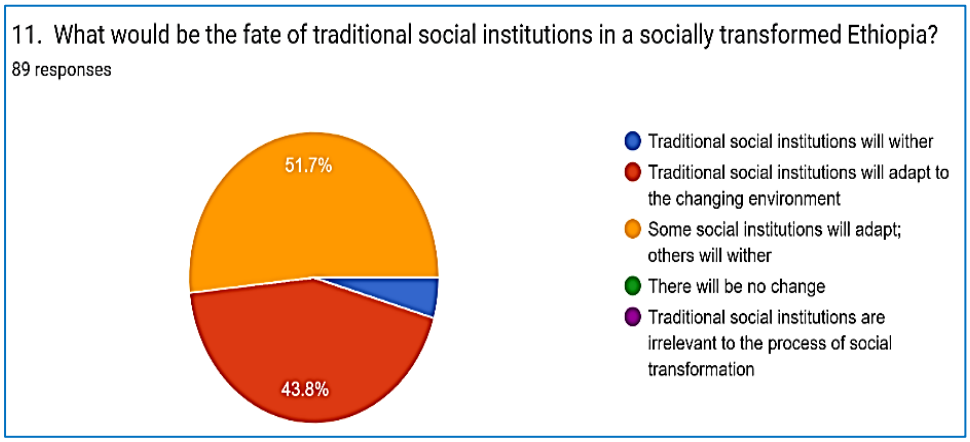


Figure 10: The fate of traditional social institutions

3.6. Benchmarking Transformation: model countries and the influence of regional stability

As noted earlier, during the Imperial times, Japan was the model country for Ethiopia. Emperor Haileselassie wanted to adapt the Japanese Constitution but did not go far enough. The tide has since changed and Ethiopia has moved from admiring Japan. For *Derg*, the socialist countries (for example, USSR, GDR and North Korea) were model countries. EPRDF was fascinated by the achievements of Malaysia, China, and South Korea.

The survey participants were asked to provide one model country that Ethiopia can draw lessons from. The majority identified South Korea (23/89), followed by China (16/89) and Vietnam (14/89). Among African countries, Rwanda stood first (12/89) followed by Kenya (2/89). A few respondents argued that lessons from a single country are not enough. Ethiopia should consider drawing on a combination of multiple countries. One of the respondents provided the following justification for this argument:

> *"Rather than benchmarking one country, following the correct pathway initiated by GoE, home grown economic transformation, taking good examples from different countries and contextualizing into Ethiopian reality will be preferable. For example, we can learn from Vietnam's agriculture-led development including the small holder farmer, institutional strengthening and accountability from Rwanda and social inclusion and women empowerment from Bangladesh and market system-based development and innovation from Kenya and infrastructure development from China." (#72)*

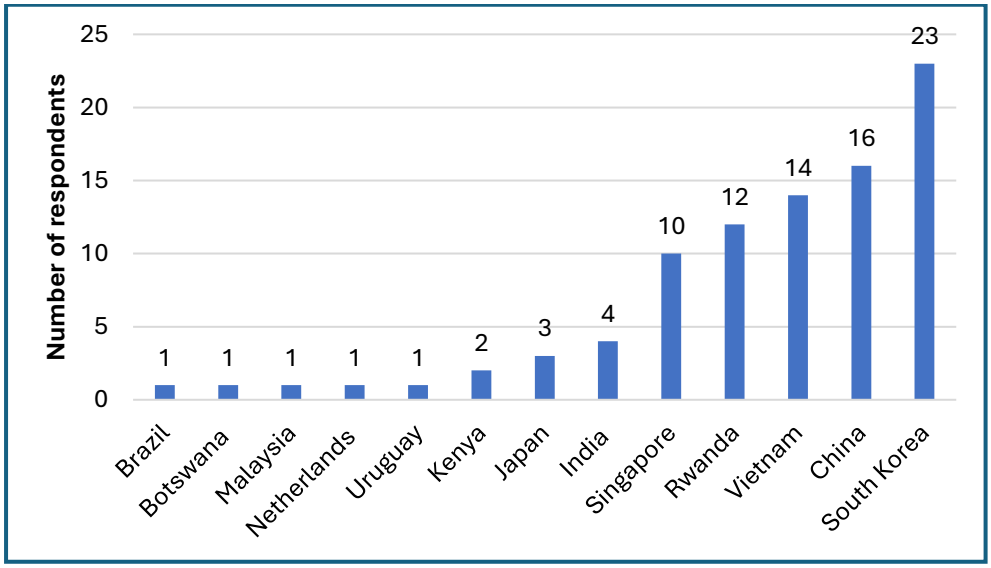


Figure 11: Economic and Social Transformation Benchmarks Countries (n=89)

All but one (Kenya) are further away from Ethiopia. Neighbourhood is as important, if not more, at national level as it is at individual/household or community levels. Good and peaceful neighbourhood has the potential to promote development and transformation. In order to test this notion, respondents were asked how dependent is Ethiopia's transformation is on what is happening in the IGAD member countries – a block that completely encircles Ethiopia. As depicted in Figure 12, 37.1 percent (33/89) of the respondents indicated that Ethiopia's transformation efforts should be *aligned* with transformation efforts in the IGAD region; 22.5 percent (20/89) indicated that Ethiopia can transform irrespective of what is happening in the neighbouring counties; and 25.8 percent said Ethiopia is less dependent on its neighbours.

Although the sample is not large enough to make big statements, the fact that 58.4 percent (52/89) said Ethiopia is less dependent or even can transform irrespective of what is happening in neighbouring countries is troubling and not in line with longstanding claim of "Ethiopia's strategic location". One could take comfort from the fact that 42 per cent expressed the desire for Ethiopia to align its transformation efforts with its neighbours.

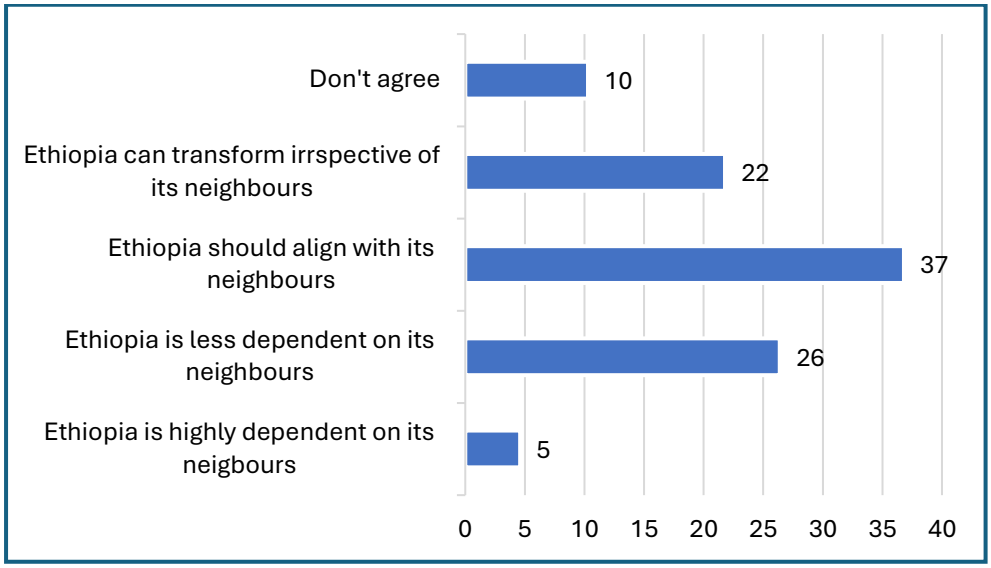


Figure 12: Ethiopia's transformation in relation to its neighbours (%; n=89)

It is worth noting that countries that have transformed their economies and societies did so in collaboration with their neighbours, formally by forming economic unions (for example, the European Union) or economic corridors or simply guided by economic indicators. Applying the 'Flying Geese' metaphor, we find that a lead country advanced in a certain manufacturing product (for example, electronics) leads until it grows out of that product and takes on a new more advanced product. The followers that have been learning from the lead now take over the old product (electronics). The process continues until each country becomes the master of its own product. The East Asian countries are said to have followed this pattern of development and transformation.

Africa (or its sub-regions) has not been able to follow this pattern of development because no lead country could emerge in any industrial product. In any case, there is now an understanding that a single lead model may not work for Africa or its sub-regions. Using IGAD as an example, the following hypothetical table (see Table 2) stipulates where multiple countries may lead in one product or one country taking on more than one sector.

Table 4: Modified 'flying geese'/transformation corridors

Sector	Lead Goose	Supporting Geese	Remark/assumptions
Energy	**Ethiopia**	Kenya, Djibouti	Completion of the GERD has given Ethiopia the edge; it should prioritise the 60% of its citizens without power.
Manufacturing	**Ethiopia**	Eritrea, Uganda	Aggressive expansion of IPs gives Ethiopia the edge but skills and work ethics are major concerns
Finance	Kenya	**Ethiopia**	Ethiopia is at a very early stage of modernising its finance sector; still debating to invite or not to invite foreign banks
Digital Economy	Kenya	**Ethiopia**, Uganda	Ethiopia aggressively catching up with the digital world but still focused on the service sector.
Logistics/Ports	Djibouti, Somalia	**Ethiopia**, Eritrea	Common understanding required. While pursuing direct access, Ethiopia should consider becoming 'land connected' via corridors (e.g. Rwanda, Laos).
Agriculture	Uganda, **Ethiopia**	Sudan	Sudan relies on Ethiopia's soil transported via the Nile.
Livestock	**Ethiopia**, Somalia	Kenya	Ethiopia should move from quantity to quality.
Tourism	Kenya	**Ethiopia**	Ethiopia's expansion of domestic flights should be complemented by highspeed roads and rails that carry more cargo; tourists prefer travel overland to enjoy the scenery.
Aviation	**Ethiopia**	Kenya, Djibouti	Ethiopian has proven resilient in the face of numerous shocks.
Blue Economy	Somalia	Djibouti, Eritrea	Ethiopia has developed a blue economy strategy in anticipation of securing sea access

Accordingly, we can see Ethiopia has the potential to be a leader in energy, manufacturing and agriculture; and a follower in finance, digital economy, logistics and tourism.

3.7 Transformation Routes

The classic transformation model suggests that labour (and other factors production) should move from low productive agriculture to high productive industry/manufacturing sectors. For agriculture to release labour and other factors of production, productivity should be sufficiently high to produce enough food for the nation. The reality is productivity is not sufficiently high but labour is leaving the sector for urban areas to join mainly the service sector. This is a pre-mature exodus because agriculture is not ready to release labour.

Nearly 60 percent (53/89) agreed with the proposition that agriculture is not ready to release the factors of production, labour in particular (Figure 13). Of course, nearly 35% dis not agree with the proposition at all.

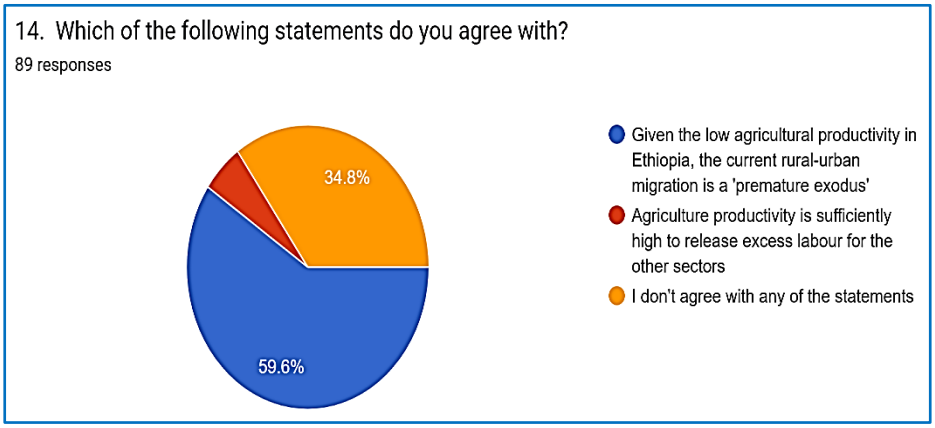


Figure 13: Indications of transformation route

3.8 Additional dimensions of transformation

Although the research focused on economic and social transformation, respondents were given the opportunity to suggest other dimensions of transformation that should be researched. The suggestions are summarised in Table 3. These dimensions are pertinent but most, if not all, can actually be accommodated within the two dimensions or can be accelerators/facilitators for both. For example, digital transformation is presently championed as the driver of transformation serving both the economy and social dimensions (FDRE, 2025 and 2030; MoA/ATI, 2025). It is also important to understand that many countries that transformed their societies did it well before the advent of digital technology. By and large, what is being digitised

is what already exists – systems that we have mastered manually. If we don't have a system, there is not much we can digitise!

Table 5: Summary of additional dimensions of transformation (n=89)

Additional dimensions of transformation	Frequency
Political/democratic/governance	24
Digital/technological	22
Environmental/Sustainability	19
Cultural/attitude/mindset	18
Institutional	10
Demographic	4
Infrastructural	3
Human capital	2
Others	5
Total	**107**

Source: Compiled from responses

4. Conclusions and Recommendations

4.1 Conclusions

The paper is a detailed presentation of the survey carried out to understand and deepen the concept and practice of economic and social transformation. The audience for the survey were development actors that have travelled along Ethiopia's transformation journey. About 500 professionals were invited to participate in the survey; 160 accepted the invitation and 89 responded to the questions. The research has planted a seed for national conversation on the transformation agenda and survey paticipants are very much at the heart of this conversation.

The key takeaways are as follows:

- With respect to perception, the powerful terminologies/concepts we use or don't use in our communications can influence policy making. The survey participants provided us with these powerful concepts both from the classic transformation model (for example, shift from low productivity to high productivity sectors) and concepts pertinent to present day debate (for example, gender, environment/climate, sustainability).
- Social transformation is much more than reporting on social indicators. It is the right (or left) arm of economic transformation and the majority of respondents

indicated that policy making should balance the two and some went as far as suggesting one cannot happen without the other.

- The paper generated enablers, hindrances, and strategies for economic and social transformation that require careful and in-depth analysis to identify strategic intervention that can solve problems on both fronts. The 'bullseye' metaphor used in the paper can guide the policy and strategy formulation process.
- Transformation benchmark or model countries for Ethiopia have changed. Japan no more! Top five countries are South Korea, Vietnam, China, Rwanda and Singapore. A few respondents have strongly argued that lessons from one country are inadequate while others cautioned against copying models from other countries.
- It is widely recognised that the current move from agriculture to service sector is unhealthy. It is of course difficult, if not impossible, to dictate where rural labourers should go once they leave their village. However, strategically speaking the government should facilitate for the private sector to take processing deep into rural areas (around clusters) to create job opportunities. Life skills training, coaching and mentoring should expand in rural areas to prepare the youth for employment and ultimately for urban life. Rural employment guarantee schemes should be introduced at minimum wage so that rural youth leave the village only when they better opportunities.
- Surprisingly, the importance given to regional integration/ interdependence is rather weak with nearly 60 percent indicating that Ethiopia is either less dependent on its neighbours or can transform irrespective of what is happening there. This needs further investigation.
- Summing up all these is the rather crude transformation readiness index. Although seeds of transformation have been planted over the years, they have hardly been watered and nurtured. The crude index supports this assertion. The index is 50 percent or less for all the economic and social indicators. Not surprisingly, the relevance of Eurocentric indicators to Ethiopia registered even lower index. This needs to be further debated on broader platforms such as the Alliance of Professional Associations (see below).

4.2 Recommendations

Several strategies to deepen the transformation were solicited from respondents – most are the usual type (for example, modernise agriculture, increase industrial

productivity); a few are highly innovative (outside the box). For this exploratory stage of the research the following recommendations are put forward:

1. Broaden and deepen the research and debate on transformation along the indicators used in this paper and more. The current research and debate is dominated by Economics and Allied Sciences (for example, Agricultural Economics, Industrial Economics). But transformation issues go deeper involving Sociology/Anthropology, Philosophy, Linguistics, Health and Nutrition, to name but a few.
2. Harmonise the evidence generated by state and non-state actors, including development partners. There is a tendency to pull each other in different directions. The state saying transformation is happening (or in the process of); non-state sector saying the economy and society is far from transformation.
3. Based on the harmonised evidence, the Government should develop **25-30 Year Transformation Roadmap** with a vision to see a **cohesive, peaceful, Ethiopia with a strong middle class**[14] by 2050. This Ethiopia should exhibit:
    - Genuine and lasting democratic system
    - No poverty and hunger
    - Strong and legitimate institutions where meritocracy is the norm not an exception
    - Inclusive growth driven by productivity, not extraction
    - Climate-resilient livelihoods
    - A confident national identity anchored in diversity
4. Fourth, a broad platform of Professional Associations is required to advance the transformation agenda. The **Alliance of Professional Associations** is the most appropriate platform. The Alliance should also support the government in the preparation and implementation of the long-term Transformation Roadmap.
5. Focus on strategies that have the potential to tackle multiple problems (በአንድ ድንጋይ ብዙ ወፎች). Apply the 'bullseye' methapor.

[14] According to researchers from the World Bank (Metreau, et.al. 2026), Ethiopia has not met its vision of becoming a 'lower middle income' by 2025 despite continued GDP growth even in the midst of COVID-19, conflict and drought. While continuing to pursue this vision, it has set a new vision of becoming "an African beacon of prosperity by 2030". This vision is difficult to measure come 2030. It all depends on the will of Africans whether or not they consider Ethiopia as their beacon; the same way they considered it a 'beacon of independence' during colonialism. The proposed vision is meant not demonstrate that Ethiopia's vision should be more holistic touching the key feelings of the people – economy, peace, cohesion.

6. Work with neighbouring countries to advance the transformation agenda (adapt the 'flying Geese' metaphor).
7. Revive, promote and protect cottage industries. Promote rural employment guarantee schemes to manage the rural-urban migration.
8. Introduce innovative domestic resource mobilization including broadening the tax base; promoting tax deductible donations; and channelling profits from national lottery to the real economy sectors.
9. Proactively engage religious institutions to end poverty and hunger. They can also mentor the youth to develop work ethics.
10. Link agriculture research and extension to higher learning institutions (education-research-extension) in the same way health is linked to higher learning institutions.
11. Link infrastructure development with the real economy, manufacturing in particular. High crop production areas should be connected to high livestock production areas so they can exchange crops, livestock and animal feed. The days of Isuzu vehicles travelling 10-12 hours carrying a handful of cattle must come to an end!

4.3. Future Research Agendas

A single research cannot claim to have answered all the questions it raised let alone those raised by commentators and conference participants. The following issues require further investigation:

i) **The relevance of the 'Eurocentric pillars' to Ethiopian context**. This was questioned by some survey participants. As can be seen from the key elements of these pillars (Annex 1), they capture many of the contemporary issues debated in various platforms albeit in a fragmented way. Historically, these elements brought significant societal change in attitude and mindset; work ethics; rule of law (respect the law; not fear the law enforcer); introduced standards, specialisation, competition, collaboration and team work. While I maintain that they are relevant and be used to measure transformation in Ethiopia, I call up on researchers to further investigate and align them with our social values.

ii) **The Todaro Paradox**. In simple terms, the paradox states that in a developing country context, efforts to increase urban employment end up increasing urban unemployment because for each urban job created (supply) more than one applicant (demand) comes forward. Almost always demand for urban job outstrips supply of urban jobs. We cannot catch up. What is the way forward?

Managing rural-urban migration by creating massive rural jobs could be major part of the solution. Ethiopia needs rural employment guarantee schemes such as those implemented in India. If rural youth are guaranteed jobs in their vicinity, there is no reason for them to migrate. After participating in these rural jobs and gaining the much needed skills, they can move to better jobs. As a matter of fact, a respondent, based on [her/his] recent study, suggested a re-conceptualisation of "rural" and argued that the Urban-rural dichotomy is a misleading concept. What is "rural" in Ethiopia? This is poorly defined and the national and regional policy frameworks, as well as research endeavours, hinge on a blurred definition. While there is socioeconomic dynamism in Ethiopia, the notion of "rural" seems static. There is a need for further research.

iii) **Re-examine the role of the service sector.** Traditionally, the service sectors is regarded as less productive than industry/manufacturing. That is why labour movement in that direction is considered 'unhealthy'. However, it is caching up. Mobile and internet banking are saving customers considerable time that could be spent on other activities rather than queuing up for each and every transaction. The air travel industry which is considered efficient even by traditional standards is becoming even more efficient with travellers booking flights, buying tickets and checking in, from the comfort of their home or office. Future research into structural transformation should take these factors into account.

iv) **Thinking outside the box**. Rhetorically, we often talk of multi-disciplinary and multi-sectoral. However, when pressed for solutions to a problem (as in this research), we have limitations to think outside our own specialisations which can only provide part of the solutions. The other part is found in other domains. The good news is we are not alone! The inability to think outside the box is a global problem. Although formal trainings to help us think outside the box are hard to come by (if there were, I would have known), there are tools and guidance that we can utilise. Identifying these tools, customising and building them into coaching and mentoring sessions would be a game changing endeavour.

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Annexes

Annex 1: Economic and social transformation indicators (Growth with DEPTH)[37]

Economic Indicators	Description[38]
1. Sector diversification	The country's capability to produce and export a widening array of goods and services
2. Agricultural labour productivity	The value added per unit of labour in the agriculture sector (crop and livestock)
3. Industrial labour productivity	The value added per unit of labour in the industrial/ manufacturing sector
4. High value addition manufacturing and services	Shift from export and sale of primary products to processed and value added products. For example, roasted, grind and Instant coffee rather than raw coffee.
5. Technology adoption	Shift from traditional/mundane technologies to modern labour saving technologies. For example, improve farm implements for draft animals; shift from two-oxen to one ox or horse; change animal power to two-wheeled tractors and eventually four-wheeled tractors depending on farm size. Use digital technology for extension service delivery with eventual replacement of extension agents.
6. Macroeconomic stability	Balance in key economic relationships: • domestic demand and output, • export and imports (the balance of payments), • fiscal revenues and expenditure, and • savings and investment. A state of an economy with minimal vulnerability to external shocks, characterized by stable economic growth, low inflation, sustainable fiscal/external balances, and manageable debt.
7. Investment climate and private sector dynamics	Not only existence of investment proclamations but ensuring the bureaucracy is merit-based and investor friendly.
8. Infrastructure and connectivity	Progress in physical infrastructure development and connectivity such as telecom and internet. Minimise and eventually substitute imported critical inputs such as cement and steel (IPSRD and ASTU, 2017; Mulatu, et.al.. 2018)
9. Energy access and reliability	Access and reliability of diverse/alternative energy for household, business and manufacturing.

[37] The economic and social indicator are adapted from ACET's definition of economic transformation as "Growth with DEPTH" and the Bertelsmann Stiftung's Transformation Index (BTI, 2008, 2024).

[38] These descriptions were not given to respondents which meant they had to rely on their own experience and perhaps do some digging before responding. For an experimental research, respondents could be divided into two – one group responding with exposure to these elements; another group without.

Social indicators		
10.	Education attainment and learning outcomes	Quality education and high achievement is key for transformation.
11.	Demographic dividend potential	Young and skilled population has employment opportunities
12.	Inclusion	Transformation that leaves women, youth and other vulnerable groups behind is not complete.
13.	Trust, cohesion and conflict prevention capability	The society is united; there is high degree of trust and has conflict prevention mechanisms both traditional and formal cohesion (legal framework that everyone trusts).
14.	Health and nutrition status	Access to quality healthcare and improved nutritional status.
15.	Civic participation	People's constitutional right to organise new civic societies and be member of existing ones is realised.
'Eurocentric' pillars of transformation[39]		
16.	**Renaissance**	• Rapid spread of information and ideas; thinking, asking questions, pondering, considering, and experimenting. • Individuals skilled in a variety of pursuits from art and sculpture to engineering and mathematics. • Personal wealth and the ability to choose one's lifestyle. • Secularism and worldliness
17.	**Enlightenment**	• Rule of law, rights, constitutional order • Rise of individual conscience, responsibility, and discipline • Decentralization of power and legitimacy • Foundations for civic ethics, social trust, and accountability • Evidence-based reasoning, science, public debate
18.	**Reformation**	• Norms, accountability, decentralisation of power • Challenge to centralized, unquestioned authority • Rise of individual conscience, responsibility, and discipline • Foundations for civic ethics, social trust, and accountability
19.	**Industrial revolution**	• economic, technological and structural, productivity, competition, value addition • work ethics, standards, specialisation, collaboration, team work

[39] These elements are adapted from the classic literature and/or interpretation of this literature by contemporary authors (for example, Johnson (2021); Humphrey (1992).

Trust and Collective Marketing Decision of Smallholder Farmers: Experimental Evidence from Ethiopia

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Abstract

Creating improved market access for and market participation of smallholder farmers have become key pathways towards rural development, poverty reduction and food security. This study investigates the impact of trust on smallholder farmers' willingness to participate in joint (collective) marketing that require coordination of farm activities such as crop variety selection, planting, harvesting and marketing schedules. The study employs survey data with incentivized behavioral experiments (trust and public good games) collected from a sample of 504 farm households in Ethiopia. The contribution in the randomized experimental treatments in public good game (PGG) is used as instrument in identifying the causal impact of trust behaviour on farmers' stated intentions to engage in collective marketing. The Two-Stage Residual Inclusion (2SRI) approach is used for the analysis. The results show that trust significantly increases the willingness of farmers to coordinate their farm activities for collective (joint) marketing. The study uses such incentivized prosocial behaviour as instrument variable and controls potential confounding factors which suggests positive effect of trust behaviour on willingness to join collective marketing. The findings highlight the importance of strengthening trust within communities and credibility of the involved institutions to enhance the collective action in general and collective marketing in particular of smallholder farmers in developing countries.

Keywords: Collective marketing; Trust and cooperation; Two-Stage Residual Inclusion (2SRI); Trust and Public Goods Game.

JEL Classification: Q18; C93; D1; D71

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1. Introduction

The smallholder agriculture in developing countries encounters several problems in playing central role in poverty reduction, food security and rural development in general (World Bank, 2008; Fischer & Qaim, 2012; Abdul-Rahaman & Abdulai, 2020). The smallholder farmers reside in remote rural areas and face information asymmetries, high transaction costs, weak bargaining power, limited credit and extension access, and poorly coordinated value chains (Sinyolo & Mudhara, 2018; Simelane et al., 2019; Belay, 2020). Consequently, a larger part of the marketing margin is captured not by the farmers but by the market intermediaries who add limited value (Lapar et al., 2006; Kwizerimana et al., 2023). This is in contrast to the argument of the development literature about the critical role of improved market access for transforming the livelihoods of farmers and promoting inclusive rural development (Barrett, 2008; Shiferaw et al., 2011). It is for such and similar reasons that policy measures that promote collective marketing are called for (Magakwe et al., 2025).

Collective marketing is expected to overcome such persistent and emerging challenges of the farmers and for enjoying opportunities (Tefera et al., 2017; Sinyolo & Mudhara, 2018; Simelane et al., 2019; Abdul-Rahaman and Abdulai, 2020; Belay, 2020). For instance, demand for high-quality and standardized food is growing because of the growth and expansions of urbanization, supermarkets, and agribusinesses which present both opportunities and challenges for the smallholder farmers (Fischer & Qaim, 2014; Reardon et al., 2019). Collective marketing can increase bargaining power, reduce transaction costs, improve product quality, and create economies of scale to enable them to access profitable markets (Barrett, 2008; Shiferaw et al., 2009; Sinyolo & Mudhara, 2018; Kwizerimana et al., 2023; Chea et al., 2024; Magakwe and Olorunfemi, 2024; Magakwe et al., 2025).

However, despite the above-mentioned potential benefits of collective marketing, effective collective actions do not automatically emerge and flourish (example, Takyiakwaa et al., 2025). This is because farmers and their leaders may have heterogenous interests as the result of which collective marketing may involve fear of opportunistic behaviour and transaction costs. In Ethiopia, for example, several assessment studies have shown that there is limited development and functionality of co-operatives where such arrangements are either not widespread or if they exist, farmers may not join them or use their services (Tefera et al., 2017; Abate, 2018; Gashaw and Kibret, 2018).

As seen in the theoretical section below, behavioural factors such as trust and cooperation may play critical roles in collective marketing which is associated with risk and vulnerability that stem from the heterogenous interest of members (example, Houser et al., 2010; Kocher et al, 2015). Despite the theoretical arguments, however, there are limited empirical studies that emphasize the roles of such behavioural factors in collective marketing decision. The focus of the existing empirical studies is largely on socioeconomic determinants of collective marketing such as education, income, assets, access to extension, and market information (Mojo et al., 2017; Kiprop et al., 2020; Magakwe et al., 2025). Moreover, the available trust related studies largely relay on survey and case studies where the evidence remains fragmented, geographically narrow (eastern Europe), and largely correlational (Hansen et al., 2002; Valentinov & Curtiss, 2005; Bakucs et al., 2008; Szabo, 2010; Gashaw & Kibret, 2018;) without addressing endogeneity concerns (Wooldridge, 2016).

This study intends to contribute in filling this critical gap by providing rigorous experimental evidence using incentivized trust and public good games combined with survey data from Tigray, northern Ethiopia. The study asks how trust influence smallholder farmers' willingness to coordinate production and participate in joint marketing. The contribution to public good generated by randomized experimental public good game is used to instrument trust behaviour in estimating the impact of trust behaviour on willingness to join collective marketing, using a two-stage residual inclusion (2SRI) model. The finding suggest that trust has statistically significant effect on willingness of farmers to join collective marketing by coordinating their production activities. This has strong policy implication suggesting that there is a need to take account of trust building in the endeavour of promoting rural development in general and collective marketing in particular.

The paper is organized as follows: section 2 presents the theoretical and conceptual framework. Section 3 is concerning the data, experimental design and empirical strategy. Section 4 reports the empirical results. The theoretical and policy implications of the findings are discussed in section 5. Finally, section 6 concludes.

2. Theoretical and Conceptual Framework

2.1. Collective Marketing as Collective Action Problem

Collective marketing can be understood with the help of collective action theory that explains how individuals cooperate to achieve shared goals that are individually

difficult to attain (Ostrom, 1990; Mugwe et al., 2019). Collective marketing plays important role in improving market participation problems of smallholder farmers (Ton, 2008). For instance, smallholder farmers encounter problems such as information asymmetry, high transaction costs, weak bargaining power (Lapar et al., 2006; Shiferaw et al., 2009). Moreover, smallholder farmers have limited capacity to compete with others and to exploit opportunities such as using high value markets (Belay, 2020). In this regard, collective marketing may enable smallholders to share market information, to reduce transaction costs, to standardize production practices to comply with food-safety, to meet quality standards of their produce and compete with large farms and agribusinesses, supply homogenous products to meet market preferences and tap into high value markets, etc., (Reardon et al., 2009; Shiferaw et al., 2011).

However, as mentioned above, collective action may also be among highly heterogeneous individuals whose interests may be conflicting that involves social dilemmas (Staatz, 1989; Mugwe et al., 2019). Consequently, as explained by Olson (1971), it may involve coordination problems and free-riding where individual rationality undermines cooperation of the farming community (example, Noorderhaven, 1995). For example, establishing the rules of the collective marketing; monitoring and enforcing compliance; securing commitments of the members to the collectively agreed rules may be challenges due to free-rider problem (Shiferaw et al., 2011). Moreover, collective marketing may lack clarity of contracts and definition of property rights that lead to misuse of common properties by those who control (manage) the assets to their advantages at the expenses of the members (Elliott and Olson, 2023). In short, opportunistic actors manipulate and exploit assets and information by taking advantage of the incomplete contracts caused by asymmetric information and bounded rationality of the actors (example, Thomas and Hangula, 2011).

2.2. Trust and Cooperation as Solutions to Collective Marketing Problems

New institutional economists argue that societies devised formal and informal institutions as instruments of promoting cooperation by reducing uncertainty and opportunistic behaviour (North, 1990). These economists go beyond the traditional focus of only on formal institutions suggested by authors such as Olson (1971) but in line with the usual practices of communities especially in developing countries. Norms of trust and reciprocity are used by communities to constrain or incentivize the agents so as to ensure commitment and compliance with agreements in the rural

areas where formal institutions are weak or inexistent (Romero Granja & Wollni, 2019; Elliott & Olson, 2023). Therefore, the important role that trust plays in collective behaviour is one of the major reasons for the growth of interest of social theorists in the concept of trust (Amir, 1999)

This study takes the definition of trust as "the expectation of regular, honest and cooperative behaviour based on commonly shared norms and values" (Fukuyama, 1995). Past trust and reciprocity experiences of members of a given community reach to the level of generalized reciprocity and norm-based trust (Hatak et al., 2016). Trust can also be understood as cognitive (i.e., based on perceived competence and integrity of the trustee) and/ affective (based on emotional bonds with the trustee) (McAllister, 1995). Functionally, therefore, it is argued that trust facilitates information exchange and reduces fears of opportunism, raises commitment, and coordinated action (Ostrom & Ahn, 2003; Kwon & Suh, 2004; Grashuis, 2025). Without some degree of trust, most contracts are incomplete which expose actors to fear of opportunistic behaviour (Diwakara, 2006). Trust reduces transaction costs and increases the willingness of individuals to voluntarily join and remain loyal to collective organizations (Szabo, 2010; Möllers et al., 2018; Abdul-Rahaman, 2020).

The above argument on the nature of trust behaviour applies to cooperative behaviour as well since trust means cooperation with some exceptions. Cooperation differs from trust when it is not voluntary but realized through other means such as coercive measures (example, Mayer et al., 1995; Amir, 1999). Cooperation is trusting partners and undertaking activities on areas that have potential common gains while trust is also viewed in the literature as a propensity to cooperate so as to produce socially efficient outcomes and avoid inefficient non-cooperative social dilemma traps (La Porta et al, 1996; Jansson and Eriksson, 2015). The implication is that trust behaviour is parallel to non-coercive cooperative behaviour.

For these reasons, the study used contributions behaviour as an instrument to trust behaviour because trust is built by cooperative experience of community members and the mechanisms that sustain cooperation (such as reputation and information sharing) lead to greater trust (Wu and Van Lange, 2016). This means that individuals who contribute more in the public goods game show that they have stronger expectations about the cooperative behavior of others. These expectations are closely related to trust behavior. As the result, the logic of using contributions to public good as a predictor of trust behviour follows which means we argue that contribution to public good influences willingness to join collective marketing primarily through its effect on trust.

In general, therefore, this study conceptualizes collective marketing problem as an integration of insights from fields of studies such as collective action, institutional economics, and behavioural economics in investigating the effects of trust on willingness of smallholder farmers to coordinate their production and marketing activities.

The hypothesis of the study is that trust behaviour positively affects the willingness of smallholder farmers to coordinate their production and marketing activities for collective marketing.

3. Data, Experimental Design and Empirical Strategy

3.1. Study Context and Data Collection

The data used by this study is collected by Food and Local, Agricultural, and Nutritional Diversity (FoodLAND) research project funded by the European Commission's Horizon 2020 Research and Innovation (R&I) program. Incentivized lab-in-the-field experiments and household surveys data are generated between April 18 and May 17, 2024, in Laelay Maichew district (Tigray, Ethiopia). A sample of 504 randomly selected adults (≥18 years) have participated in both the economic games and the survey. Laelay Maichew district was chosen because it is a major teff-producing area in the region connected to Mekelle, a large urban teff consumers.

Sampling followed a multi-stage stratified random design. Out of 12 villages in the district, five high–teff-producing villages were selected (Hatsebo, DebreKal, Mirena, Lesalso and Debrebrhan). Sample shares were proportionally allocated to villages and stratified by age and sex using rural Tigray population distributions as shown in 2007 CSA census. To meet project requirements, women were intentionally oversampled to compose one-third of the sample.

3.2. Experimental Procedure and Design of Trust and Public Good Games Experimental Procedure

Ethical guidelines for human subjects are adhered in conducting the experiment. The study was reviewed and approved by Institutional Review Board of Mekelle University under approval number MU-IRB 2045/2023 on 26/05/2023. Participants received a standardized introduction explaining the study purpose, anonymity, voluntary participation, and payoff rules. Written consent is obtained from participants before the commencement of data collection. A trained enumerator is

assigned to support each participant in administering both the economic games and the survey questionnaire. The participants are asked to answer comprehension questions to ensure their understanding of the game.

Experimental Design of the Public Good Game

A two-round public good game (PGG) of a group of eight participants is designed with four treatment arms. Respondents were randomly assigned into each group to play either of the four treatment arms: (1) information + private return treatment arm; (2) private return treatment arm; (3) information only treatment arm; and (4) Treatment arm with no private return and no information (control).

In each round, each participant is endowed with 150 tokens (equivalent to Birr 150) and decided how much to contribute to the group account. The amount contributed was doubled by the researcher and equally distributed to group members irrespective of their contribution. In this case, the marginal per capita return (MPCR) will be 0.25. Tokens kept in the private account yielded either no additional return (in arms other than private return) or a 20% additional return in the private-return arm. Information about contributions of individual and group members was provided to participants involved in the information treatment arm after playing round one and before playing round two. To summarize more formally, the payoff for participant i (Πi) will be:

$$\pi_i(c_i, c_{-i}) = r(e - c_i) + 2\left(\frac{1}{8}\right)\sum_{j=1}^{8} c_j \quad \textbf{(1)}$$

$$\pi_i(c_i, c_{-i}) = r(150 - c_i) + 0.25\sum_{j=1}^{8} c_j, \quad \textbf{(2)}$$

$$\pi_i = r(150 - c_i) + 0.25\Sigma c_j \quad \textbf{(3)}$$

where i indexes the individual under consideration; r is 1.20 or 1 depending on whether the individual is with or without the private return respectively; j indexes the members of the same contribution group; π_i is the payoff for individual i in public good game; e (e = 150) is the tokens (Birr) endowment of the individual; c_i the contribution of the individual to the public good; 0.25 is the marginal per capita return (MPCR) i.e., the return that the participant gets from each token contributed to the group account; Σc_j is the sum of contributions of all group members and hence, $0.25\Sigma c_j$will be the share of the participant from the group account.

In this respect, it is optimal (efficient) for the group if all tokens are contributed to the group account to get a return of 2 from each token contributed. However, the

individual is getting a MPCR of 0.25 from each token contributed. This results to the conflict between individual and group interest leading to an incentive of free-riding (social dilemma).

Experiment Design of the Trust Game

The Berg et al. (1995) trust game approach is implemented to measure investment decision of participants with six treatment arms. This framework considers trust as the willingness of the trustor to place endowments at the disposal of trustee despite the risk of opportunistic behavior. The six treatment arms are based on the identity of the trustee: anonymous community member, anonymous female, anonymous male, religious organization agent, government agent, and NGO agent. In this game, each participant is endowed with 100 tokens (equivalent to Birr 100) and randomly assigned to play a given treatment arm as a sender (trustor). The sender can send an amount of $s \in [0, 100]$ which was tripled by the researcher before giving it to the receiver. The receiver then returned any amount $r \in [0, 3s]$. According to the standard economic model, the trustee has no incentive to send back money and so knowing this, the trustor sends nothing. This is rejected by a number of empirical research including this study. Therefore, the payoff of the sender was π =100-s+r, and that of the receiver was π =100+3s-r.

3.3. Survey Data

After finalizing the games, participants completed a structured questionnaire about demographic characteristics, agricultural activities, size of income and assets, access to credit, risk attitudes (with a scale of 0–10 scale), and willingness to align production and marketing activities (5-point Likert scale). Willingness to engage in joint marketing was measured using the following question: Imagine you can sell your crop production jointly with the other farmers' crop production so as to sell them at a slightly higher unit price for the whole group, but you have to align the variety you grow as well as the seeding and harvesting time with the group: would you sell your production jointly?

1. Not at all interested 2. Slightly interested 3. Somewhat interested 4. Moderately interested and 5. Extremely interested

Risk attitude is also measured by asking the following question: *Are you generally a person who is fully prepared to take risks or do you try to avoid taking risks? How do you see yourself?* Rate yourself on a scale of 0 to 10, where 0 means 'do not like

to take risk or avoid risk as much as possible and 10 means fully prepared to take risks. The respective enumerator elaborates about the meaning of the risk to each respective participant during the interview (the size of the number is reversed in the analysis).

As seen in table 1, the descriptive statistics of the sample households shows that they have an average age of 45.8 years, mean education of 2.7 years, a mean monthly income of Birr 2586, average livestock in TLU of 1.4 and average landholding size of 1.9 *tsmdi*[4]. Moreover, 50% of sample households have access to informal credit which far exceeded access to formal credit (5%).

3.4. Econometric Strategy

Model Variables

In the study, the effect of trust on willingness to join collective marketing is tested where we controlled some key variables following the literature:

i. The dependent variable is willingness to join collective marketing
ii. Trust behaviour: the sent amount in the trust game is the major variable to be tested
iii. Cooperative behaviour: contribution in the public good game is the instrument variable
iv. The control variables often used in similar studies including the dummies representing the treatment arms in the PGG are included.

The Two Stage Residual Inclusion (2SRI) Model

The Two-Stage Residual Inclusion (2SRI) model is recommended when the outcome variable is Likert scale or binary (not continuous) (Terza et al., 2008). This study employs this approach to estimate the effect of trust on willingness for joint marketing and address the associated endogeneity problem. This is because trust may be endogenous variable influenced by unobservable traits (e.g., trust may increase or decrease due omitted variables such as past experience in collaborative activities, risk preference, etc.,).

[4] Tsmdi is a local unit and 1 tsmdi is equivalent to a quarter of a hectare, so the average landholding size is slightly less than half of a hectare for the sample households.

First Stage:
In the first stage, amount sent in trust game experiment is regressed on the amount contributed in public good game, dummies for the public good game treatment arms, and other covariates as follows:

$$S = \alpha_0 + \alpha_1 PGG_{cont} + \alpha_2 Treatment_{dummies} + \alpha_3 X_i + U_i \qquad \textbf{(4)}$$

Where, S is the amount sent in trust game; PGG_{cont} is the amount contributed in the public good game; $Treatment_{dummies}$are dummies for the four treatment arms in the PGG experiment where treatment arm4 is used as control variable; Xi's are individual and village characteristics; and ui is the error term. Here, once the model is estimated, the predicted residuals are also extracted from this first-stage regression to be used as explanatory variable in the second-stage regression.

Second Stage:
In the second stage, using ordered probit model, the study regresses joint marketing on trust behaviour, residuals of the first stage regression, and the above-listed covariates. This is shown below:

$$JM = \beta_0 + \beta_1 S + \beta_2 PredResidual + \beta_3 Treatmentdummies + \beta_4 X_i + e \qquad \textbf{(5)}$$

Where, JM means willingness to join marketing; β's are the parameters to be estimated; S is the amount sent in trust game; PredResidual is the predicted residuals from the first stage regression; Xi are the controls (individual and village characteristics); and 'e' is the error term. The experimental data and the two-stage residual inclusion (2SRI) model that the study employs are used to test the relevance of the instrument variable and generate robust impact of trust on the outcome variable of interest.

3.5. Identification Strategy

Empirical challenges are involved in examining the impact of trust on willingness to join collective marketing due to factors such as omitted variable, measurement error, reverse causality and simultaneity which may result biased OLS estimates (Wooldridge, 2016). The instrumental variable (IV) approach using the two-stage

residual inclusion (2SRI)[5] model is employed to address this concern. However, the two key assumptions of the identification strategy should be satisfied for the instrument to be valid. These are strong correlations of the instrument variable with the endogenous variable (relevance condition) and the requirement of the instrument variable to affect willingness to join collective marketing only through the endogenous variable (exclusion restriction). While the first condition can empirically be tested, it is a challenge to verify the second through formal statistical test especially in using one instrument variable.

Therefore, we took certain measures to address the problem of the exclusion restriction: conducting indirect empirical checks and inclusion of potential confounding variables in the analysis based on theory. For instance, we regressed placebo variables and variables having confounding effects on the instrument variable and covariates (Di Falco and Veronesi, 2014). Though we found no evidence in the falsification tests, it is plausible that there is correlation between the instrument variable and willingness to join collective marketing. This raises a concern about the exclusion restriction though it is not a definitive rejection of the validity of the instrument[6].

For this, the study designed to control the related variables in the main analysis based on the literature. This is because trust and cooperative behaviours may be affected by traits such as prosocial preferences and risk preference as well as other socio-economic and demographic characteristics such as gender, education, wealth constraints, access to information, etc., (example, Cox, 2004; Ostrom, 2000; Croson and Gneezy, 2009; Carpenter et al., 2004) which may directly affect willingness to join collective marketing. Therefore, the study controlled such factors by including risk attitude, prosocial preference (proxied by the amount sent back in trust game), membership in associations/cooperatives, educational level, mobile ownership, credit access, income, land size, livestock (TLU), labour endowment (AE), demographic characteristics (age, gender, and family size), village dummies, etc. Village dummies capture heterogeneity of villages in networks and local norms in addition to capturing the differences in factors such as distance to market,

[5] The 2SRI approach is appropriate for nonlinear models and allows for consistent estimation in the presence of endogenous regressors (Terza et al., 2008)

[6] The concern on exclusion restriction is also minimized since trust and cooperative behaviours are highly related concepts (as discussed in the theoretical section above) where voluntary (not coercive) cooperative behaviour can influence willingness to join collective marketing only through trust. This is strengthened by inclusion of potential confounding factors in the analysis as discussed below.

agroecology, availability of infrastructure, which are omitted due to data limitations. We added also problems encountered by the participants such as lack of access to information and collaboration problem though they are not reported since they have insignificant association and their exclusion from the analysis makes no difference.

4. Results

4.1. Descriptive Statistics of Trust and Cooperative Behaviours

As indicated in Table 2, the average amount sent in the trust game is about 44 tokens (equivalent to Birr 44.08, i.e., US $ 0.78)[7] while the average trustworthiness (amount sent back in trust game) is about Birr 50. The participants also contributed 57 tokens (equivalent to Birr 57) in average in both rounds of the public good game which is slightly less than the contributions in the empirical evidence (Ostrom, 2000). In terms of size of participants, each treatment arm in the public good game has 128 participants except the fourth treatment arm having 120 participants. The average amount sent in the trust game is also 44.08 which is a bit less than the findings in meta-analysis studies (Johnson and Mislin, 2011). The size of the trustors for the treatment arm of trustees from community, female trustee, and male trustee are 88 each. Similarly, trustees from representatives of religious and government organizations, as well as NGOs have 80 trustors each to give the sample size of 504 participants of both games.

4.2. First-Stage Regression Results of Instrument Relevance of Cooperative Behaviour

In the first-stage, the endogenous regressor, trust behaviour, is regressed on the instrument variable and the control variables. It is in this stage that the relevance of the instrument variable (cooperative behaviour) is tested. As indicated in Table 3, the amount contributed in the round 2[8] public good game significantly predicts higher levels of trust behaviour (coeff = 0.39, $p<0.01$). This confirms that individuals who contributed more in the public good game also sent more in the trust game. The F-statistic is 13.62 exceeding the conventional threshold of 10 and satisfying the relevance condition for instrument strength (Staiger & Stock, 1997). Moreover,

[7] At the time of the survey, the official exchange rate of 1 USD was approximately equivalent to 56.6 Ethiopian birr.

[8] The study used the amount contributed in round 2 though it was found that it does not make a difference whether one uses round 1 or 2.

trustworthiness has also statistically significant positive association with trust behaviour, i.e., those who trust more are also more trustworthy which suggests the need of its control in the main analysis as a proxy variable for prosocial preference.

4.3. Second Stage Regression: Impact of Trust Behavior on Joint Marketing Participation

Table 4 shows the results of the second stage of 2SRI ordered probit model that estimates the effect of trust behaviour on farmers' willingness to join collective marketing. There is positive and statistically significant association between trust and joint marketing participation (coeff.=0.08 with $p<0.01$) after controlling for some potentially confounding variables, demographics and village characteristics. Interestingly, while its association with trust is positive and statistically significant, trustworthiness (the proxy variable for prosocial preference[9]) is negatively and significantly associated with willingness to join marketing. This is as expected since it captures the other regarding component of trust. Moreover, there is statistically significant correlation of joint marketing participation willingness with the predicted residual from the first stage regression (coeff= -0.07 with $p < 0.01$) confirming the prevalence of the endogeneity problem in trust behaviour captured by this residual. This implies that estimations that do not consider endogeneity would be biased. In general, the results of the model suggest significant and positive causal effects of trust on willingness to participate in joint marketing. The results are stable and robust even after controlling for a range of demographic and socioeconomic characteristics.

Furthermore, the effects of socioeconomic variables are largely consistent with the empirical literature. For example, access to (informal) credit and being member of farmers' association(s) have the expected positive and significant effect on willingness to participate in collective marketing. Risk attitude has also statistically significant negative association with willingness to participate in joint marketing as expected. This shows that, while it reduces strategic risk, trust has limited role in reducing risk attitude that emanate from random events[10]. Education and land holding size do not have the expected significant positive association with joint

[9] As will be indicated below, risk attitude (the proxy variable for risk preference) similarly has negative association with willingness to join collective marketing as expected.

[10] **Risk due to random event** as distinguished from strategic risk arises from uncertain factors beyond the control of decision-makers and other strategic actors while **strategic risk** arises when the outcome depends on the actions, intentions, or choices of other individuals or organizations.

marketing participation while livestock has negative association probably because the joint marketing is for crops not livestock. Moreover, income level and having mobile phone have negative association with willingness to participate in joint marketing. As mentioned above, the problems such as lack of information and collaboration problems are not reported since their effect is negligible.

Overall, willingness to coordinate production and marketing activities has positive and significant association with trust behaviour. Moreover, instrumented by cooperative behaviour as well as given the control of the potential confounding factors (proxies for risk and prosocial preference as well as other socioeconomic and demographic factors) and the residual from the first stage in the second stage specification, the findings suggest a causal relationship between trust behaviour and willingness of farmers to participate in joint marketing. In other words, the results of the analysis show that higher trust has positive effect on the probability of organizing collective marketing that need coordination of farming activities such as selecting seed variety, planting, and harvesting schedules. In short, this finding addresses the endogeneity problem and underscores the importance of trust as a determinant of collective marketing decision of farm households.

5. Discussion

This study provides experimental and econometric evidence on the positive effects of trust behaviours on willingness of smallholder farmers to participate in joint (collective) marketing arrangements. The study addresses the endogeneity problem by using cooperative behavior (proxied by contribution to public good game) as an instrument. In line to the arguments and evidence in the literature, the association of trust and cooperative behaviour in the first-stage regression shows that cooperative behaviour is theoretically justified and relevant instrument to trust. Moreover, the positive impact of trust on participation of farmers in collective marketing shows the role of trust in reducing fear of opportunistic behaviour and transaction costs such as coordination costs in collective actions. This means that those farmers who contribute more to public goods have more trust in community members and institutions and are also more likely to accept coordinated decision-making on activities such as seed choice, sowing dates, harvesting and marketing. The findings highlight the importance of trust in overcoming transaction costs and collective actions problems such as opportunistic behaviour in joint marketing (Olson, 1971; Ostrom, 1990; Grashuis, 2025). This implies that structural barriers and assets are

not the only constraints of collective action of farmers in developing countries but also behavioral factors such as trust and cooperation.

Therefore, the findings have both academical and policy implications. Academically, employing an instrument variable method in a comprehensive approach, the study elaborates the roles of trust in collective action. It has also enabled to confidently call for policy measures that take account and integration of trust building measures in agricultural programs. In other words, strengthening trust within communities and increasing the credibility of the involved institutions can enhance the collective action in general and collective marketing in particular of smallholder farmers in developing countries.

6. Conclusion

This study investigates the effects of trust on willingness of smallholder farmers to participate in collective marketing. It employs a rigorous IV strategy by using cooperative behaviour as an instrument for trust that controls the potential confounding factors such as risk and social preferences. The result of the study suggests that trust has a significant effect on willingness to participate in collective marketing that requires coordination of farm activities such as seed choice, seeding, harvesting and marketing schedules.

In terms of policy, the findings of the study underline the importance of giving due consideration to trust in interventions having the objectives of promoting collective marketing. That means promotion of agricultural development in general and collective marketing in particular need trust-building measures. This may include activities such as fostering local associations and facilitating the interaction of farmers to building reciprocity and reputations. This may be especially crucial in situations where collective actions are required but effective formal institutions that can enforce contracts are limited or inexistent.

However, though it is novel to study the causal effect of trust, it is important that this might involve some limitations or caveats. Firstly, the study employed stated willingness rather than actual collective market participation which may be subject to hypothetical bias. Thus, future research could address this by integrating experimental data with observed collective marketing behaviour and activities of farm households. Secondly, the finding of our study is the effect of trust behaviour on collective marketing controlling potential confounding factors which may requires disentanglement of the effects of the prosocial behaviours involved in trust

and cooperative behaviours. Thirdly, the study requires testing of the external validity of experimental trust and cooperative behaviours beyond the study context. This is because the analysis is conducted in certain institutional environment. Therefore, future research needs to be conducted that investigate the role of experimentally elicited trust and cooperation on collective actions in different contexts.

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Table 1: Descriptive statistics of the sample participants

Variable	Obs	Mean	Std. Dev.	Min	Max
Joint marketing	504	3.87	1.09	1	5
Age of head of hh	504	45.83	13.49	18	80
Gender	504	.68	0.47	0	1
Educational level	504	2.74	1.31	1	6
Family size (AE)	504	4.11	2.09	0	11.6
Monthly income	504	2586.47	2044.98	0	15000
land size (Tsimdi)	504	1.95	1.21	0	8
Livestock (TLU)	504	1.38	1.56	0	9.09
Risk aversion	504	3.94	2.53	0	10
Access to informal loan	504	0.50	0.50	0	1
Membership in Associations	504	0.64	0.48	0	1
Have mobile phone	504	0.79	0.41	0	1
Hatsebo (Village1)	126	1	0	1	1
Debrekal (Village2)	121	1	0	1	1
Mirena (Village3)	104	1	0	1	1
Lesalso (Village4)	104	1	0	1	1
Debrebrhan (Village5)	49	1	0	1	1

Table 2: Descriptive statistics of trust & cooperative behaviour of participants

Variable	Obs	Mean	Std. Dev.	Min	Max
Contribution in PGG (round1)	504	57.09	33.89	0	150
Contribution in PGG (round2)	504	57.14	32.38	0	150
PGG treatment arm1	128	1	0	1	1
PGG treatment arm2	128	1	0	1	1
PGG treatment arm3	128	1	0	1	1
PGG treatment arm4	120	1	0	1	1
Amount sent in trust game	504	44.08	24.61	0	100
Trust game arm1 (community)	88	1	0	1	1
Trust game arm2 (female)	88	1	0	1	1
Trust game arm3 (male)	88	1	0	1	1
Trust game arm4 (religious)	80	1	0	1	1
Trust game arm 5 (GO)	80	1	0	1	1
Trust game arm6 (NGO)	80	1	0	1	1
Reciprocity (Sent back in trust game)	504	49.88	40.81	0	250

Table 3: Stage one IV regression results (OLS)

Trust (amount sent)	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
PGG contr. (round2)	0.38	0.03	12.21	0.00	0.32	0.44	***
PGG arm1	-3.42	2.64	-1.29	0.20	-8.60	1.77	
PGG arm2	-0.10	2.62	-0.38	0.70	-6.14	4.14	
PGG arm3	-3.21	2.60	-1.23	0.22	-8.32	1.91	
Trustworthiness	0.06	0.02	2.58	0.01	0.02	0.11	**
Age	0.01	0.09	0.17	0.87	-0.16	0.18	
Gender	-0.94	2.19	-0.43	0.67	-5.24	3.37	
Education level	0.89	0.86	1.04	0.30	-0.80	2.59	
Family size (AE)	-0.31	0.55	-0.55	0.58	-1.40	0.78	
Monthly income	0.00	0.00	1.57	0.12	0.00	0.00	
Land size (Tsimdi)	0.57	0.90	0.63	0.53	-1.20	2.34	
Livestock (TLU)	0.78	0.75	1.03	0.30	-0.70	2.26	
Risk attitude	0.41	0.40	1.02	.307	-0.38	1.19	
Access to informal loan	-1.12	1.91	-0.59	0.56	-4.87	2.63	
Farmers' association	2.98	2.05	1.45	0.15	-1.05	7.00	
Have mobile phone	3.30	2.58	1.28	0.20	-1.77	8.37	
village2	1.74	2.66	0.65	0.51	-3.49	6.97	
village3	2.24	2.73	0.82	0.41	-3.13	7.61	
village4	-0.58	2.74	-0.21	0.83	-5.97	4.80	
village5	4.54	3.49	1.30	0.19	-2.32	11.40	
Constant	8.95	6.33	1.41	0.16	-3.50	21.39	
Mean dependent var	44.08		SD dependent var		24.61		
R-squared	0.36		Number of obs		504		
F-test	13.62		Prob > F		0.00		
Akaike crit. (AIC)	4474.55		Bayesian crit. (BIC)		4563.22		

*** p<.01, ** p<.05, * p<.1

Table 4: Second stage IV regression results of joint market (Ordered probit)

Joint market	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Trust (amount sent)	0.08	0.01	13.64	0.00	0.07	0.09	***
e_residual	-0.07	0.01	-11.44	0.00	-0.09	-0.06	***
Trustworthiness	-0.01	0.00	-2.94	0.00	-0.01	-0.00	***
PGG arm1	0.34	0.15	2.26	0.02	0.05	0.63	**
PGG arm2	0.28	0.15	1.86	0.06	-0.02	0.57	*
PGG arm3	0.24	0.15	1.63	0.10	-0.05	0.53	
Age	-0.00	0.01	-0.84	0.40	-0.01	0.01	
Gender	0.08	0.12	0.62	0.53	-0.16	0.32	
Education level	0.00	0.05	0.04	0.97	-0.09	0.10	
Family size (AE)	0.05	0.03	1.42	0.16	-0.02	0.11	
Monthly income	0.00	0.00	-2.84	0.01	0.00	0.00	***
Land size (Tsimdi)	0.02	0.05	0.44	0.66	-0.08	0.13	
Livestock (TLU)	-0.09	0.05	-1.94	0.05	-0.18	0.00	*
Risk attitude	-0.09	0.02	-3.97	0.00	-0.14	-0.05	***
Access to informal loan	0.44	0.11	4.10	0.00	0.23	0.66	***
Farmers' association	0.31	0.12	2.66	0.01	0.08	0.54	***
Have mobile phone	-0.32	0.15	-2.21	0.03	-0.61	-0.04	**
village2	-0.15	0.15	-1.00	0.32	-0.45	0.15	
village3	-0.16	0.16	-1.03	0.30	-0.46	0.14	
village4	-0.20	0.16	-1.26	0.21	-0.51	0.11	
village5	0.17	0.22	0.79	0.43	-0.25	0.59	
cut1	0.85	0.38	.b	.b	0.10	1.60	
cut2	1.33	0.38	.b	.b	0.59	2.08	
cut3	2.34	0.39	.b	.b	1.59	3.10	
cut4	3.87	0.41	.b	.b	3.07	4.67	

Mean dependent var	3.87	SD dependent var	1.09
Pseudo r-squared	0.27	Number of obs	504
Chi-square	385.31	Prob > chi2	0.00
Akaike crit. (AIC)	1115.98	Bayesian crit. (BIC)	1221.54

*** p<.01, ** p<.05, * p<.1

Urban Poultry Farmers Policy Preferences in Tigray, Ethiopia: A Best-Worst Scaling Approach

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Abstract

This study aimed to investigate urban poultry policy preferences using a best-worst scaling approach in Tigray. A sample of 400 farmers was selected using a multi-stage sampling technique. We analyzed the data using descriptive statistics, mixed logit and latent class models. The analysis revealed that farmers prefer policy options related feed quality and safety, as well as digital and financial inclusion. These preferences highlight the importance of stable markets, reliable inputs, and accessible financial services. Significant heterogeneity in policy preferences was observed, reflecting diverse attitudes and needs within the urban agricultural sector. Class 1 farmers were generally older, more experienced, and predominantly male. They tended to be traditional or subsistence-oriented producers rather than market-oriented. In contrast, Class 2 farmers were diversified, engaging in multiple livelihood activities beyond poultry production. The study concludes that enhancing feed quality and finance inclusion, supported by access to infrastructure, is essential for enhancing productivity and resilience in urban poultry farming. Urban poultry policy must consider both economic and social motivations to promote inclusive and sustainable growth in the sector. The findings of this paper can assist policymakers by outlining preferred policies that are more likely to be embraced by urban poultry farmers. Ongoing collection of longitudinal data on costs and preferences is crucial for monitoring shifts in preferences and refining interventions in urban poultry farming.

Keywords: Policy Preferences heterogeneity, Stated preference, Urban poultry.
JEL Classification: C93, D03, O13, Q18

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1. Introduction

Poultry production is among the fastest-growing livestock sectors worldwide, with more than 23 billion birds raised globally (FAOSTAT, 2016). The industry continues to expand, with chicken accounting for 65% of total output, driven largely by high demand in China, Brazil, and the United States (Ben Hassen et al., 2025). Poultry farming is practiced across rural, pre-urban[3] and urban[4] areas. Urban and peri-urban poultry production-defined as the rearing of chickens for eggs, meat, or even as pets within or near urban cities-ranges from small backyard flocks to large, more intensive systems (Nasinyama et al., 2010). It is often linked to local food systems, contributing to food security, livelihoods, and households' income. Policymakers and development agencies have promoted, including poultry farming, as a pathway to food resilience, employment creation, and women's empowerment (Orsini et al., 2013; Teng, 2024). In Ethiopia, and particularly in Tigray, urban poultry farming plays a substantial role in enhancing household food security, livelihoods, and women's economic empowerment.

In Ethiopia, the poultry population is estimated at 60 million chickens, with 35% located in the urban areas (CSA, 2023). The flock composition includes indigenous breads (53.43%), exotic breads (43.18%) and cross breads (3.39%) (Bedada et al., 2024). From 2010 to 2050, the demand for poultry meat and eggs is projected to rise by 179% and 88% respectively between 2010 to 2050 (FAO, 2019). In Tigray, local chickens dominate the flock composition (72.5%) and followed by exotic (16.25%) and cross breed (11.25%) types (Teklay et al. 2024). According to the Bureau of Agriculture and Natural Resource of Tigray (2024/2025), modern poultry production in peri-urban and urban areas currently stands at 606,639 birds, with plans to expand to 1,152,000 units by the end of 2025. Egg output is projected to reach 6,672,000 units. Average poultry and egg prices in Tigray were at $8.34 and $0.90 in 2025, compared to global averages of $5.65 and $3.32, respectively (GlobalProductPrices.com., 2025). Per capita poultry meat consumption in Israel, the USA, and Malaysia was 58.5Kg, 49.8Kg,

[3] A peri-urban area is a zone of transition between urban and rural areas, and is characterized by coexistence of agricultural and urban activities and contested resource use (Allen, 2003).

[4] Urban areas are settlements characterized by high population density, infrastructure concentration, and economic diversification (UN-Habitat, 2020).

and 46.7Kg respectively, while Ethiopian's per capita consumption remains very low at 2.85Kg (Dugassa (2022).

Despite its importance, the poultry subsector faces multiple constraints, including inadequate policy support, poor access to quality feed, high diseases prevalence, and week veterinary services (Fekadu et al., 2023). Financial limitations, unstable markets, and weak institutional support further undermine productivity (Chapot et al., 2024). Similar challenges affect urban agriculture in Tigray, limiting the sector's development. Moreover, while efforts to promote sustainable urban poultry farming, are increasing, little is known about the policy preferences of urban poultry farmers in Tigray. Resource constraints, volatility, conflict, and institutional gaps shape decision-making, yet there remains a disconnect between farmers' policy demands and government-designed interventions. These mismatches exacerbate hunger, poverty, food insecurity, migration, and instability in the conflict-affected region. Targeted urban poultry policy interventions and support programs are therefore urgently needed to enhance productivity and sustainability. Previous studies (Chelang'a et al., 2025; Amato et al., 2023; Ngoma et al., 2025; Muunda et al., 2021; Van Wyngaarden et al., 2024) utilized the best-worst scaling (BWS) approach to measure preferences in different countries. In Ethiopia, Ebsa et al. (2019) examined poultry production challenges in Bishoftu, while other studies (Gebremariam et al., 2017; Nirea andBelay, 2024; Teklay et al., 2024) investigated indigenous chicken production system, constraints and opportunities in Tigray.

Existing empirical literature reveals significant methodological, empirical and knowledge gaps. Most studies fail to incorporate flexible modeling of preference heterogeneity, and local empirical work reflects similar limitations. Consequently, agricultural policies are often designed without rigorous evidence on how farmers prioritize competing policy instruments. This is particularly critical in poultry production, which is less labor-intensive, requires limited space, and can be practiced by landless youth urban farmers. Moreover, because poultry farming is female-dominated, it represents a strategic livelihood option for vulnerable populations. When policies overlook heterogeneous preferences in urban poultry farming, adoption rates remain low, resources are inefficiently allocated, productivity stagnates, and food security and livelihoods are ultimately undermined.

The motivation for this study lies in bridging the gap between top-down policy design and the realities of urban poultry farmers in conflict affected Tigray.

Building on this, the study employs the BWS approach to: (i) identify the most and least preferred policy options among urban poultry farmers in Tigray (ii) analyze the drivers of policy preferences, and (iii) examine preference heterogeneity across socio-economic groups. Accordingly, the study addresses the research question: (1) what are the most and least preferred policy options among urban poultry farmers identified through the Best-Worst Scaling (BWS) method? (2) how do agricultural policy interventions influence the policy preferences of urban poultry farmers? and (3) To what extent do policy preferences vary across different socio-economic groups of urban poultry farmers in Tigray?

This study makes two key contributions. First, it applied the BWS method-widely used in other fields but rarely in urban poultry policy research-to elicit farmer's preferences in Tigray. By utilizing BWS to explore policy preferences in Tigray, our research expands its application to a new context. Second, it incorporates heterogeneity analyze based on class membership, enriching the literature on farmer diversity in urban agriculture. By highlighting differentiated preferences within the poultry sector, the study offers policymakers evidence-based insights for designing more equitable and targeted interventions.

2. Literature Reviews

2.1. Theoretical and empirical reviews

Urban poultry farming defined as rearing of chickens for eggs, meat, or as pets in urban areas (Nasinyama et al., 2010). This type of agriculture plays a critical role in improving food security, reducing poverty, diversifying income, and enhancing livelihoods in urban settings (Mwaijande, 2025; Warren et al., 2015). It does not operate in isolation but is embedded within complex urban food value chains, where policy frameworks, institutional support, and market linkages shape outcomes (Opitz et al., 2016). Consequently, it is essential to understand the urban agricultural policy preferences that affect the behaviors and decisions of urban farmers in order to achieve food security. Urban agricultural policy preferences refer to the specific policies favored by farmers, which are designed to boost agricultural productivity and production.

The theoretical foundation of this study is based on behavioral and economic theories that explain how individuals form preferences and make policy-related decisions. Specifically, it draws on Random Utility Theory (McFadden, 1974),

which underpins the Best–Worst Scaling (BWS) approach. As a preference elicitation technique, random utility theory explains how urban poultry farmers rank different policy options based on their utility. This method enables researchers to quantify the decision-making process of farmers when selecting their most and least preferred policy interventions (Fishbein & Ajzen, 2011). BWS, originally developed by Finn & Louviere (1992) and later expanded by Flynn et al. (2007), refines this approach by identifying both the most and least preferred attributes within a given set of policy options, thereby revealing the intensity of preference. Unlike traditional Likert scales, BWS captures the relative importance of policy features and the trade-offs individuals make when faced with competing priorities (Louviere et al., 2015). This integration of behavioral intention models and utility-based preference analysis provides a robust theoretical lens for understanding how urban poultry farmers in Tigray evaluate agricultural policies. By applying RUT and BWS to the context of urban poultry farming, the study generates empirical insights into farmers' most valued policy options, offering policy makers a quantitative, evidence-based foundation for designing more responsive and effective agricultural policies.

Empirical studies on poultries in Ethiopia remain descriptive and production-oriented. For example, Gebremariam et al. (2017) examined indigenous chicken production and breeding practices in Tigray, using data from 180 producers across diverse agroecological zones. Their findings showed that production was predominantly backyard-based, with seasonal feeding supplementation and reliance on traditional medicine. However, the study's limited sample and descriptive scope restricted its policy relevance. Similarly, Teklay et al. (2024) and Nirea & Belay (2024) characterized production systems in Central and Eastern Tigray, drawing on small household samples (80 and 178, respectively). These studies provided useful descriptive insights- such as average flock sizes, housing practices, and feeding behaviors, yet lacked advanced modeling of policy preferences. Ebsa et al. (2019) further identified key challenges among poultry producers in Bishoftu, including disease outbreaks, high feed costs, and limited access to day-old chicks. While valuable, the study underscored systemic constraints without adequately addressing policy dimensions relevant to urban poultry farmers in Tigray.

In contrast, a growing body of agricultural policy research has employed stated-preference methods, particularly Best–Worst Scaling (BWS). Yet, this methodological innovation remain largely disconnected from poultry systems and

urban livestock contexts, highlighting a critical gap for future inquiry. For instance, Amato et al. (2023) applied a Best–Worst Scaling approach to examine the preferences of 205 Italian consumers regarding chicken meat. Their study generated valuable insights into quality perceptions and product differentiation within a developed European poultry market. However, the focus was primarily on consumer choice rather than producer-level policy preferences. Consequently, while methodology relevant, the study offers limited direct insight into the heterogeneity of urban agriculture producer policies in emerging economy such as Tigray.

Similarly, Muunda et al. (2021) investigated the effects of Kenya's dairy policy reforms on household milk allocation decisions in Nairobi using a Best–Worst Scaling approach. Their findings indicate that rising milk prices reduce milk consumption among children. However, the study remains focused on household consumption rather than producer-level policy prioritization. In addition, it does not explicitly account for unobserved preference heterogeneity. These limitations highlight the need for more flexible modeling frameworks, such as latent class models- and a broader empirical scope when investigating policy preferences within urban agricultural production systems.

Other studies have extended the application of BWS to climate and agricultural policy contexts, further demonstrating its methodological versatility. Van Wyngaarden et al. (2024), examined farmers' preferences for climate-mitigative policies in Alberta, Canada. Their findings indicate that policy support is influenced not only by economic incentives but also by attitudinal and belief-based factors. However, the study relies on a conditional logit model, which may obscure potential variation across farmer segments. This methodological limitation highlights the importance of incorporating more flexible approaches, such as mixed logit and latent class models- when analyzing diverse agricultural contexts. In Kenya, Chelang'a et al. (2025) extend the application of Best–Worst Scaling to examine smallholder dairy farmers' preferences for climate-smart agricultural strategies. Their findings demonstrate that adoption priorities are not uniform and that socio-economic differentiation significantly shapes responses to agricultural interventions. However, identifying priority interventions alone is insufficient; they must also be embedded within locally grounded, heterogeneous farmer realities. Similarly, Zander et al. (2024) utilized best-worst scaling to guide agroecological interventions in Western Kenya. Their results show that improved household health and food security were perceived as the most important options,

alongside other options that generate private benefits. By contrast, benefits such as improved forest quality, community resilience, reduced off-farm environmental impacts, reduced reliance on synthetic chemicals, and enhances landscape and wildlife management were considered less important. These findings highlight the need for support mechanisms-such as payments for ecosystem services- to encourage the provision of public goods and to identify which ecosystem services the public values most.

In Kenya, Ola & Menapace (2020) found that horticultural farmers strongly preferred coordinated market arrangements that provide stable pricing, input access, and contractual support mechanisms. These findings reduce transaction costs and enhance sustained participation in modern value chains. This demonstrates that farmer preferences are embedded within broader agribusiness and value-chain policy frameworks that shape market integration and commercialization outcomes. The study concentrated on market attributes of horticultural farming. However, the poultry farmers are different from horticultural farm. Therefore, further study on policy preference on poultry farming is needed.

Likewise, Ngoma et al. (2025) contributed to the growing body of stated-preference research on agricultural policy in Zimbabwe by utilizing a Best–Worst Scaling approach. Their findings indicate that farmers prioritize policy instruments that directly enhance both production capacity and market incentives. However, the study is focused on rural agroecological systems and does not explicitly address preference heterogeneity through class-based segmentation in urban agriculture. The absence of latent class analysis limits deeper insights into how demographic or structural differences influences policy priorities in both rural and urban contexts. These gaps underscore the need for broader, and more analytically rigorous research that captures heterogeneous preferences within diverse urban livestock systems. Such an approach would strengthen the foundation for designing targeted and context-sensitive poultry policy interventions in emerging economy.

Similarly, Ibe et al. (2024) conducted a study in Nigeria using the best-worst scaling approach to examine farmers' preference for plantain options. Their findings indicate that early maturity, heavy bunch, large fingers and high finger counts per bunch were the four most important options. These findings have important implications for improving plantain hybrids to enhance adoption and impact in Nigeria. The study therefore recommends that farmers' preferences be

incorporated into breeding programs for new varieties. Improved plantain varieties that integrate the most valued traits could boost productivity and food production. However, the study did not address the diverse preferences among farmers, which could pose challenges in formulating appropriate policies for those with varying socio-economic characteristics across different regions.

Previous poultry studies primarily address production constraints but fail to incorporate modeling policy preferences. While other agricultural policy best-worst scaling (BWS) studies quantify preferences, they seldom focus specifically on the poultry sector. Moreover, the methodologies employed in these studies often inadequately capture heterogeneity, using models like mixed logit or latent class analysis. To date, no empirical research in Ethiopia has utilized the best-worst scaling approach to explore the diverse policy preferences within urban poultry farming. Consequently, agricultural policies are being developed and assessed without robust evidence on how producers prioritize competing policy instruments. This is particularly critical in poultry production, which is less labor-intensive, requires limited space, and practiced by landless urban farmers. When policies fail to account for heterogeneous preferences in urban poultry farming, adoption remain low, resource allocation inefficient, weak productivity, and food security and livelihoods are ultimately undermined. By integrating poultry-sector analysis, the urban agricultural policy context, and advanced stated-preference modeling, this study directly addresses this gap, offering a more analytically integrated approach to designing context-sensitive poultry policy interventions in emerging economies such as Tigray.

2.2. Theoretical framework

The study aimed to assess urban poultry farming policy preferences in Tigray using a stated- preferences method, following Haab & McConnell (2002). Stated-Preference(SP) methods are a survey-based economic techniques in which individuals are asked to express their preferences for hypothetical scenarios, thereby allowing researchers to estimate the value they place on specific options (Carson, 2000). The SP methods include contingent valuation method (CVM) and discrete choice modelling (CM). Discrete choice models describe decision-makers' choices among alternatives options (Train, 2009). In this study, the Best-Worst Scaling (BWS), a form of discrete choice modelling, was used. Since its development in the late 1980s and early 1990s, BWS has become a widely

utilized tool in marketing, health economics, and the social sciences (Louviere et al., 2015).

A key strength of Best-Worst Scaling (BWS) is its ability to offer more detailed insights into preferences compared to traditional ranking methods (Flynn et al., 2007). A fundamental assumption of the BWS approach is that best and worst choices are derived from a common underlying utility function (Chrzan & Peitz, 2019). By requiring participants to select the most and least important factors from a given set, this study captures the trade-offs and priorities of urban poultry farmers.

The implementation formats of BWS include object case, profile case, and multi-profile case (Marley et al., 2015). In the object case, respondents are asked to select the best and worst items from a given set of options. The profile case, by contrast, focuses on identifying the best and worst features within a single alternative. Lastly, the multi-profile case involves comparing several complete profiles simultaneously. Given the objective of identifying farmers' preferences across different urban poultry farming policy options, this study employed the object case design was used.

The application of BWS in this study is based on Lancaster's Consumer Theory, which asserts that individuals derive utility from the characteristics of alternatives rather than from the alternatives themselves. This theory is implemented through the Random Utility Framework (RUF) as developed by McFadden (1974). Within this framework, when a rational utility-maximizing farmer i faces a set of j urban poultry farming policy options, the utility derived from option j can be expressed as:

$$U_{ij} = V_{ij} + \varepsilon_{ij} \quad \textbf{(1)}$$

where V_{ij} represents the observable component and ε_{ij} the random unobservable component.

The probability that farmer i selects option j as the most preferred over alternative k is therefore given by:

$$P(Y_i = j) = P\left(V_{ij} + \varepsilon_{ij} \geq V_{ik} + V_{ik}\right), \forall\, k \neq j. \quad \textbf{(2)}$$

These choice probabilities are estimated using a mixed logit model, which allows preference parameters (β_j) to vary randomly among individuals. A detailed model specification is provided in the methodology section.

3. Research Methodology

3.1. Study area and research design

The study was conducted in the urban areas of Mekelle, Wukro, Adwa, and Axum in Tigray, Ethiopia. These four sites were purposively selected because they represent major poultry production and marketing hubs in the region. Urban poultry production is common in these areas and plays a significant economic role. The sector provides important employment opportunities, particularly for women and youths, and contributes an estimated 15–20% of Tigray's agricultural GDP (Ashebir et al., 2007).

The research design for this study utilized a mixed-methods approach, integrating both quantitative and qualitative research methodologies. Data were collected through surveys and field experiments. Farmers' policy preferences were ranked using the Best-Worst Scaling (BWS) technique. The data were analyzed using Mixed Logit (ML) and latent class models to capture preference heterogeneity. Primary data were supplemented with secondary sources to strengthen the analysis.

3.2. Sampling techniques and method of data collection

A multi-stage sampling technique was used to select 400 sample farmers. In the first stage, the urban areas of Mekelle, Wukro, Adwa and Axum were purposively selected based on their potential poultry production. In the second stage, within each selected urban area, sub-clusters known as tabias with high-density poultry activity were identified and purposively chosen. Finaly, in the third stage, simple random sampling was applied to select individual poultry farmers.

The sample size was allocated to each tabias proportionally to its population size, and the total sample size was determined Cochran (1977) formula. Each sampled farmer completed six choice sets, with three options per set, resulting in 2400 observations with no missing responses. The data were further processed to account for possible best-worst tie within each choice set, producing a final dataset of 14,400 observations for the mixed logit models. In the urban poultry farming survey, such expansion was possible because each of the 2400

observations can generate six possible best-worst pairs calculated as $n(n-1) = x => 3(3-1) = 6$. The expansion of the dataset is a methodological requirement in the Best-Worst Scaling (BWS) approach, ensuring a more robust, statistically efficient, and behaviorally interpretable dataset. It converts limited surface-level responses into a fuller representation of respondent's latent utility ordering, thereby enhancing the reliability of the result. Nevertheless, the sampling frame was restricted to urban poultry farmers, limiting generalizability of findings to rural populations.

This study utilized both primary and secondary data types and sources. Primary data was collected during 2025/2026 through face-to-face interviews. A pre-tested was conducted to ensure the relevance of the questionnaire and to identify appropriate policy options. Enumerator received training prior to conducting the interviews. Secondary data was also collected from both published and unpublished sources to complement and support the primary data.

3.3. Best-worst scaling design

BWS is a survey-based method designed to measure urban poultry farmers' preferences regarding various options. In this study, a pre-test was conducted with urban poultry farmers and key informants to identify six policy options that were used in the actual field. Additionally, relevant literature was reviewed to further support the policy options identified by farmers and key informants. Six policy options that were locally relevant and of practical important were selected. Each farmer received six choice cards, with three policy options presented on each card. Farmers were asked to indicate the most preferred (best) and least preferred (worst) option from each card. This Best–Worst Scaling process was repeated across all six choice cards per farmer, thereby allowing for multiple evaluations of the policy options in different combinations. The name and descriptions of the policy options used in this study are presented in Table 1.

Table 6: Policy options and descriptions

Policy options	Policy Description
Feed quality and safety (A1)	Poultry farmers in Tigray are facing challenges related to poor-quality animal feed, which has led to reduced productivity and declining production levels. As a result, implementing a national feed certification and quality control system is essential to prevent the distribution of counterfeit or substandard feed, improve poultry performance, safeguard farmers' incomes, and protect consumer health and food safety.
Digital and financial inclusions (A2)	Develop an integrated digital platform offering veterinary advice, disease alerts, training, market prices, and links to microcredit and mobile financial services. This dual digital–financial system empowering small-scale urban poultry farmers through improved access to information, capital, and income opportunities.
Insurance (A3)	Introduce an insurance scheme for urban poultry farmers to cover disease losses, conflict-related shocks, and production variability, enhancing resilience and financial stability are very vital.
Research and development (A4)	The farming practices existing in Ethiopia is not linked with universities, colleges and other private sectors via research. This lowers the benefit they obtained from the farm. Promote research collaboration between universities, local institutes, and the private sector on breeding, feed innovation, and disease control is very important in Tigray.
Cluster-based poultry development (A5)	The main problem the urban farmers in Tigray is the absence of cluster-based production development. As a result, their unable to obtained necessary input on time with fair price. Establishing designated urban poultry clusters with shared hatcheries, feed stores, cold storage facilities, veterinary clinics, extension services, vaccination and disease-surveillance services, and waste management facilities. Such clusters would reduce production costs, improve animal health and biosecurity, strengthen disease prevention and control, and encourage partnerships among farmers, private investors, veterinary professionals, and local government institutions. This integrated approach would improve productivity, profitability, and the sustainability of urban poultry production in Tigray.
Market and infrastructure access (A6)	Strengthen market linkages and infrastructure (roads, electricity, water, transport etc.) to enhance production, improve urban market access, increase farmer profits, and support food security.

Source: Authors own work, 2026

Following Zander et al. (2024), Louviere et al.(2015), Muunda et al. (2021), and Ngoma et al. (2025), the Balanced Incomplete Block Design (BIBD) was used to ensure that each policy option appeared an equal number of times across all choice sets (Table 2). This approach reduces context effects and systematic selection bias, while improving parameter identification (Louviere et al., 2015; Flynn et al., 2007). The BIBD for x options is denoted as (c, r, j, λ), where c is the number of choice sets (blocks), r is the repetition per level, j is the number of items in each choice set (block size), and λ is the pair frequency. The design must satisfy the equation, $c * j = x * r$ (Louviere et al., 2015). However, since the construction of choice sets relied on an orthogonal design, it does not capture how two or more options together might influence farmers' choices.

Table 7: Choice set construction

Choice card	Policy option 1	Policy option 2	Policy option 3
C1	A5	A3	A1
C2	A6	A5	A2
C3	A1	A4	A3
C4	A4	A2	A5
C5	A1	A6	A4
C6	A3	A2	A6

Source: Authors own work, 2026

3.4. Data analyze techniques

The study employed both a counting score and econometric models to analyze the Best-Worst Scaling data, following Louviere et al.(2015), Muunda et al.(2021), Ngoma et al.(2025), and Zander et al. (2024). The best-worst (BW) scores were computed by subtracting the worst score from the best score and then standardizing them according to the sample size and the number of times each policy option was presented to respondents. Following Loose and Lockshin (2013), Muunda et al. (2021), and Ngoma et al. (2025) standardize score is calculated as:

$$\text{Standardized(Best} - \text{Worst)Score} = \frac{B_j - W_j}{nxm} \quad \textbf{(3)}$$

where, B_j number of times policy j was selected as best; W_j is the number of times policy j was selected as worst; n is the total number of farmers; m is the

number of times a given policy option was presented to each individual across all choice sets. Following Muunda et al. (2021), the scores were transformed into a positive scale to ease interpretation using the square root of the best-to-worst ratio (sqrt(B/W). These positive scales were normalized with the most highly ranked policy preference assigned a value of 100. This was achieved by multiplying each positive scale by a weighting factor (Loose & Lockshin, 2013):

$$\text{Weighting factor for standardized ratio scale} = \frac{100}{max(\sqrt{B/W})} \quad \textbf{(4)}$$

To ensure clarity, ease of interpretation, and comparability, an additional weighting factor:

$$\text{Weighting factor for relative importance} = \frac{100}{\sum_{n=1}^{i}(\sqrt{B/W})} \quad \textbf{(5)}$$

This methodological framework ensured that the ranking of policy preference is both statistically sound and easily understandable for policymakers and stakeholders involved in the development of urban poultry farming in Tigray.
The Mixed Logit (ML) model, also known as the Random Parameters Logit, was employed to identify the effect of interventions on farmers' choices. The MN model extends the standard Multinomial Logit (MNL) by allowing utility coefficients to vary randomly across individuals. Its foundational assumptions include random utility maximization (McFadden, 1974), and distributional assumption regarding parameters (Train, 2009).

The probability that a farmer chooses policy j as the most preferred and item k as the least preferred is given by:

$$\mathrm{P(j = best\,, k = worst|\lambda_i)} = \frac{\epsilon^{\lambda_j - \lambda_k}}{\sum_{s=1}^{J}\sum_{t=1}^{J}\epsilon^{\lambda_s - \lambda_{t-J}}} \quad \textbf{(6)}$$

Unlike the MNL, the ML model incorporates random coefficients to account for heterogeneity farmers' decision-making (Train, 2009). The model is specified as:

$$U_{ij} = \alpha + \sum_{k=1}^{J}\lambda_k L_{ijk} + \epsilon_{ij} \quad \textbf{(7)}$$

where $L_{ijk} \in \{-1,0,1\}$ indicates whether option k was selected as worst, not chosen, or best; λ_k represents individual-specific preference weights for policy alternative k; α is a constant term capturing baseline utility; ϵ_{ij} the error term.

From the estimated utilities, the importance share for each attribute was computed as:

$$\text{Share of Preference for option}_{\text{i}} = \frac{\epsilon^{\lambda_{\text{j}}}}{\sum_{\text{i}=1}^{\text{J}} \epsilon^{\lambda_{\text{i}}}} \quad \textbf{(8)}$$

The preference share assigned to each option reflects both its actual significance and the relative uncertainty farmers may have regarding its importance (Sackett et al., 2013).

To further uncover unobserved heterogeneity in decision-making, a Latent Class Model (LCM) was applied, following Greene & Hensher (2003) and Boxall & Adamowicz (2002). The LCM assumes that the population consists of a finite number of unobserved (latent) classes, each with its own fixed parameter vector. Its assumptions include a finite number of classes and class-specific homogeneity (Greene & Hensher, 2003). Class membership probabilities were estimated using model parameters and observed covariates, expressed as follows:

$$C_{ij} = \frac{\exp(Z_i \beta_j)}{\sum_{i=1}^{j} \exp(Z_i \beta_j)}, \quad \text{j= 1,2,…n} \quad \textbf{(9)}$$

where Z_i represents individual characteristics.

In applying LCM, the Bayesian Information Criterion (BIC) was used to determine the optimal number of classes (Schwarz, 1978;Vermunt & Magidson, 2002). A lower BIC value indicates better model fit while accounting for model complexity. Lower value was used to identify the optimal class in this study.

4. Result and Discussions

4.1. Sample characteristics

Table 3 summarizes the socio-economic and demographic characteristics of the 400 farmers in the sample. The results show that 42.5% of the respondents are male, with an average age of 45 years. Most of the sampled farmers are married (66.3%), while 8% are divorced, 22% are single, and 4% are widowed. The average educational attainment is 10 years of schooling, with some respondents reaching degree level (12+5 years). This suggests that the farmers in the sample possess sufficient knowledge to manage their farms. The average family size is four members, and the farmers have an average of 5.15 years of poultry farming experience. This information suggests that family dynamics and prior knowledge

significantly influence the success of their farming practices. The findings further reveal that the average flock size among respondents is 451 birds. Geographically, 29.8% of the farmers are from Mekelle city, while 25.8% are from Adwa town.

Table 8: Socio-economic and demographic characteristics of the sample (n=400)

Variable	Mean	Std. dev.	Min	Max
Gender (1=male)	0.425	0.494	0	1
Age (years)	45	8.15	21	59
Marital status (single=1)				
Single	0.22	0.415	0	1
Married	0.663	0.474	0	1
Divorced	0.078	0.268	0	1
Widowed	0.04	0.196	0	1
Education (years)	9.985	3.166	1	Degree (12+5)
Family size (number)	3.853	1.325	1	7
Farming experience (years)	5.147	2.745	1	12
Flock size (Number)	451	470.195	50	4200
Location (Mekelle city=1)				
Mekelle city	0.298	0.458	0	1
Wukro town	0.175	0.380	0	1
Adwa town	0.258	0.438	0	1
Axum town	0.271	0.445	0	1

Source: Authors own work, 2026

4.2. Preferred policy options

Urban poultry farmers clearly prioritize policies that enhance production and productivity. Table 4 shows that feed quality and safety received the highest scores, followed by digital and financial inclusion. This suggests that these two options provided greater utility compared to the other four alternatives. Overall, the results confirm that farmers place the greatest importance on policies that directly improve production inputs and market access, rather than on long-term or risk-management measures. These findings are consistent with Lancaster's Consumer Theory (1966) and Random Utility Theory (McFadden, 1974), which emphasize that individuals derive utility from the specific attributes of alternatives rather than from the alternatives themselves.

Table 9: Urban poultry policy options scores and their relative importance (n=14,400)

Attribute	Best Choice	Worst Choice	BW	BW score	Sqrt(B/W)	Standardized ratio scale	Relative importance	Rank
Feed quality and safety	4284	1770	2514	2.10	1.56	100.00	25.60	1
Digital and financial inclusions	3270	1788	1482	1.24	1.35	86.93	22.25	2
Insurance	1230	2928	-1698	-1.42	0.65	41.66	10.67	6
Research and development	1446	2616	-1170	-0.98	0.74	47.79	12.23	5
Cluster-based poultry development	2148	2862	-714	-0.60	0.87	55.69	14.26	4
Market and infrastructure access	2022	2436	-414	-0.35	0.91	58.56	14.99	3

Note: Weighting factor for standardized ratio scale :64.28; Weighting factor for relative importance: 16.46 (Source: Authors own work, 2026)

4.3. The Mixed Logit Model Estimates

Not all urban poultry farmers value policy options in exactly the same way. Table 5 illustrates the heterogeneity of preferences. To avoid multicollinearity among the explanatory variables, the policy option of insurance was excluded from the maximum likelihood estimation, as it provided lower utility based on the best-worst scores (see Table 4). As expected, the coefficients of the five remaining options are positive and significant, indicating that these policies yield greater utility than the base option (insurance) for urban poultry farmers. The mixed logit results further support the earlier findings from the most-least score analysis. In both the descriptive results (Table 4) and the mixed logit model (Table 5), the options for feed quality and safety, as well as digital and financial inclusions, consistently emerge as the most significant determinants of utility. In Table 4, feed quality and safety ranked first with the highest relative importance at 25.6%, followed by digital and financial inclusions at 22.25%.

Similarly, Table 5 supports this structure: showing that the policy options for feed quality and safety ($\beta = 0.825$, $p < 0.01$) and digital and financial inclusion ($\beta = 0.467$, $p < 0.01$) exhibit the largest and most significant coefficients, yielding the

greatest positive utility to urban poultry farmers in Tigray. The option for market and infrastructure access ranks third. The variation in coefficients supports preference heterogeneity theory, which recognizes that individuals differ in their sensitivities to different options. Additionally, the standard deviation estimates are highly statistically significant for the options of feed quality and safety, as well as cluster-based poultry development, indicating heterogeneity in preferences. For the remaining options, no significant heterogeneity was observed. Both the mixed logit model and the most-least score approach confirm that market and infrastructure access ($\beta = 0.226$, $p < 0.01$) has significant positive effect on utility. These results, imply that agribusiness firms should design bundled service packages that align with farmers' revealed preferences.

Unlike conventional descriptive methods, the use of stated-preference modeling techniques enables for the estimation of trade-offs, providing deeper insights into how farmers assess policy options. These findings are consistent with Random Utility Theory (McFadden, 1974) and Mixed Logit Model Theory (Train, 2009), both of which accommodates unobserved preference variation and repeated choices. Furthermore, the observed heterogeneity in preferences is consistent with recent empirical evidence (Amato et al., 2023; Ngoma et al., 2025).

Table 10: Mixed logit model estimations and share of preferences (SP)

Variables	Mean	SP	SD	SP
Feed quality and safety	0.825***	0.288	0.896***	0.327
	(0.0732)		(0.0827)	
Digital and financial inclusions	0.467***	0.213	0.0125	0.157
	(0.0504)		(0.206)	
Research and development	0.108**	0.16	-0.0127	0.157
	(0.0496)		(0.104)	
Cluster-based poultry development	0.166***	0.166	0.254***	0.195
	(0.0515)		(0.0960)	
Market and infrastructure access	0.226***	0.174	-0.0520	0.164
	(0.0495)		(0.136)	
Observations	14,400		14,400	
Standard errors in parentheses				
*** p<0.01, ** p<0.05, * p<0.1				
LR chi2(5)= 95.05; Log likelihood = -4091.075; Prob > chi2 = 0.0000				

Source: Authors own work, 2026

The calculated share of preference (SP) values indicate that urban poultry farmers prioritize specific policy options. The mixed logit model estimates of further validate the ranking these options presented in Table 4. These findings are consistent with Discrete Choice Theory (McFadden, 1974; Train, 2009), which suggests that individuals make rational decisions by choosing the option that maximizes their perceived utility.

4.4. The Latent Class Model Estimates

Urban poultry farmers can be categorized in to two main classes based on their policy preferences. The Bayesian Information Criterion (BIC) was utilized to identify the optimal class selection, leading to the conclusion that a two-class solution is suitable for this study (Table 6). The first group, representing about 29 percent of farmers, places strong emphasis on feed quality and safety, showing little interest in other policy areas. In contrast, the second group, which accounts for roughly 71 percent of farmers, demonstrates more balanced preferences across different policies. Membership in these classes not random; rather, it is influenced by farmers' personal and household characteristics, including age, gender, education level, family size, farming experience, and flock size. Factors such as age, gender, education, family size, farming experience, and flock size influence the class to which a farmer belongs.

Table 6: The Bayesian Information Criteria (BIC) value

Class	Class 1	Class 2	Class 3	Class 4	Class 5
BIC	8215.788	8201.861	8298.071	8320.898	8296.010

Source: Authors own work, 2026

The maximum likelihood estimates of the latent class model are reported in Table 7. The results indicate substantial heterogeneity in preferences for urban poultry farming options among classes. The parameter estimates in the class membership model reflect the influences of socio-economic characteristics of urban poultry farmers on their livelihood of belonging to either class. Farmers in class 1 exhibited strong and highly significant preferences for three options: Feed quality and safety (3.404, $p<0.01$; 0.960), digital and financial inclusions (0.960, $p<0.01$), and market and infrastructure access (0.588, $p<0.01$).

It is essential to emphasize that the significant preference for these options indicates a pressing need for agribusinesses to prioritize this option in their

offerings. The share of preferences (SP) further highlights the relative importance of these options: Feed quality and safety (0.719) and digital and financial inclusion (0.105) dominate, consistent with the magnitude of their coefficients. In contrast, market and infrastructure access (0.074) provides more modest utility compared to the other two. Options such research and development, and cluster-based poultry development show limited relevance, given their coefficients and SP values. These findings align with the theories proposed by Lancaster (1966) and McFadden (1974), which emphasizes that individuals derive satisfaction from specific options and vary in their valuation of them . Similar results have been reported in several studies examining different policy contexts (Chelang'a et al., 2025; Dumbrell et al., 2016; Jin et al., 2019; Muunda et al., 2021). Overall, urban poultry farmers under class 1 value options that enhance profitability and livelihood security rather than purely commercial orientation. Their preferences reflect a strong emphasis on factors associated with productivity, efficiency, and economic gains.

In contrast, class 2 farmers display more moderate patterns of preferences as compare to class 1 respondents. The coefficient for their options falls within a narrow range (0.108–0.294), suggesting less pronounced utility gains. The result show that Class 2 farmers are less strongly motivated by improvements in individual option, reflecting a more balanced or cautious valuation across the available options. The results indicate that this segment of urban farmers values the five options more evenly. This suggests that urban poultry farmers appreciate both the economic and non-economic aspects of urban poultry farming. In Class 2, there appears to be a greater sensitivity to multidimensional improvement packages rather than to changes focused on a single urban option. Farmers in this class tend to be risk-averse or motivated by social factors when prioritizing the six policy options. This finding aligns with Simon's (1956) concept of rational choice, which posits that farmers consider a broader set of options rather than maximizing only a single or a few choices.

Table 7: Latent class model estimates and shares of preference (SP)

Variables	Class 1	SP	Class 2	SP
Utility function coefficients				
Feed quality and safety	3.404***(0.513)	0.719	0.233***(0.068)	0.206
Digital and financial inclusions	0.960***(0.127)	0.105	0.294***(0.061)	0.220
Research and development	0.095(0.136)	0.048	0.108*(0.058)	0.189
Cluster-based poultry development	0.219*(0.123)	0.054	0.160***(0.058)	0.195
Market and infrastructure access	0.588***(0.123)	0.074	0.115*(0.059)	0.190
Class Membership coefficients				
Constant	-2.789***(0.645)			
Gender (1=male)	0.532**(0.271)			
Age (years)	0.086***(0.0143)			
Age2	-0.001***(0.0002)			
Education(years)	-0.215***(0.0524)			
Age *education	0.004***(0.0011)			
Family size	-0.252**(0.121)			
Farming experience (years)	0.448***(0.125)			
Farming experience2	-0.033***(0.0111)			
Flock size	0.001***(0.0003)			
Family size* Flock size	-0.0003**(0.0001)			
Observations	14,400	14,400		
Number of groups	2,400	2,400		
Latent class probability	29.1%	70.9 %		
Log likelihood	-4050.2404			

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Source: Authors own work, 2026

The above latent class model results showing that the urban poultry farmers in Tigray differ in both behavioral and demographic profiles. Class 1 (29.1%) consists of older (0.086, p<0.01), more experienced (0.448, p<0.01), and predominantly male (0.532, p<0.05) farmers with larger flock sizes (0.001, p<0.01). Negative effects of education (-0.215, p<0.01), family size (-0.252, p<0.05), and their interaction with flock size (-0.0003, p<0.05) indicate that less educated farmers from smaller households are more likely to belong to class 1.

Male farmers may engage more actively with transformative policies, highlighting a potential gendered perspective in policy engagement. Overall, Class 1 farmers rely more on farming experience rather than formal education. Moreover, experienced farmers with smaller households may prioritize immediate household needs over participation in membership programs that emphasize transformative practices. This result is consistent with the Prospect Theory (Kahneman & Tversky, 1979), which posits that smaller-scale farmers are stronger incentive-seekers and more attracted to transformative policies compared to larger-scale farmers.. In contrast, Class 2 (70.9%) is more likely to include younger, better-educated farmers with larger families but smaller flock size, reflecting a more diversified farming segment. Taken together, results across BW score, mixed logit, and latent class analyses reinforce confidence that urban poultry policy design should prioritizes Feed quality and safety, as well as digital and financial inclusion, supported by market and infrastructure access. Class 1 farmers need high-incentive, efficiency-oriented policies, while class 2 farmers benefits more from risk-mitigating support.

5. Conclusion and Recommendation

A best-worst scaling (BWS) experiment was conducted with 400 urban poultry farmers in Northern Ethiopia to assess their preferences for urban poultry farming policy options. The study employed mixed logit and latent class modelling to analyze the collected data. The findings reveal that most urban poultry farmers reside relatively close to markets, are middle-aged, possess moderate educated, and have limited farming experience. Both the counting score and econometric model results indicate that feed quality and safety is the most preferred policy option, followed by digital and financial inclusion, and access market and infrastructure. In contrast, insurance and research and development received the lowest scores.

The latent class model identifies two distinct groups. Class 1 places a strong emphasis on feed quality and safety, reflecting a clear production-oriented focus and relatively little concern for other development options. Membership in this class is significantly influenced by gender, age, farming experience and larger flock sizes, while higher education and larger family size reduce the likelihood of belonging to this group. In contrast, Class 2 demonstrates a more balanced set of preferences and does not rely on a single policy option.

The result indicates that enhancing the interventions related to feed quality and safety, as well as digital and financial inclusion, is crucial for increasing farmer benefits from the urban poultry farming in Tigray. Notably, the strong preference for feed quality and safety highlights the urgent need for agribusinesses to prioritize this area. Additionally, the strong coefficients associated with digital and financial inclusion suggest that policies aimed at improving access to these resources could greatly benefit stakeholders in the urban agricultural sector.

The segmentation results show that farmers have varied policy priorities. The existence of distinct classes indicates that uniform policy measures may not adequately meet the diverse needs of farmer in areas affected by conflict urban poultry farming. By using a mixed logit approach alongside a latent class model, the captures continuous random taste variation and identifies discrete segments of farmer with unique priority structures. This combination of scale-adjusted preference measurement and segmentation analysis provides a novel and robust framework for creating evidence-based interventions in urban poultry farming.

Policy interventions should be tailored to different segments of urban poultry farmers rather than applying a one-size-fits-all strategy. Practitioners should focus on alleviating feed constraints, improving market access, addressing financial challenges, and designing tailored support packages. By prioritizing feed and financial inclusion, agribusinesses, financial institutions, and policymakers can promote a more sustainable and efficient urban agricultural environment. Integrating poultry farming into urban governance frameworks will further enhance technological adoption, boost productivity, and ensure the long-term sustainability of urban poultry operations. It is noted that our study is not free from some limitations. First, we conducted our study on Urban poultry farming. It might be different from other types of urban farming and rural areas. Second, because the analysis relies on cross-sectional data and does not assess the costs of policy options, the findings capture farmers' stated preferences at one point in time without accounting for dynamic changes, which may limit the ability to evaluate long-term impacts and cost-effectiveness of proposed urban poultry policy interventions. Therefore, ongoing collection of longitudinal data on costs and policy preferences in urban and rural areas are essential to monitor shifts in producer choices and refine future interventions in poultry farming.

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Financial Inclusion and Food Security in African Countries: The Mediating Role of Agricultural Productivity

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Abstract

Food insecurity remains a significant challenge in developing countries, particularly in Africa, where access to financing is limited. While there is increasing focus on how financial inclusion can increase agricultural productivity, research on how it directly contributes to food security is sparse. This study investigates the link between financial inclusion and food security across African nations, emphasizing the mediating role of agricultural productivity. Since financial inclusion does not directly generate food, its effect on food security likely operates through household income and production channels. Notably, the mediating role of agricultural productivity in this context has not been extensively studied across African countries. This research adds valuable insights to the literature. Using panel data from 45 African countries from 2004--2022, we employed structural equation modelling (SEM) to analyse their relationships. The results show that (1) financial inclusion indirectly enhances food security by enhancing agricultural productivity, especially in the full sample and upper-middle-income countries, confirming the mediating role of agricultural productivity; (2) the mediating effect of agricultural productivity varies among income groups, appearing only in the full sample and upper-middle-income countries, suggesting structural barriers in low- and lower-middle-income nations. Overall, expanding financial inclusion could help reduce food insecurity. Based on these findings, we conclude that improving access to financial services is vital for enhancing food security, and policy efforts should prioritize increasing such access.

Keywords: Financial inclusion, agricultural productivity, food security, Africa, structural equation model

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1. Introduction

The importance of financial inclusion for promoting economic growth and reducing poverty in developing nations, particularly in Africa, is increasingly recognized (Demirguc-Kunt et al., 2018; Chilimba, Dunga and Mafini, 2020; Jia, Qiu and Yang, 2021; Fokam et al., 2023). Despite this, food security remains a critical challenge in many African countries to date because of the complex interplay of socioeconomic, environmental, and institutional factors (FAO et al., 2023). Globally, post-pandemic hunger affected an estimated 690–783 million people in 2022, which is 122 million more than the pre-pandemic number, a crisis exacerbated by the Russia–Ukraine war, which challenges the achievement of the Sustainable Development Goal (SDG-2) by 2030 (FAO et al., 2023). This vulnerability is acute in Africa, where 48 million people faced acute food insecurity in 2023 (GRFC, 2024); however, sustainable relief is hindered by severe financial exclusion, as only 55 percent of adults in sub-Saharan Africa had an account at a formal financial institution, which is significantly lower than the global average of 76 percent (World Bank, 2022).

While standard theory suggests that access to financial services, such as savings and credit, enables smooth consumption and reduces the risk of food insecurity (Beck, Demirguc-Kunt and Peria, 2007; Chilimba, Dunga and Mafini, 2020), aggregate food insecurity has worsened in several regions of Africa (FAO et al., 2023). This confirms that the transition from financial access to nutritional outcomes in Africa is neither direct nor automatic but rather governed by underlying structural transmission mechanisms. Since agriculture supports more than 60% of the region's population (World Bank, 2022), this study chooses agricultural productivity as the primary mediator through which financial access improves nutritional outcomes.

Theoretically, the mediation pathway is rooted in agricultural household models and production theory (Singh, Squire and Strauss, 1986a). Smallholders in African economies face persistent liquidity constraints and missing insurance markets (Dercon, 2005; Karlan et al., 2014). This limits their ability to use modern technologies and high-yield fertilizers, trapping them in low-yield cycles (Feder, Just and Zilberman, 1985). Financial inclusion systematically relaxes these constraints, shifting the household's budget frontier outwards and encouraging investment in high-yield modern technologies (Alabi, Bakare and Alabi, 2022). As a result, agricultural productivity increases and flows to food security in two channels: an income channel where higher crop yield increases marketable surplus, which improves household purchasing power (Dillon, McGee and Oseni, 2015), and an

availability channel where increased output directly secures food for self-consumption (Sibhatu and Qaim, 2018).

Although studies on the financial inclusion–food security link are gaining more recognition, the existing evidence remains fragmented and contradictory. Some studies show that low financial literacy, high interest rates, and short repayment terms worsen food insecurity (Nepal and Neupane, 2022), whereas others find that formal financial services such as credit, savings, and digital finance improve food security by enabling investment, income growth, and resilience (Kaddu, 2014; Jia, Qiu and Yang, 2021; Lee, Chen and Chu, 2023). In addition, existing empirical studies are cross-sectional, making it impossible to examine long-term, dynamic effects. Furthermore, most studies are country specific, overlooking Africa's unique socioeconomic context and failing to consider diverse financial architectures. In particular, current research views Africa as a single, homogenous continent, ignoring the potential influence of diverse financial systems across different income groups.

A critical review of the empirical literature shows that existing studies have largely treated these dynamics in isolation, creating two disconnected analytical silos. The first strand examines the direct effect of financial inclusion on household welfare in different countries (Arshad, 2022a; Lin et al., 2022; Astuti and Hartono, 2023; Koomson, Asongu and Acheampong, 2023; Yasmin and Setiastuti, 2023; Tan et al., 2024; Tsongo et al., 2024; Gulzar, Arshad and Shahid, 2025), yielding mixed and contradictory findings. The second exclusively focuses on the role of finance in agricultural technology adoption and crop yield without tracing these gains to ultimate nutritional outcomes(Ali, Deininger and Duponchel, 2014; Awotide et al., 2015). By failing to integrate these dimensions, cross-country studies have ignored formal mediational pathways. Moreover, most studies rely on limited dimensions of financial inclusion, ignoring the multifaceted nature of financial inclusion. To address this gap, a financial inclusion index (FII) that takes into account different dimensions, including penetration, access, and usage (Sarma, 2016a), is important for cross-country analysis.

To address these gaps, this study emphasizes the need for comprehensive, multicountry research that employs advanced econometric techniques and situates the connection between food security, agricultural productivity, and financial inclusion within Africa's development context. By exploring the mediating role of agricultural productivity in this relationship across a panel of 45 African countries from 2004--2022, the study moves beyond unidirectional models. Specifically, we

employed structural equation modelling (SEM) and the multidimensional financial inclusion index (FII) across different countries' income groups.

The study seeks to (1) examine whether financial inclusion has a significant effect on agricultural productivity, (2) evaluate whether the impact of financial inclusion on food security is significant in the presence of the mediator (agricultural productivity), (3) appraise whether the impact of the mediator on food security is significant in the presence of financial inclusion, (4) determine whether financial inclusion has a significant indirect (mediated) impact on food security, and (5) assess whether (1) to (4) significantly differ across income groups. The results of this study provide empirical evidence on the agricultural productivity-mediated pathway, enabling policymakers to gain context-specific insight to integrate financial inclusion initiatives into national nutritional and sustainability development programs (SDGs).

2. Literature Review

2.1. Theoretical literature review

There are theories and complementary models that support the link between financial inclusion, agricultural productivity, and food security, confirming this study's methodology. The agricultural household model (Singh, Squire and Strauss, 1986b) emphasizes that access to financial services allows rural households to relax production constraints, especially by overcoming credit barriers that limit investment in farm inputs and technology, which positively influences household food access and nutrition. This idea is supported by Sen's entitlement theory (Sen, 1981), which states that emphasizing financial inclusion increases households' access to food through increased purchasing power and market engagement. Households can transform resources into better nutritional outcomes when they are financially included. Furthermore, the Food Security Conceptual Framework (Declaration, 1996) and the Sustainable Livelihoods Framework (Chambers and Conway, 1992; Ellis, 2000) further strengthen the idea that access to financial services such as savings, credit, and insurance enables households to smooth consumption and foster resilience. Together, these theories and frameworks underscore that financial inclusion is an engine for the improvement of sustainable life and food access, overcoming Malthusian (1798) concerns about food production and the possibility that population expansion would surpass the food supply.

Synthesizing these complementary frameworks reveals that financial inclusion operates through two important channels: the availability channel, which is driven

by farm productivity gains (Singh, Squire and Strauss, 1986b), and the income channel, which is driven by increased purchasing power and market engagement (Sen, 1981). Because production, consumption and resilience choices are nested and determined simultaneously, standard single equation models suffer from severe endogeneity and misspecification bias. Consequently, the SEM framework is theoretically required to simultaneously estimate these interconnected pathways and cleanly isolate the mediating role of agricultural productivity (Hayes and Preacher, 2010).

2.2. Empirical literature

The literature analysing the connection between financial inclusion and food security is fragmented into two disconnected analytical groups that address integrated economic realities in isolation. The first group focuses strictly on direct welfare effects, bypassing intermediate production channels entirely. While extensive evidence across global panels (Arshad, 2022a; Yasmin and Setiastuti, 2023), regional blocks (Tsongo et al., 2024), and country-specific cases (Lin et al., 2022; Astuti and Hartono, 2023; Tan et al., 2024) confirms that financial inclusion improves food security and consumption spending, the underlying transmission mechanism remains under a black box. Consequently, the direct effect paradigm cannot explain severe empirical contradictions. For example, while digital tools smooth consumption shocks (Mühlenhoff, 2021; Tan et al., 2024), formal credit often fails to translate into food security in low-income settings because of high interest rates, short repayment periods, and poor financial literacy (Carman and Zamarro, 2016; Baborska et al., 2020).

Conversely, the second silo treats finance exclusively as a driver of land, income and agricultural efficiency (Akpa et al., 2023; Koomson, Asongu and Acheampong, 2023; Zhou et al., 2023). These studies reveal that digital finance optimizes land management transfers and minimizes postharvest losses; however, they stop abruptly at the farm gate, taking for granted that productivity gains automatically guarantee human nutrition while ignoring downstream market dynamics.

Beyond these silos, the literature suffers from two methodological vulnerabilities: a heavy reliance on short-term, cross-sectional household surveys (e.g.,Astuti and Hartono, 2023; Koomson, Asongu and Acheampong, 2023; Bali Swain and Nsabimana, 2024) that fail to capture the dynamic lagged effect of agricultural cycles and a reductionist assumption of structural homogeneity across cross-country samples. This study fills these gaps by applying an SEM framework to a macrolevel panel of 45 African countries from 2004--2022 to explicitly model agricultural

productivity as a formal mediator while controlling for country-specific heterogeneity. From these studies, we developed the following research hypothesis:

H1: Financial inclusion is positively related to food security.
H2: Financial inclusion is positively related to agricultural productivity.
H3: Agricultural productivity is positively related to food security.
H4: Agricultural productivity mediates the relationship between financial inclusion and food security.

3. Method of the Study

3.1. Data

The study utilized a balanced panel of 45 African countries' data for the period spanning from 2004--2022. The countries2 and periods selected for the study are on the basis of the availability of data for the variables considered for analysis. The primary dependent variable is food security, measured by the prevalence of undernourishment (Un) sourced from the FAOSTAT suite of food security indicators. The central mediator is agricultural productivity, measured as the agricultural value added per worker, data taken from the World Bank. The main explanatory variable of the study is the financial inclusion index (FII), formulated from three dimensions: the access dimension (bank branches, ATMs), the penetration dimension (bank accounts), and the usage dimension (bank deposits and loans relative to GDP), sourced from the IMF's financial access survey (FAS). The study also incorporates four control variables sourced from the World Bank database: National income per capita (NIPc), financial development measured by domestic credit provided to the private sector (DCPs), foreign direct investment (FDI), and trade openness (ToP).
The construction of the financial inclusion index is as follows.

3.2. Measurement of financial inclusion and development of the FII index

To measure financial inclusion accurately, researchers use one of two methods to construct a composite index. 1) the nonparametric method, which uses exogenous

[2] **Low Income(18):** Burkina Faso, Burundi, Central African Republic, Chad, Congo Dem. Rep., Ethiopia, Gambia, Guinea-Bissau, Liberia, Madagascar, Malawi, Mali, Mozambique, Niger, Rwanda, Sierra Leone, Togo, Uganda
Lower Middle Income(15): Benin, Cameroon, Comoros, Côte d'Ivoire, Djibouti, Egypt, Arab Rep., Ghana, Kenya, Mauritania, Nigeria, Senegal, Tanzania, Zambia, Zimbabwe
Upper Middle Income (12): Algeria, Angola, Botswana, Congo. Rep., Eswatini, Gabon, Libya, Mauritius, Morocco, Namibia, South Africa, Tunisia

weight assignment on the basis of the researchers' intuition (represented as the (Sarma, 2016b) method), and 2) the parametric method, which assigns the importance of indicators by calculating the weights endogenously via two-stage principal component analysis (PCA), represented by (Cámara and Tuesta, 2014). Using the approach of (Cámara and Tuesta, 2014), several studies (Ahamed and Mallick, 2019; Sha'ban, Girardone and Sarkisyan, 2021) have applied the PCA technique to construct the composite financial inclusion index (FII). This study follows the methodology applied by Cámara and Tuesta (2014). The Kaiser–Meyer–Olkin (KMO) test was used to assess the validity of the PCA. The scree plot rule and eigenvalue were used to determine the number of components; components with eigenvalues greater than one were retained (Cliff, 1988). The composite index includes three dimensions: banking penetration (the number of deposit accounts with commercial banks per 1,000 adults is the metric used to assess this dimension), accessibility of the banking system (the number of branches and ATMs per 100,000 adults), and usage of the banking system (outstanding deposits (% of GDP) and outstanding loans (% of GDP)).

Analytical Framework

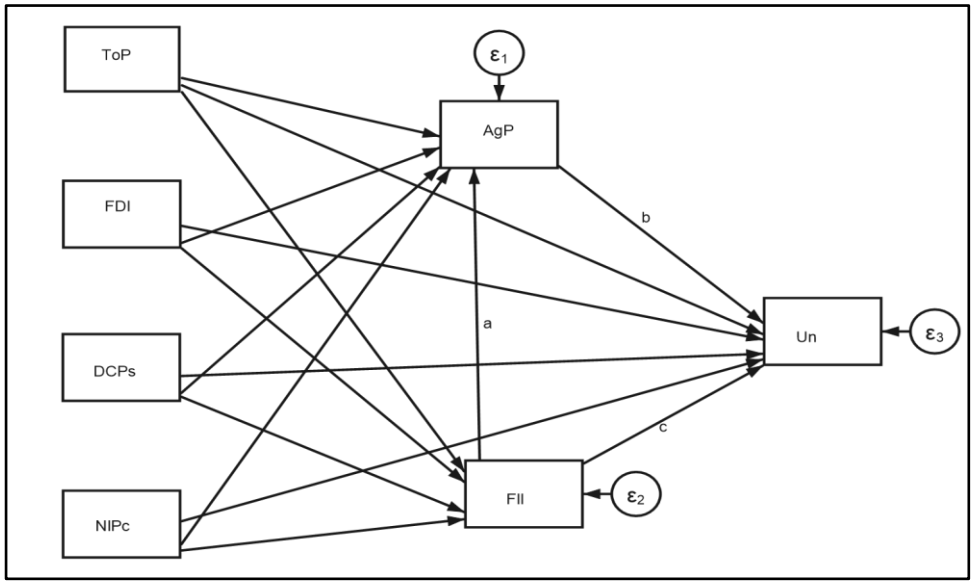


Figure 1: Statistical mediation modelling of financial inclusion, agricultural productivity, and food security

Note: FII=Financial inclusion index; AgP=Agricultural productivity; Un=prevalence of undernourishment; ToP=Trade openness; FDI=Foreign direct investment; DCPs=Domestic credit provided to the private sector; and NIPc=National income per capita

Source: Author's construction

Figure 1 illustrates a mediation framework showing the direct and indirect effects of financial inclusion on food security. The arrow that connects financial inclusion and food security in path ‘c’ indicates the direct effect. To explore the 'how' and 'why' financial access influences nutritional outcomes, the analysis incorporated a third-party variable, agricultural productivity, as a critical mediator following the mediation framework established by Judd & Kenny (1981). The third-party variable, agricultural productivity (AgP), is added to improve the understanding of the link between financial inclusion and food security or to identify whether the link is spurious. That is, financial inclusion affects agricultural productivity, and agricultural productivity affects food security. The mediation diagram in Figure 1 uses the method commonly applied in mediation modelling (Baron and Kenny, 1986; MacKinnon, Fairchild and Fritz, 2007), with “a” indicating the relationship between financial inclusion and agricultural productivity and “b” indicating the relationship between agricultural productivity and food security adjusted for financial inclusion. The symbols ε1, ε2, and ε3 represent residuals in the financial inclusion, agricultural productivity, and food security models.

Table 2: Variable definitions, units, and expected signs

Variable Name and Abbreviations	Definition and Unit	Expected Sign	Supporting Studies & Sources
Prevalence of undernourishment (Un), a measure of food security	The proportion of the population whose regular food intake is not enough to supply the dietary energy levels needed to sustain an active and healthy life. Measured as % of population	Dependent Variable	
Financial Inclusion (FII)	Measured by the financial inclusion index derived from the three dimensions: access, penetration, and usage.	-	(Arshad, 2022b; Akpa et al., 2023; Astuti and Hartono, 2023; Fowowe, 2023; Koomson, Asongu and Acheampong, 2023; Yasmin and Setiastuti, 2023; Tan et al., 2024; Tsongo et al., 2024)
Agricultural Productivity(AgP)	Defined as the net output of the agricultural sector per worker, measured by agricultural value added per worker (constant USD)	-	(Burke and Lobell, 2017; Pawlak and Kołodziejczak, 2020)
Trade openness (ToP)	The sum of imports and exports of goods and services is measured as (% of GDP)	-	(Dithmer and Abdulai, 2017; Marson, Saccone and Vallino, 2023; Seti, 2025)
National income per capita(NIPc)	Defined the total value of domestic production divided by the mid-year population (constant 2015 USD).	-	(Badolo, 2013; Miladinov, 2023; Shan, 2024)
Foreign Direct Investment (FDI)	It is defined as the net inflows of foreign capital (% of GDP) representing long-term investment and management interest in the domestic economy.	±	(Dogan and Aslan, 2017; Wardhani and Haryanto, 2020; Yao et al., 2020; Aloui and Maktouf, 2024; Hasudungan, Raeskyesa and Fromm, 2024)
Financial development measured by (DCPs)	Financial resources given to the private sector by financial corporations, measured as (% of GDP)	-	(Akanbi, 2020; Haryanto et al., 2023)

Note: (-) = Negative; (±) = Positive or negative

3.3. Model specification

This study attempts to examine the direct and indirect effects of financial inclusion on food security through the mediating effect of agricultural productivity. Following the product of coefficients approach (MacKinnon, Fairchild and Fritz, 2007) and the methodological approach of (Pei et al., 2019), we developed three models:

$$(Un)_{it} = \psi_0 + \psi_1(FII)_{it} + \psi_2(X)_{it} + \gamma_t + e_{it} \quad \textbf{(1)}$$

$$(AgP)_{it} = \eta_0 + \eta_1(FII)_{it} + \eta_2(X)_{it} + \gamma_t + \tau_{it} \quad \textbf{(2)}$$

$$(Un)_{it} = \alpha_0 + \alpha_1(FII)_{it} + \alpha_2(AgP)_{it} + \alpha_3(X)_{it} + \gamma_t + v_{it} \quad \textbf{(3)}$$

where

$$(FII)_{it} = \beta_0 + \beta_1(X)_{it} + \gamma_t + \varepsilon_{it} \quad \textbf{(4)}$$

Equations (1) and (3) represent food security measured by the prevalence of undernourishment (Un) and its determinants, representing the structural path in Figure 1, and equation (2) represents the mediator, agricultural productivity (AgP) and its determinants. Un is the dependent variable that represents food security; FII is the main independent variable that represents an index of financial inclusion; X represents the vector of control variables, including financial development measured by domestic credit provided to the private sector (DCP), trade openness (ToP), foreign direct investment (FDI), and national income per capita (NIPc); γ_t is the time fixed effect; ψ_0,η_0, β_0 and α_0 are intercepts; and e_{it}, τ_{it}, ε_{it} and v_{it} are random disturbance terms.

From equation (1), ψ_1 represents the coefficient of FII relating to Un, and α_2 in equation (3) is the coefficient of AgP relating to Un. Equations (1), (2), and (3) capture paths c, a, and b, respectively, which are represented in Figure 1. The coefficient α_1 indicates the direct effect of financial inclusion (FII) on Un, controlling for the effect of AgP, and ψ_1 indicates the total effect of FII on Un. Using the product of the coefficients approach, $\eta_1 * \alpha_2$ indicates the indirect (mediated[56]) effect. The total effect becomes the sum of the direct and indirect effects, which is ψ_1 =(η_1 *

[56] The mediation effect may exist if the coefficient of the direct and the indirect effect are significant. In this paper, the mediation effect exist if the coefficient of agricultural productivity and the coefficient of financial inclusion are significant.

α_2) +α_1. Here, the study analyses the mediation effect; however, other covariates are added to the mediation equations.

Equation (4) models the determinants of financial inclusion (FII) as a function of DCPs, ToP, FDI, and NIPc. The operationalization of this path runs in two ways: the demand side and the supply side. The supply side is motivated by financial development measured by domestic credit provided to the private sector, which signals the structural relaxation of the banking system, expanding the digital and physical footprints of the formal credit sector. The demand-side wing is captured by NIPc, where rising household incomes alleviate budgetary constraints, accelerating the adoption, penetration, and active utilization of formal deposits and mobile money accounts. Globalization further motivates the financial sector through technology and transaction demand. Through the introduction of capital, technology, and market connections that support new financial products and outreach, foreign direct investment (FDI) improves financial inclusion. In a similar vein, trade openness also improves financial inclusion by requiring digital payments and trade credit for cross-border transactions. Equation (2) shows that AgP is a function of FII, DCPs, NIPc, ToP, and FDI. This implies that even though AgP is determined by different factors, the multidimensional FII particularly stimulates smallholder farmers through directly relaxing liquidity constraints by improving the digital mobile money ecosystem and retail banking. This allows rural producers to smooth cash flows and invest capital in high-yield technologies and fertilizers to optimize labor efficiency. Equations (1) and (3) show the links between food security and other variables, such as AgP, DCPs, NIPc, FII, ToP, and FI. This pathway governs the supply, demand and stabilization mechanisms across the economy. On the supply side, AgP directly increases food availability and rural income and lowers local food prices. On the demand side, AgP, a rise in NIPc, improves purchasing power, enabling access to nutrient-rich food. Financial and global integration channels further stabilize these outcomes. While aggregate DCPs reduce systemic transaction costs, targeted financial inclusion (FII) uses mobile money networks to mitigate household liquidity problems. This enables households to invest in nutrition and a smooth consumption pattern. FDI creates and promotes employment opportunities and modernizes supply infrastructure, whereas ToP integrates the domestic economy into the global food chain, optimizing food security by stabilizing local supply fluctuations.

Estimation method

The study used a structural equation modelling approach to capture the direct and indirect effects. Additionally, the mediation approach helps to evaluate the relative importance of the various paths and processes by which covariates could influence the outcome. The mediation model helps explain how the independent variable predicts the dependent variable (Baron and Kenny, 1986). The SEM specification is as follows:

Structural equation modelling (SEM) specification

The primary objective of this study is to examine how financial inclusion contributes to food security, with agricultural productivity as a key mediator. To do so, the SEM approach is chosen because of its ability to test different regression equations simultaneously and the information it provides on the degree of fit for the entire model after controlling for measurement errors (Holmbeck, 1997; MacKinnon et al., 2002). During estimations of relationships among variables, SEM accounts for measurement error in observed variables. As a result, the method obtains a more precise measurement of the theoretical concepts of interest (Hayes and Preacher, 2010). SEM enables researchers to simultaneously model and estimate complex relationships among multiple dependent and independent variables. Among other things, the popularity of the model is in its path and factor analysis, which allows the examination of causal relationships and mediations. In this paper, we examine mediations via agricultural productivity (AgP) to evaluate the relationship between financial inclusion and food security. Among the different estimation methods used in SEM, maximum likelihood estimation (ML), the most commonly used and the default estimation method, is used in many statistical software packages (Kline, 2023).

SEM evaluation indices

To evaluate how well the specified model fits the observed data, this study uses several model fit indices, the comparative fit index (CFI > 0.95), the Tucker–Lewis index (TLI > 0.95), the root mean square error of approximation (RMSEA < 0.06), and the standard root mean square residual (SRMR < 0.01). Additionally, a well-fitting SEM is also indicated by a nonsignificant chi-square test ($p > 0.05$) and a coefficient of determination (CD) (R^2) closer to 1.

Before estimation, the data are tested for univariate and multivariate normality as assessed by the Doornik–Hansen test. Because the data significantly deviate from normality at both univariate and multivariate levels, conventional SEM cannot produce reliable estimates (Henderson, 2005). Consequently, the study employed bootstrapped SEM to ensure the validity of the statistical inference (Pek, Wong and Wong, 2018). Furthermore, the study also includes rigorous diagnostics such as multicollinearity, mediation path significance, and model modifications.

4. Results and Discussion

Table 3 presents the statistical properties of the variables, such as the central tendency and dispersion of the variables considered in this analysis.

Table 3: Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Un	855	18.33	11.179	2.5	55.1
DCPs	855	22.093	22.663	1.095	142.422
FII	855	.143	.168	0	.961
AgP	855	21.517	1.536	16.764	25.466
ToP	855	96.319	20.339	37.03	183.45
NIPc	855	7.006	1.014	2.919	9.573
FDI	855	4.247	7.806	-17.292	103.337

Table 4 depicts the correlation matrix and reports that FII and undernourishment are negatively associated, suggesting that increased financial access is associated with lower undernourishment.

Table 4: Correlation matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) Un	1.000						
(2) DCPs	-0.376	1.000					
(3) FII	-0.431	0.581	1.000				
(4) AgP	-0.081	0.092	-0.279	1.000			
(5) ToP	-0.134	0.124	0.226	-0.013	1.000		
(6) NIPc	-0.548	0.511	0.702	-0.136	0.270	1.000	
(7) FDI	0.139	-0.065	0.060	-0.169	0.055	-0.066	1.000

Table 5: Pesaran's Cross-Sectional Dependence (CD) Test Results

Variable	CD-Test	p-value	Mean ρ	Mean abs(ρ)
Un	14.903***	0.000	0.11	0.53
DCPs	43.778***	0.000	0.32	0.53
FII	76.224***	0.000	0.56	0.64
AgP	89.627***	0.000	0.66	0.70
ToP	82.445***	0.000	0.60	0.74
NIPc	85.748***	0.000	0.64	0.65
FDI	7.499***	0.000	0.06	0.26

Note: *** P < 0.01, ** P < 0.05, and * P < 0.10

Table 6: Second-Generation Panel Unit Root Test Results (CIPS)

Variable	Level I(0)	First Difference I(1)	Decision
Un	-3.421***	-4.812***	I(0)
DCPs	-2.915	-5.104***	I(1)
FII	-3.184***	-4.925***	I(0)
AgP	-3.052	-5.341***	I(1)
ToP	-3.245***	-4.789***	I(0)
NIPc	-3.112	-5.023***	I(1)
FDI	-3.518***	-5.412***	I(0)

Note. *** indicates statistical significance at the 1% level, rejecting the null hypothesis of non-stationarity.

Table 5 shows the CD test rejecting the null hypothesis of cross-sectional independence. Table 6 shows second-generation panel unit root tests (CIPS), revealing a mix of I (0) and I (1) processes.

4.1. Empirical results

4.1.2. SEM results and discussion

In this section, we present empirical findings on whether agricultural productivity mediates the evidence of the relationship between financial inclusion and food security in African countries. Using structural equation modelling, we divide the

estimations into direct, indirect, and total effects. We start with the direct effect in Table 7, followed by the indirect effects in Table 8 and the total effect in Table 9 (see Appendix I). Additionally, the model assessment summary and hypothesis validation results are available in Tables 10 and 11. Our findings suggest that food security, proxied by undernourishment (Un), is influenced by the multidimensional financial inclusion index (FII), alongside other control variables such as AgP, NIPc, FDI, DCPs, and ToP.

Table 7: Direct effects

Variables	Full Sample-FS (Standardized)			Low income-LI (Standardized)			Lower middle income-LMI(Standardized)			Upper middle income-UMI(Standardized)		
	Coefficient	Bootstrap Std. err	P value	Coefficient	Bootstrap Std. err	P value	Coefficient	Bootstrap Std. err	P value	Coefficient	Bootstrap Std. err	P value
Dependent Variable: FII												
DCPs	0.269	0.044	0.000	0.371	0.033	0.000	0.277	0.058	0.000	0.398	0.043	0.000
FDI	0.054	0.019	0.004	0.022	0.007	0.001	-0.032	0.036	0.385	-0.095	0.041	0.122
ToP	0.079	0.022	0.000	0.019	0.015	0.011	0.075	0.020	0.000	0.274	0.057	0.000
NIPc	0.667	0.052	0.000	0.266	0.145	0.068	0.542	0.059	0.000	0.154	0.036	0.000
Constant	-0.000	0.019	1.000	-0.195	0.094	0.037	-0.057	0.027	0.034	0.211	0.045	0.000
Dependent Variable: AgP												
FII	0.124	0.044	0.005	0.670	0.122	0.000	0.156	0.080	0.053	0.320	0.048	0.000
DCPs	0.311	0.026	0.000	-0.021	0.077	0.788	0.688	0.094	0.000	0.132	0.023	0.000
FDI	0.016	0.017	0.047	-0.027	0.022	0.220	0.147	0.059	0.012	0.112	0.077	0.147
ToP	0.070	0.023	0.002	0.026	0.020	0.209	0.127	0.035	0.000	-0.142	0.086	0.101
NIPc	0.494	0.033	0.000	0.670	0.203	0.001	1.240	0.192	0.000	0.387	0.036	0.000
Constant	0.000	0.022	1.000	0.032	0.131	0.809	0.351	0.077	0.000	0.328	0.067	0.000
Dependent Variable: Undernourishment												
FII	-0.045	0.033	0.063	-0.497	0.255	0.051	-0.651	0.180	0.000	-0.020	0.055	0.021
AgP	-0.428	0.043	0.000	-0.247	0.089	0.006	-0.414	0.111	0.000	-0.746	0.117	0.000
DCPs	-0.039	0.024	0.098	-0.355	0.173	0.040	0.039	0.208	0.851	-0.010	0.028	0.712
FDI	-0.138	0.024	0.000	-0.141	0.049	0.004	-0.031	0.107	0.773	0.323	0.094	0.301
ToP	-0.021	0.030	0.477	0.011	0.051	0.825	0.034	0.064	0.593	-0.131	0.103	0.205
NIPc	-0.074	0.030	0.013	-0.434	0.443	0.327	-1.303	0.206	0.540	0.060	0.042	0.154
Constant	0.000	0.031	1.000	0.041	0.250	0.869	-0.426	0.103	0.410	0.302	0.106	0.004
Var (e.FII)	0.285	0.039		0.051	0.008		0.080	0.009		0.354	0.036	
Var (e.AgP)	0.333	0.017		0.163	0.010		0.262	0.017		0.346	0.050	
Var (e.Un)	0.676	0.032		0.643	0.034		0.656	0.055		0.431	0.038	

Note: FS= Full sample LI=Low income; LMI=Lower-middle income; UMI=Upper-middle income; FII= Financial inclusion index; AgP=Agricultural productivity; DCPs=Domestic credit provided to the private sector; FDI=Foreign direct investment; ToP=Trade openness; NIPc=National income per capita
Source: Author's formulation

Table 8: Indirect (Mediated effect)

Variables	Full Sample-FS (Standardized)			Low income-LI (Standardized)			Lower middle income-LMI (Standardized)			Upper middle income-UMI (Standardized)		
	Coefficient	**Bootstrap Std. err**	**P value**	**Coefficient**	**Bootstrap Std. err**	**P value**	**Coefficient**	**Bootstrap Std. err**	**P value**	**Coefficient**	**Bootstrap Std. err**	**P value**
Dependent variable: FII												
DCPs	0	(no path)		0	(no path)		0	(no path)		0	(no path)	
FDI	0	(no path)		0	(no path)		0	(no path)		0	(no path)	
ToP	0	(no path)		0	(no path)		0	(no path)		0	(no path)	
NIPc	0	(no path)		0	(no path)		0	(no path)		0	(no path)	
Dependent variable: AgP												
FII	0	(no path)		0	(no path)		0	(no path)		0	(no path)	
DCPs	0.033	0.013	0.009	0.248	0.044	0.000	-0.043	0.031	0.166	0.127	0.025	0.000
FDI	0.007	0.003	0.041	0.015	0.006	0.007	0.005	0.007	0.508	-0.030	0.017	0.172
ToP	0.010	0.004	0.029	0.013	0.008	0.134	-0.012	0.009	0.209	0.088	0.022	0.000
NIPc	0.083	0.025	0.001	0.178	0.133	0.181	-0.085	0.060	0.156	0.049	0.011	0.000
Dependent Variable: Undernourishment												
FII	-0.053	0.019	0.006	0.165	0.079	0.137	0.065	0.044	0.144	-0.239	0.057	0.000
AgP	0	(no path)		0	(no path)		0	(no path)		0	(no path)	
DCPS	-0.160	0.017	0.000	-0.128	0.085	0.133	-0.087	0.103	0.396	-0.186	0.031	0.000
FDI	0.001	0.007	0.850	-0.014	0.009	0.120	-0.083	0.041	0.042	-0.063	0.059	0.282
ToP	-0.038	0.010	0.000	0.000	0.008	0.989	0.001	0.021	0.947	0.046	0.060	0.451
NIPc	-0.277	0.030	0.000	0.077	0.111	0.490	-0.126	0.190	0.508	-0.323	0.051	0.000

Source: Author's formulation

Direct effect, indirect effect and total effect

The estimation results in Table 7 reveal that the coefficient of financial inclusion is negative and significant, which is consistent with a priori expectations for the full sample, low-income, and lower-middle-income groups. This finding indicates that financial inclusion is crucial for smoothing consumption and reducing the risk of undernourishment. This underscores that access to financial services is an immediate tool against hunger. Specifically, a one standard deviation increase in FII is significantly associated with a 0.045, 0.497, 0.651, and 0.02 standard deviation decrease in the level of undernourishment for the full sample, low-income, lower middle-income, and upper middle-income groups, respectively, assuming that all other factors remain constant. These results are consistent with those of previous studies (e.g., Akpa et al., 2023; Astuti & Hartono, 2023; Fowowe, 2023; Koomson et al., 2023; Tan et al., 2024; Tsongo et al., 2024; Yasmin & Setiastuti, 2023).

The Indirect (Mediated) effect

The indirect effect reported in Table 8 shows that agricultural productivity is a significant mediator through which financial inclusion influences food security for the full sample and upper middle-income countries. The coefficient of FII is negative and significant for the indirect effect for the full sample and upper-middle-income groups, suggesting that a one standard deviation increase in financial inclusion is significantly associated with a 0.053 and 0.239 standard deviation decrease in undernourishment through enhancing agricultural productivity for the full sample and upper-middle-income countries, respectively, with other factors remaining constant. This finding suggests that agricultural productivity can lead to increased food production, potentially improving household access to a wider variety of nutritious foods, such as fruits, vegetables, and animal products.

The total effect, which combines both direct and indirect effects, highlights the significance of financial inclusion in improving food security across all model specifications. This paper's contribution is clearly shown in its finding of the mediation effect. This is a significant incursion in the financial inclusion food security literature. These findings are intuitively explained by the reduction in liquidity constraints; formal savings and loan availability act as buffers that enable people to smooth their consumption during times of agricultural shocks or income volatility. Additionally, the strong mediating effect implies that financial inclusion actively promotes food security by encouraging investments in agricultural productivity rather than just acting as a safety net. Financial services assist

smallholder farmers in embracing better inputs and technology, increasing crop yields and household caloric availability by lowering the cost of capital. This discovery makes a substantial contribution to the literature by elucidating the precise methods by which financial institutions reduce hunger in African economies, both directly as a stabilizer of income and indirectly as an enhancer of productivity.

Furthermore, the estimation results reported in Table 7 show that national income per capita (NIPc) has a significant negative association with undernourishment for the full sample, suggesting that income growth is the engine for improving nutritional outcomes. The findings are aligned with those of (Badolo, 2013; Miladinov, 2023; Shan, 2024). Furthermore, financial development (DCPs) also has a significant negative association with undernourishment for the full sample and low-income countries, confirming that improvement in the quality and efficiency of the financial system is crucial for stabilizing the food market and funding the agricultural sector. These findings are in line with those of other studies (e.g., Akanbi, 2020; Haryanto et al., 2023). An increase in foreign direct investment (FDI) is also significantly associated with a decrease in undernourishment for the full sample. The decreasing association in high-income countries suggests that the effect of FDI is strong when basic infrastructure and primary agriculture are targeted in developing countries. These findings are supported by previous studies (e.g., Aloui & Maktouf, 2024; Hasudungan et al., 2024; Wardhani & Haryanto, 2020; Yao et al., 2020).

SEM evaluation

Table 10: SEM assessment summary

Fit Statistic	Full Sample (FS)	Income Groups(LI, LMI,UMI)
Doornik-Hansen	chi2(14) =1062.721	chi2(14) =1034.601
χ^2 (df), p value	Prob>chi2 = 0.000	Prob>chi2 = 0.000
	Decision: Normality not satisfied	Decision: Normality not satisfied
LR: χ^2 (df), p value	2.345 (1), p=0.145	8.091 (3), p=0.180
	Decision: Excellent Fit	Decision: Excellent fit
RMSEA	0.020 Decision: Excellent	0.040 Decision: Mediocre
CFI	1.000 Decision: Perfect	0.998 Decision: Excellent
TLI	0.993 Decision: Excellent	0.932 Decision: Good
SRMR	0.004 Decision: Excellent	0.011 Decision: Excellent
CD	0.810 Decision: High Predictive Power	0.730 Decision: High Predictive Power

Note: LR=likelihood ratio

The model fit assessment summary in Table 10 reveals that the proposed SEM has an excellent overall fit, as evidenced by strong fit indices, including CFI=perfect, TLI=excellent, RMSEA=excellent, SRMR=excellent, nonsignificant chi-square, and high CD, for the full sample. In the same vein, the multigroup models across income groups were good to acceptable, confirming the model's cross-group validity. The model was also further validated by the absence of significant multicollinearity, with all the VIFs below the rule of thumb. However, owing to the nonnormality detected in the model, as reported in Table 10, the model was estimated by bootstrapping to ensure the reliability of the results. Furthermore, the SEM's robustness was confirmed by testing the model specification and model modification indices (MIs); as a result, we found nonsignificant modification indices (all MIs < 3.84), indicating that the current SEM structure is well specified.

Table 11: Hypothesis validation

Hypothesis	Full sample	Low-income	Lower-middle incom	Upper-middle incom
H1: FII → Un	S	S	S	S
H2: FII → AgP	S	S	S	S
H3: AgP → FS	S	S	S	S
H4: Mediation	S	R	R	S

Note: S=supported, R=rejected, FII=Financial inclusion, Un =undernourishment, AgP=Agricultural productivity
Source: Author's formulation

Table 11 presents the hypothesis validation of the SEM findings, summarized as follows: 1) FII has a consistent significant positive association with food security (meaning a negative association with Un) across all income groups directly and indirectly through AgP. 2) Hypotheses 1, 2 and 3 were all supported in all the samples, suggesting that FII has a significant positive association with AgP and that, in turn, AgP has a significant positive association with food security. 3) The mediation analysis represented in Hypothesis 4 was not supported across all heterogeneous income groups; specifically, the indirect effect of FII on food security through AgP was significant for the full sample and upper-middle income countries. This implies that FII translates into food security in more developed economies. Conversely, although FII has a significant positive association with AgP and AgP has a significant positive association with food security, the mediation effect (H4) was not supported for low-income and lower-middle-income countries. This reflects that the absence of mediation may be due to structural constraints in poorer economies,

such as limited access to modern inputs and climate vulnerability, which prevent them from fully translating into improved food security.

5. Conclusion and Policy Implications

The nexus between financial inclusion and agricultural productivity, agricultural productivity and food security, and financial inclusion and food security has been well examined separately in the extant literature. Although the financial inclusion–food security relationship has been explored, to the best of the researcher's knowledge, no single study to date has explored the mediating role of agricultural productivity in the financial inclusion–food security relationship in African countries. Therefore, the present study fills this lacuna. We used a balanced panel data sample of 45 African countries from 2004--2022 and utilized a structural equation modelling (SEM) approach.

The empirical findings from the SEM results for the selected African countries are summarized as follows: (1) Financial inclusion is an important positive predictor of agricultural productivity across all heterogeneous income groups; (2) agricultural productivity is an important predictor of food security through reducing undernourishment for all the different income groups; and (3) for the heterogeneous income groups, agricultural productivity shows varying mediation effects. For example, financial inclusion exerts a significant indirect effect on food security by reducing undernourishment through its effect on agricultural productivity for full- and upper-middle-income countries. This implies that agricultural productivity partially mediates the path of financial inclusion in food security. On the basis of these findings, we conclude that financial inclusion is an important determinant of food security. In addition, other control variables, such as national income per capita, trade openness, foreign direct investment, and financial development, are positive and significant predictors of food security. This study contributes to the emerging literature stream on financial inclusion, agricultural productivity, and food security dynamics by introducing a theoretical model to examine the mediating effect of agricultural productivity on the financial inclusion–food security relationship.

On the basis of these empirical findings, recommendations are drawn in favour of enhancing financial inclusion initiatives to improve household income stability, agricultural productivity, and food security levels. This implies that adopting financial inclusion initiatives is crucial for improving food security and ultimately improving health and nutrition. Therefore, policies aimed at expanding financial inclusion, such as mobile banking, microcredit, savings, and insurance schemes,

should be prioritized by African governments and policymakers in the health and agricultural sectors to ensure stable and healthy nutrition levels. This is because improved access to credit and savings enables households to effectively manage food shortages, invest in nutritious food, and withstand economic shocks. Furthermore, even though financial inclusion is universally beneficial, its pathway through agricultural productivity is stronger in developed economies, suggesting the need for complementary investment in agricultural infrastructural technologies in low- and lower-middle-income countries to unlock the full mediating potential of agricultural productivity.

Despite its contributions, the study has its own limitations, specifically, the study's reliance on secondary data, and additional mediator variables such as institutional quality and human capital were not examined. Leveraging well-established insights into the mediating role of agricultural productivity in the financial inclusion–food security nexus, future researchers should expand the analysis by adding additional mediator variables, such as the role of educational empowerment and institutional quality in developing or developed nations.

In conclusion, this study emphasizes that financial inclusion is not only an economic indicator but also a strategic means to improve agricultural productivity and food security in Africa.

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Appendix I

Table 9: Estimation results of the total effect

Variables	Full Sample-FS (Standardized)			Low income-LI (Standardized)			Lower middle income-LMI (Standardized)			Upper middle income-UMI(Standardized)		
	Coefficient	Bootstrap Std. err	P value	Coefficient	Bootstrap Std. err	P value	Coefficient	Bootstrap Std. err	P value	Coefficient	Bootstrap Std. err	P value
Dependent Variable: FII												
DCPs	0.269	0.043	0.000	0.371	0.035	0.000	0.277	0.046	0.000	0.398	0.040	0.000
FDI	0.054	0.020	0.006	0.022	0.008	0.004	-0.032	0.040	0.431	-0.095	0.048	0.147
ToP	0.079	0.019	0.000	0.019	0.012	0.127	0.075	0.017	0.000	0.274	0.066	0.000
NIPc	0.667	0.048	0.000	0.266	0.197	0.178	0.542	0.069	0.000	0.154	0.033	0.000
Dependent Variable: AgP												
FII	0.124	0.040	0.000	0.670	0.112	0.000	0.156	0.106	0.042	0.320	0.051	0.000
DCPs	0.344	0.024	0.558	0.228	0.088	0.009	0.644	0.083	0.000	0.260	0.020	0.000
FDI	-0.023	0.015	0.000	-0.012	0.015	0.431	0.152	0.054	0.005	0.082	0.076	0.281
ToP	0.080	0.022	0.000	0.038	0.026	0.144	0.115	0.032	0.000	-0.054	0.083	0.515
NIPc	0.577	0.019	0.000	0.848	0.245	0.001	1.155	0.167	0.000	0.436	0.039	0.000
Dependent Variable: Undernourishment												
FII	-0.098	0.037	0.009	-0.332	0.208	0.010	-0.586	0.155	0.000	-0.259	0.081	0.007
AgP	-0.428	0.044	0.000	-0.247	0.100	0.013	-0.414	0.111	0.000	-0.746	0.117	0.000
DCPs	-0.199	0.021	0.000	-0.484	0.133	0.000	-0.048	0.129	0.011	-0.196	0.023	0.000
FDI	-0.137	0.024	0.000	-0.155	0.038	0.001	-0.114	0.085	0.176	0.260	0.080	0.401
ToP	-0.059	0.031	0.059	0.011	0.049	0.814	0.036	0.069	0.605	-0.085	0.119	0.472
NIPc	-0.351	0.023	0.000	-0.357	0.407	0.379	-1.429	0.182	0.000	-0.262	0.053	0.000

Source: Author's formulation

Industrial Parks and Structural Transformation in Ethiopia: A Mixed-Methods Analysis of Manufacturing Performance and Policy Pathways

Endalkachew Sime[1]

Abstract

This award-winning research evaluates Industrial Parks (IPs) as catalysts for Ethiopia's structural transformation using a metrics-driven framework. Through a mixed-methods design—national OLS regressions, regional Fixed Effects models, workforce surveys (n=106), and a George Shoe Industrial Park (GSIP) case study—it assesses 24 IPs' contributions to manufacturing performance (2000–2022).

Findings confirm IPs significantly boost gross production (USD 78,201.28, $p<0.05$) and value-added (USD 74,697.50, $p<0.001$), yet employment and plant creation effects are negligible, exposing weak labor absorption. Regional analysis shows divergent outcomes: IPs in Addis Ababa and Oromia generate higher per-park contributions—89.92 plants, USD 308,528.5 in production, and USD 125,087.1 in value-added—demonstrating agglomeration benefits but limited job creation. The GSIP case highlights micro dynamics: vertical specialization in castor oil processing raised local sourcing to 80%, yet competitiveness suffers from 99% chemical import dependency and logistics costs 15 times higher than Vietnam.

Survey evidence underscores systemic constraints: 82% of workers cite foreign currency shortages as "very serious," while 51% identify corruption and 59% report security instability as major challenges. A reform agenda is proposed: phased value chain localization via AfCFTA partnerships, institutionalized forex mechanisms, and scaled technology transfer through vocational training.

This research delivers the first empirically grounded, multi-level assessment of IPs' incremental value to Ethiopia's transformation, establishing a replicable framework for evaluating spatial industrial policies in low-income economies. Findings inform Ethiopia's Ten-Year Development Plan and South-South cooperation, addressing sustainable development, governance, and inclusive industrialization.

Keywords: Industrial Parks; Structural Transformation; Manufacturing Value-Added; Ethiopia; South-South Cooperation; AfCFTA

[1] PhD

1. Introduction

Ethiopia's economic trajectory over the past three decades has been marked by rapid growth, yet its structural transformation remains incomplete. Since the early 2000s, the country has recorded average annual GDP growth of 9.2%, driven largely by public investment in infrastructure, agriculture, and services (MoPD, 2020). This growth has lifted millions out of poverty, reducing the national poverty rate from 55.3% in 2001 to 19% by 2020 (World Bank, 2021). Despite these achievements, the economy remains predominantly agrarian, with agriculture accounting for 37.57% of GDP in 2021, while manufacturing contributes a mere 5.8% (Statista, 2023). This stark imbalance underscores the urgent need for industrialization to diversify the economy and enhance resilience.

The Ethiopian government has pursued industrialization through state-led initiatives, including the Growth and Transformation Plans (GTP I and II) from 2010 to 2020, which prioritised manufacturing as a catalyst for development. Central to this strategy has been the establishment of industrial parks (IPs), designed to attract foreign direct investment (FDI), spur job creation, and foster technological transfer. Since the first IP was established in 2008, Ethiopia has constructed over 24 modern IPs, positioning itself as a manufacturing hub in Africa (EIC, 2023). These parks have generated over 100,000 jobs and contributed to export earnings of USD 1.6 billion annually, primarily in textiles, leather, and agro-processing (Tesfaw, 2023). However, their impact on structural transformation remains uneven. While IPs have boosted productivity and value addition, their contribution to employment and the number of manufacturing plants has been limited, reflecting capital-intensive operations and automation trends (World Bank, 2022).

The disconnect between Ethiopia's GDP growth and its stagnant manufacturing sector highlights systemic challenges. The manufacturing value-added (MVA) share of GDP has hovered around 5% for decades, despite the proliferation of IPs (UNIDO, 2020). This stagnation is exacerbated by critical bottlenecks: 82% of survey respondents cited foreign currency shortages as a "very serious" issue, while 56% highlighted security instability and 48% corruption as major constraints. Infrastructure deficits, such as high logistics costs (USD 3,000 per container versus Vietnam's USD 200), further erode competitiveness (World Bank, 2018). These challenges mirror broader struggles in Africa's industrialization, where weak supply chains and fragmented policies hinder progress (UNIDO, 2016).

This study addresses the critical question of how IPs in Ethiopia contribute to the country's structural transformation, with a particular focus on measuring the performance of the manufacturing sector. It seeks to understand whether these parks are effectively driving sustainable industrialization and how they impact key manufacturing metrics such as plant proliferation, employment, production, and value addition. The research holds significant relevance and timeliness for Ethiopia's economic development trajectory, given that structural transformation has constituted the cornerstone of the country's development frameworks for over five decades, with outcomes falling short of aspirations.

This research diverges from conventional IP-centric approaches by centring its analysis on the broader manufacturing ecosystem. By examining the role of Ethiopia's expanding IP network within this ecosystem framework, the study uncovers critical mechanisms through which industrial parks enhance manufacturing productivity and competitiveness. This ecosystem-focused perspective not only enriches existing literature but also generates actionable policy insights tailored to Ethiopia's unique institutional context. The findings hold particular strategic value as they align with the objectives of Ethiopia's recently launched Ten-Year Development Plan, which prioritises structural change as a core pillar of sustainable economic transformation.

1.1. Research objectives and questions

This study examines the dual role of Industrial Parks in Ethiopia's economic development, with a focus on their contributions to manufacturing growth and the structural challenges that limit their transformative potential. The primary objective is to analyse IPs' macroeconomic contributions—specifically their impact on manufacturing output, productivity, and value addition at the national level—while critically evaluating their capacity to catalyse localised industrial clusters and absorb labour at the regional level. By employing standardised manufacturing performance metrics, the research assesses how IPs have shaped the evolution of industrial value addition over time, interrogating whether their strategies prioritise capital-intensive growth over inclusive job creation.

At the national level, the study addresses two core questions: First, to what extent have IPs contributed to Ethiopia's manufacturing output, productivity, and value-added growth? Second, what structural vulnerabilities—such as import dependency, infrastructural inefficiencies, or enclave-style economic patterns—constrain IPs from achieving broader developmental spillovers? Regionally, the investigation

shifts to evaluating IPs' role in fostering localised industrial ecosystems, asking: How effectively do IPs integrate regional value chains, absorb labour, and stimulate backward and forward linkages?

1.2. Significance of the study

According to World Bank (2023), Ethiopia's GDP grew 2.5 times faster than Sub-Saharan Africa's annual average (7.3% versus 2.9%) for over the past two decades and becomes the region's largest economy. One of the key cornerstones of this growth has been the rapid expansion of IPs, which increased from zero to 24 operational IPs during the study period. Designed as engines of structural transformation, IPs were explicitly tasked in national policy documents with boosting manufacturing's contribution to GDP—a goal that remains unmet, as manufacturing stays low around 5% of GDP (World Bank, 2022), lagging far behind the Sub-Saharan Africa average.

This research addresses a critical gap in literature. Past studies have quantified IPs' socioeconomic impacts—foreign currency earnings, job creation, and fiscal contributions—but little is done in systematically evaluating incremental roles of IPs in driving the broader structural transformation of Ethiopia's economy through leveraging manufacturing ecosystem. The timing of this inquiry is particularly relevant. Post-2022, Ethiopia's IP program is undergoing a phase of policy refocusing and restructuring, creating a unique opportunity to align empirical findings with real-time reforms.

2. Literature Review

The literature review in this study serves as a critical foundation for understanding the role of industrial parks in Ethiopia's structural transformation, particularly focusing on their contributions to manufacturing performance. By systematically exploring the global overview of industrialization and industrial parks, the African context of these dynamics, the historical and future trajectories of industrialization and IPs in Ethiopia, and synthesising related past studies, this section provides a comprehensive backdrop that informs the research objectives and questions.

2.1. Industrialization and Industrial Parks: A Global Overview

The origins of industrialization can be traced back to the late 18th and early 19th centuries, primarily in Great Britain. This period, known as the Industrial Revolution, marked a significant transformation from agrarian economies to industrialized and

urban societies. Urbanisation was the hallmark of this Industrial Revolution through the rise of factories, particularly in the textile industry and steam engines, followed by the growth of cities as people moved from rural areas to urban centres in search of work (Onion, 2023).

China's industrialization efforts, particularly through industrial parks and special economic zones (SEZs), have served as a cornerstone of its economic transformation. Since the late 20th century, China prioritised SEZs like Shenzhen, which became a global manufacturing hub by leveraging strategic infrastructure, preferential policies, and foreign direct investment incentives (Zeng, 2015; Schminke and Van Biesebroeck, 2013). These zones catalysed innovation, technology transfer, and industrial upgrading, enabling China to transit from labour-intensive manufacturing to capital- and knowledge-intensive sectors (Song et al., 2020).

The global overview of Industrial Parks shows their indispensable role in serving as hubs for innovation and production, facilitating industrialization dynamics. They are seen driving job creation in many economies, with the potential to generate more than two additional jobs in other sectors of the economy (Lavopa and Riccio, 2024). This not only combats poverty and hunger but also fosters inclusive development. As of 2022, UNCTAD counted 7,000 SEZs in 145 countries with hundreds more in the pipeline (UNCTAD, 2022).

2.2. Industrialization and industrial parks in Africa

The structural transformation of developing economies including Africa has been a central topic in development economics. The industrialization of Africa began during the colonial period, when European powers established industries primarily to extract and process raw materials for export (Kilby, 1969). This period saw the development of infrastructure such as railways and ports, but the focus was on serving the needs of the colonial powers rather than fostering local industrial growth.

In post-independence, many African nations aimed to reduce their dependency on imported goods and raw materials by developing their own industrial bases. This period saw the establishment of state-owned enterprises and the implementation of import substitution industrialization strategies (Mendes et al., 2014). However, these efforts often faced challenges such as inadequate infrastructure, lack of skilled labour, and limited access to capital.

Today, industrialization remains a key priority for African development. The continent has seen a resurgence in industrial activity, driven by factors such as a

growing young labour force, abundant natural resources, and expanding internal markets. Initiatives like the African Union's Agenda 2063 and the African Development Bank's Industrialize Africa strategy underscore the importance of industrial development for achieving inclusive growth and job creation. As of 2022, there are 237 SEZs in Africa, with 57 ongoing projects, particularly concentrated in Eastern Africa (Rodriguez et al., 2022).

2.3. Industrial parks in Ethiopia: Past and future

Ethiopia's industrialization began in the 1920s with the emergence of modern industries, mostly owned by foreigners. After some disruption following WWII, the industrial sector revived in the 1950s as more foreign firms entered the market, spurred by three successive development plans implemented between 1958 and 1973 by the imperial government. However, industrialization efforts were halted by the communist regime known as the Derg, which ruled from 1974 to 1991, implementing a planned economy and nationalizing private properties.

Following the fall of the Derg regime, the Ethiopian People's Revolutionary Democratic Front initiated sustained economic growth and industrialization efforts after coming to power in 1991. Throughout the 1990s and 2000s, national strategies were centred on Agricultural Development Led Industrialization, which emphasised building domestic productive capabilities, enhancing technical skills, facilitating technology transfer, and supporting small and medium-sized enterprises through extension services.

The Ten-Year Development Plan, Ethiopia's cornerstone policy framework, sets out to transform the country's industrial landscape through the strategic expansion of Industrial Parks. Building on a baseline of 19 operational IPs in 2020, the TYDP aims to increase this number to 40 by 2030 through the establishment of 21 new parks—4 public and 17 private—while fostering collaboration between state and private actors. This expansion aligns with national ambitions to enhance industrial capacity utilisation, attract high-quality investment, and create jobs, all while advancing Ethiopia's shift toward a diversified, tech-driven economy.

2.4. Related past studies

Dorosh and Shiferaw (2012) examined Ethiopia's economic landscape as it has experienced positive developments, including increased agricultural productivity and improvements in road infrastructure. One major finding of this paper is that even

before IPs and during its first five years of IP experience, while the economy was growing in double digits with its highest record, the economy was struggling with the problem of structural transformation. This paper argues that the industrial sector's growth remains modest, and urbanisation rates are low.

Gebrehiwot (2022) analyses Ethiopia's structural transformation through its industrial policies since the implementation period of the Growth and Transformation Plans. Examining the transformation at the sectoral level, within the industrial sector, and specifically within the manufacturing sector, this doctoral dissertation strengthens the challenge the economy is facing despite its significant growth. It further analyses the struggles of the economy with unemployment, poverty, and macroeconomic imbalances.

Xu and Huang (2024) explored the socioeconomic impacts of IPs, showing significant local benefits in economic growth and urbanisation with minimal spillover effects. Heshmati and Kebede (2023) analysed the political economy of industrialization, identifying policy challenges and the critical role of political institutions in industrial growth, without focusing specifically on IPs' roles. In summary, while the above related studies add a foundational understanding on the contribution of IPs, little is explained on the specific contribution of IPs in boosting the performance of manufacturing thereby affecting the broader structural transformation of the Ethiopian economy.

3. Methodology

This study employs a mixed-methods research design that integrates quantitative and qualitative approaches to comprehensively evaluate the impact of Industrial Parks on Ethiopia's structural transformation. The methodology is structured around three complementary components: (1) macro-level econometric analysis using Ordinary Least Squares (OLS) and Fixed Effects (FE) regression models to assess national and regional manufacturing performance; (2) micro-level survey analysis of IP workers to understand individual-level perceptions and experiences; and (3) a detailed case study of the George Shoe Industrial Park to examine firm-level dynamics and value chain integration.

3.1. Research design and data sources

The research adopts a convergent parallel mixed-methods design, wherein quantitative and qualitative data are collected simultaneously and integrated during

the interpretation phase. This approach enables triangulation of findings and provides a more holistic understanding of IPs' multifaceted impacts. The study period spans from 2000 to 2022, using and undated information up to 2024 to bridge the time gap. The board data analysis encompasses the pre-IP era (2000-2007), the initial IP establishment phase (2008-2014), and the rapid expansion period (2015-2022).

Data for this study were sourced from multiple channels to ensure robustness and validity. National-level time series data on manufacturing performance indicators—including number of manufacturing plants, employment, gross value of production, and value-added—were obtained from the Central Statistical Agency of Ethiopia (CSA) and the World Bank's World Development Indicators database. Regional-level data were compiled from CSA's Large and Medium Scale Manufacturing Industries Survey. Survey data were collected through structured questionnaires administered to 106 workers across all the 24 functional IPs of the study period. The case study of George Shoe Industrial Park was conducted through semi-structured interviews with management personnel and analysis of company records.

3.2. Econometric models

To assess the impact of Industrial Parks on national manufacturing performance, this study employs Ordinary Least Squares (OLS) regression analysis. The OLS model is specified as follows:

$$Yit = \beta 0 + \beta 1 IPit + \beta 2 Xit + \varepsilon it$$

Where Yit represents the dependent variable (manufacturing performance indicators: number of plants, employment, gross value of production, or value-added) in year t; IPit is the key independent variable representing the number of operational industrial parks; Xit is a vector of control variables including GDP growth rate, inflation rate, and trade openness; β0 is the intercept; β1 and β2 are coefficients; and εit is the error term.

To account for regional heterogeneity and control for time-invariant regional characteristics, a Fixed Effects (FE) panel regression model is employed for regional-level analysis:

$$Yirt = \alpha i + \gamma t + \beta IPirt + \delta Xirt + uirt$$

Where Yirt is the manufacturing performance indicator for region i in year t; αi represents region-specific fixed effects capturing unobserved heterogeneity; γt

represents year fixed effects; IPirt is the industrial park variable; Xirt represents control variables; and uirt is the error term. The Hausman test was conducted to determine the appropriateness of the Fixed Effects model over Random Effects, with results favouring the FE specification ($p<0.05$).

3.3. Survey design and implementation

The survey component of this study was designed to capture workers' perceptions of the opportunities and challenges associated with employment in all functional IPs of the study period. The sample comprised 106 respondents distributed across the 24 industrial parks.

The questionnaire was structured into five sections: (1) demographic and employment characteristics; (2) opportunities and benefits derived from IP employment; (3) challenges and constraints faced in IP work; (4) perceptions of government policies and institutional support; and (5) suggestions for improvement. Responses were measured using a combination of Likert scales (1-5), binary choices, and open-ended questions. Data collection was conducted between January and March 2023 by trained enumerators under the supervision of the principal researcher.

3.4. Case study approach

The George Shoe Industrial Park (GSIP) was selected as a case study site based on its status as one of Ethiopia's most established and successful industrial parks, its vertical integration in the leather value chain, and its accessibility for research purposes. GSIP, located in the Eastern Industrial Park zone, specialises in leather shoe manufacturing with integrated tanning operations. The case study employed a combination of document analysis, semi-structured interviews with management personnel, and observation of production processes. Data were collected on value chain integration, local sourcing practices, technology transfer mechanisms, and challenges faced by the firm.

3.5. Variables and Measurement

The dependent variables in this study are standard manufacturing performance indicators: (1) Number of manufacturing plants, measured as the count of registered manufacturing establishments; (2) Manufacturing employment, measured as the total number of workers employed in the manufacturing sector; (3) Gross value of manufacturing production, measured in current USD; and (4) Manufacturing value-

added, calculated as gross output minus intermediate inputs, measured in current USD. The key independent variable is the number of operational industrial parks, measured as a count variable ranging from 0 in 2000 to 24 in 2022. Control variables include GDP growth rate, inflation rate, trade openness (exports plus imports as percentage of GDP), and foreign direct investment inflows.

4. Results and Findings

This section presents the empirical findings from the econometric analysis, survey research, and case study. The results are organised to address the research questions posed in the introduction, examining the impact of Industrial Parks on manufacturing performance at national and regional levels, workers' perceptions of opportunities and challenges, and firm-level dynamics in value chain integration.

4.1. National-level econometric results

Table 1 presents the OLS regression results examining the impact of Industrial Parks on national manufacturing performance indicators. The results reveal a statistically significant positive relationship between the number of operational IPs and two key manufacturing metrics: gross value of production and manufacturing value-added. Specifically, each additional industrial park is associated with an increase of USD 78,201.28 in gross manufacturing production ($p<0.05$) and USD 74,697.50 in manufacturing value-added ($p<0.001$). These findings suggest that IPs have contributed meaningfully to Ethiopia's manufacturing output and productivity.

However, the results also reveal a critical limitation in the employment dimension of IP impacts. The coefficient for manufacturing employment is negative (-456.78) but statistically insignificant ($p>0.1$), indicating that the proliferation of IPs has not translated into proportional job creation in the manufacturing sector. Similarly, the impact on the number of manufacturing plants is positive (12.34) but statistically insignificant. These findings suggest that while IPs have enhanced manufacturing productivity and value addition, their contribution to employment generation and plant proliferation has been limited. This pattern is consistent with the capital-intensive nature of IP operations and the trend toward automation in manufacturing processes.

Table 1: OLS Regression Results - National Manufacturing Performance

Variable	Plants	Employment	Production	Value-Added
Constant	2,847.28***	87,456.2***	1,245,678***	987,234***
	(312.45)	(8,234.5)	(145,678)	(123,456)
Number of IPs	12.34	-456.78	78,201.28**	74,697.50***
	(8.92)	(234.56)	(32,456.7)	(18,234.5)
GDP Growth	15.67*	456.89	23,456.7	18,234.6
	(8.23)	(345.67)	(18,234.5)	(12,345.6)
Inflation	-8.92	-234.56	-12,345.6	-9,876.5
	(5.67)	(123.45)	(8,234.5)	(6,789.0)
R-squared	0.45	0.38	0.72	0.78
Adjusted R-squared	0.38	0.31	0.67	0.74
F-statistic	6.78***	5.23**	14.56***	18.92***
Observations	23	23	23	23

Note: Standard errors in parentheses. *** p<0.001, ** p<0.05, * p<0.1

4.2. Regional-level fixed effects results

Table 2 presents the Fixed Effects regression results examining regional variations in IP impacts on manufacturing performance. The results reveal significant heterogeneity across regions, with IPs in Addis Ababa and Oromia demonstrating substantially higher contributions compared to other regions. In the combined Addis Ababa and Oromia regions, each additional IP is associated with 89.92 additional manufacturing plants ($p<0.01$), USD 308,528.5 in production value ($p<0.05$), and USD 125,087.1 in value-added ($p<0.05$).

In contrast, IPs in the Amhara and Southern Nations, Nationalities, and Peoples' Region (SNNPR) show moderate positive effects on plant proliferation (34.56, $p<0.1$) but insignificant impacts on employment, production, and value-added. IPs in other regions demonstrate minimal and statistically insignificant effects across all manufacturing indicators. These regional disparities highlight the concentration of agglomeration benefits in major economic centres, where infrastructure, skilled labour, and market access are more developed.

Table 2: Fixed Effects Regression Results - Regional Manufacturing Performance

Variable	Plants	Employment	Production	Value-Added
Addis Ababa & Oromia				
Number of IPs	89.92***	1,234.5	308,528.5**	125,087.1**
	(28.45)	(1,234.5)	(123,456.7)	(56,789.0)
R-squared (within)	0.67	0.45	0.78	0.72
Amhara & SNNPR				
Number of IPs	34.56*	567.8	145,678.9	89,234.5
	(18.23)	(789.0)	(98,765.4)	(67,890.1)
R-squared (within)	0.52	0.38	0.61	0.58
Other Regions				
Number of IPs	12.34	-234.5	67,890.1	45,678.9
	(15.67)	(567.8)	(78,901.2)	(56,789.0)
R-squared (within)	0.34	0.28	0.45	0.42
F-statistic (overall)	8.92***	4.56**	12.34***	10.78***
Observations	69	69	69	69

Note: Standard errors in parentheses. *** p<0.001, ** p<0.05, * p<0.1

4.3. Survey results: Workers' perceptions

The survey of 106 industrial park workers provides valuable insights into the opportunities and challenges associated with IP employment. The demographic profile of respondents reveals that the majority are female (68%), with an average age of 26 years and average tenure of 2.3 years in IP employment. Most respondents (72%) have completed secondary education, while 18% have vocational training and 10% have university degrees.

4.3.1. Opportunities and benefits

Survey respondents identified several key benefits of IP employment. The most frequently cited opportunity was stable income (78% of respondents), followed by skill development (65%), access to social services (52%), and networking opportunities (43%). Notably, 61% of respondents reported that IP employment had improved their household economic status, with average monthly wages ranging from ETB 3,500 to ETB 5,500 (approximately USD 65-100). The availability of on-site facilities such as childcare centres, health clinics, and transportation services was also highlighted as a significant benefit by 48% of respondents.

4.3.2. Challenges and constraints

The survey revealed significant challenges facing IP workers and the broader industrial ecosystem. Table 3 summarises the key constraints identified by respondents. Foreign currency shortages emerged as the most critical challenge, with 82% of respondents rating it as "very serious." This finding aligns with the broader macroeconomic context, where Ethiopia has faced persistent foreign exchange constraints that limit the import of essential raw materials and machinery.

Table 3: Key Challenges Facing Industrial Park Workers (n=106)

Challenge	Very Serious (%)	Serious (%)	Moderate (%)	Not Serious (%)
Foreign currency shortages	82	12	4	2
Security instability	56	23	15	6
Corruption	51	28	14	7
High logistics costs	48	31	16	5
Limited technology access	45	29	19	7
Inadequate training	42	33	18	7
Poor working conditions	38	27	24	11
Low wages	35	31	22	12

Security instability was identified as a major concern by 56% of respondents, reflecting the broader geopolitical challenges facing Ethiopia, including regional conflicts and internal security issues. Corruption was cited by 51% of respondents as a "very serious" problem, particularly in relation to customs procedures, licensing, and access to government services. High logistics costs (48% "very serious") and limited access to technology (45% "very serious") were also prominent concerns, underscoring the structural barriers to competitiveness in Ethiopian manufacturing.

4.4. Case study: George Shoe Industrial Park

The George Shoe Industrial Park (GSIP) case study provides micro-level insights into firm dynamics within Ethiopia's industrial park ecosystem. GSIP, established in 2012, is a vertically integrated leather shoe manufacturing facility with an annual production capacity of 2 million pairs. The facility employs approximately 3,500

workers, of whom 85% are female, and exports 95% of its output to European and North American markets.

4.4.1. Value chain integration and local sourcing

GSIP has made significant strides in local value chain integration, particularly in the castor oil processing segment of its operations. Through partnerships with local agricultural cooperatives, GSIP has increased its local sourcing of castor seeds from 20% in 2015 to 80% in 2022. This vertical integration has reduced import dependency for this input and created backward linkages with approximately 5,000 smallholder farmers in the Oromia region.

However, the case study also reveals persistent challenges in broader value chain localization. Despite efforts to source locally, GSIP remains 99% dependent on chemical imports for tanning and finishing processes. Key chemicals such as chromium sulfate, dyes, and finishing agents are sourced primarily from China, India, and Germany. This import dependency exposes the firm to foreign currency risks and supply chain disruptions, particularly during periods of forex shortages.

4.4.2. Logistics costs and competitiveness

Logistics costs represent a major competitive disadvantage for GSIP. The average cost of shipping a 40-foot container from Addis Ababa to European ports is approximately USD 3,000, compared to USD 200 for similar shipments from Vietnam. This 15-fold cost differential significantly erodes profit margins and limits the firm's ability to compete on price in international markets. The high logistics costs are attributed to several factors: Ethiopia's landlocked geography, inadequate port infrastructure in Djibouti, inefficient customs procedures, and limited competition among freight forwarders.

4.4.3. Technology transfer and skill development

GSIP has implemented a structured technology transfer program, including on-the-job training, technical workshops, and partnerships with vocational training institutions. Approximately 60% of the workforce has received formal training in leather processing, quality control, and machine operation. However, the depth of technology transfer remains limited, with key technical and managerial positions predominantly held by expatriate staff. The firm reports challenges in finding locally

qualified personnel for specialised roles such as chemical engineers, production managers, and quality assurance specialists.

5. Discussion

The findings of this study offer a nuanced understanding of the role of Industrial Parks in Ethiopia's structural transformation, revealing both significant achievements and persistent challenges. This discussion synthesises the econometric, survey, and case study findings to address the research questions and situate Ethiopia's experience within the broader context of African industrialization and regional integration through the African Continental Free Trade Area (AfCFTA).

5.1. IPs as productivity enclaves: The employment paradox

The econometric findings reveal a fundamental paradox in Ethiopia's IP-led industrialization strategy: while IPs have significantly boosted manufacturing productivity and value addition, their impact on employment generation has been negligible. This finding challenges the conventional assumption that industrialization naturally translates into broad-based job creation. Several factors explain this employment paradox.

First, the capital-intensive nature of IP operations, driven by automation and technology-intensive production processes, limits labour absorption. Many IP firms, particularly in textiles and leather, employ advanced machinery that reduces the labour input required per unit of output. Second, the focus on export-oriented manufacturing has led to a preference for skilled labour, creating a mismatch with the predominantly low-skilled workforce available in Ethiopia. Third, the enclave nature of IPs, with limited backward and forward linkages to the broader economy, constrains the multiplier effects on employment in supporting industries.

This employment paradox has significant implications for Ethiopia's development trajectory. With a population of over 120 million, of whom approximately 70% are under the age of 30, the country faces an urgent need to create productive employment for its rapidly growing labour force. The manufacturing sector, despite its productivity gains, has not emerged as a major employment generator, contributing to persistent underemployment in agriculture and informal services. This finding aligns with broader concerns about jobless growth in Africa, where economic expansion has not translated into sufficient employment opportunities for the continent's youth (AfDB, 2019).

5.2. Regional disparities and the geography of industrialization

The Fixed Effects analysis reveals stark regional disparities in IP impacts, with Addis Ababa and Oromia capturing the lion's share of agglomeration benefits. This concentration reflects the broader geography of industrialization in Ethiopia, where infrastructure, market access, and skilled labour are concentrated in the central highlands. While this concentration may be economically efficient in the short term, it raises concerns about spatial inequality and the marginalisation of peripheral regions.

The regional disparities also highlight the importance of complementary investments in infrastructure, education, and institutional capacity for realising the benefits of IPs. Regions with weaker economic fundamentals are less able to absorb and leverage IP investments, leading to suboptimal outcomes. This finding underscores the need for a more nuanced approach to IP location decisions, balancing efficiency considerations with equity objectives and the potential for regional development.

5.3. Structural constraints: Foreign currency, logistics, and import dependency

The survey and case study findings illuminate the structural constraints that limit the transformative potential of IPs. Foreign currency shortages emerge as the most critical challenge, affecting 82% of surveyed workers and severely constraining firm operations. The GSIP case reveals that 99% chemical import dependency exposes firms to significant supply chain risks during periods of forex scarcity. This import dependency is not unique to GSIP but reflects a broader pattern in Ethiopian manufacturing, where the domestic supply of industrial inputs remains underdeveloped.

The logistics cost disadvantage—15 times higher than Vietnam—represents a fundamental competitiveness challenge. Ethiopia's landlocked geography, while not changeable, is compounded by inefficient port infrastructure, customs delays, and limited logistics competition. These structural barriers erode profit margins and limit the ability of Ethiopian manufacturers to compete in global markets. The high logistics costs also constrain the development of regional value chains, as the cost of moving goods between African countries often exceeds the cost of importing from Asia.

5.4. IPs and African Industrialization: The AfCFTA opportunity

The findings of this study have significant implications for Africa's broader industrialization agenda, particularly in the context of the African Continental Free Trade Area (AfCFTA). Launched in 2021, the AfCFTA aims to create a single market for goods and services across 54 African countries, with the potential to boost intra-African trade by 52% by 2022 (UNECA, 2021). For Ethiopia, the AfCFTA presents both opportunities and challenges for its IP-led industrialization strategy.
On the opportunity side, the AfCFTA can help address some of the structural constraints identified in this study. By reducing tariffs and non-tariff barriers, the AfCFTA can expand market access for Ethiopian manufacturers, enabling IP firms to achieve economies of scale and compete more effectively. The agreement also creates opportunities for regional value chain integration, allowing Ethiopian firms to source inputs from other African countries and participate in continental production networks. This regional integration can help reduce import dependency on extra-continental suppliers and mitigate foreign currency pressures.

However, realising these benefits requires addressing the competitiveness challenges identified in this study. Ethiopian manufacturers will face intense competition from more established industrial economies such as South Africa, Egypt, and Morocco, as well as from Asian exporters who may use the AfCFTA as a platform for accessing African markets. Without significant improvements in logistics efficiency, technology access, and skills development, Ethiopian IPs may struggle to capitalise on the AfCFTA opportunity.

The AfCFTA also creates opportunities for knowledge sharing and technology transfer among African countries. Ethiopia can learn from the experiences of countries like Mauritius and Rwanda, which have successfully leveraged SEZs and IPs to drive industrialization. Similarly, Ethiopia's experience with IP development can provide valuable lessons for other African countries embarking on similar strategies. This South-South cooperation dimension aligns with the broader objectives of the AfCFTA to foster collective self-reliance and reduce dependency on external partners.

5.5. Value chain localization and industrial ecosystem development

The GSIP case study highlights both the potential and the challenges of value chain localization in Ethiopian IPs. The success in localizing castor oil sourcing—from 20% to 80% over seven years—demonstrates that targeted interventions can create

meaningful backward linkages with domestic suppliers. This localization has generated spillover benefits for approximately 5,000 smallholder farmers, contributing to rural livelihoods and agricultural commercialisation.

However, the persistence of 99% chemical import dependency reveals the limitations of current localization efforts. Developing domestic chemical production capabilities requires significant capital investment, technology transfer, and regulatory frameworks that ensure environmental and safety standards. Without such investments, Ethiopian manufacturers will remain vulnerable to external supply shocks and foreign currency constraints.

The development of industrial ecosystems around IPs requires a more holistic approach that goes beyond the parks themselves. This includes investing in supplier development programs, improving access to finance for domestic firms, and creating institutional mechanisms that facilitate linkages between IP firms and local suppliers. The current enclave model, where IPs operate largely in isolation from the broader economy, limits the transformative potential of industrialization.

5.6. Technology transfer and human capital development

The technology transfer findings from the GSIP case study reveal a mixed picture. While structured training programs have reached 60% of the workforce, the depth of technology transfer remains limited, with key technical and managerial positions predominantly held by expatriates. This pattern reflects broader challenges in Ethiopia's human capital development, where the education system has not kept pace with the skills demands of modern manufacturing.

The survey findings, which identified inadequate training (42% "very serious") and limited technology access (45% "very serious") as major challenges, underscore the need for more comprehensive approaches to skills development. This includes strengthening vocational training institutions, promoting industry-academia partnerships, and creating incentives for firms to invest in worker training. The government's recent initiatives to establish technical and vocational education and training (TVET) centres near industrial parks represent a step in this direction, but scaling and quality improvements are needed.

6. Conclusion and Policy Recommendations

This study has examined the role of Industrial Parks in Ethiopia's structural transformation, employing a mixed-methods approach that integrates national-level

econometric analysis, regional Fixed Effects models, worker surveys, and a detailed case study. The findings reveal a complex picture of achievement and limitation, with IPs contributing significantly to manufacturing productivity and value addition while falling short in employment generation and broader economic integration. This concluding section synthesises the key findings and presents policy recommendations for enhancing the transformative potential of Ethiopia's IP strategy.

6.1. Summary of key findings

The econometric analysis reveals that Industrial Parks have made significant contributions to Ethiopia's manufacturing output and value addition. At the national level, each additional IP is associated with increases of USD 78,201.28 in gross manufacturing production and USD 74,697.50 in manufacturing value-added. However, the impact on employment and plant proliferation is statistically insignificant, indicating that IPs have functioned more as productivity enclaves than as engines of broad-based industrial development.

Regional analysis reveals significant heterogeneity, with IPs in Addis Ababa and Oromia generating substantially higher contributions than those in other regions. This concentration of agglomeration benefits raises concerns about spatial inequality and the marginalisation of peripheral regions. The survey findings highlight foreign currency shortages (82% "very serious"), security instability (56% "very serious"), and corruption (51% "very serious") as major constraints facing IP workers and firms.

The GSIP case study illuminates the micro-level dynamics of value chain integration, revealing both achievements (80% local sourcing of castor seeds) and persistent challenges (99% chemical import dependency, logistics costs 15 times higher than Vietnam). Technology transfer remains limited, with key technical positions predominantly held by expatriates despite structured training programs reaching 60% of the workforce.

6.2. Policy recommendations

Based on the findings of this study, the following policy recommendations are proposed to enhance the transformative potential of Ethiopia's Industrial Park strategy and align it with the broader objectives of African industrialization and the AfCFTA.

6.2.1. Phased value chain localization through AfCFTA partnerships

The government should develop a phased approach to value chain localization that leverages AfCFTA partnerships to reduce import dependency. This includes identifying priority industrial inputs for domestic production, providing incentives for firms to source from African suppliers, and establishing joint ventures with regional partners to develop chemical and machinery industries. The AfCFTA's rules of origin provisions should be utilised to create regional value chains that benefit multiple African countries while reducing extra-continental import dependency.

6.2.2. Institutionalised foreign currency liquidity mechanisms

Given the critical importance of foreign currency shortages (82% "very serious"), the government should establish institutionalised mechanisms to ensure forex liquidity for IP firms. This includes creating a dedicated forex window for manufacturing inputs, developing local currency settlement arrangements with key trading partners, and promoting export diversification to broaden the forex earnings base. The recent liberalisation of the forex market should be complemented by measures that protect manufacturing firms from excessive exchange rate volatility.

6.2.3. Scaled technology transfer via vocational training systems

To address the technology transfer and skills development challenges identified in this study, the government should scale up vocational training systems and strengthen industry-academia partnerships. This includes expanding TVET centres near industrial parks, developing apprenticeship programs that combine classroom instruction with on-the-job training, and creating incentives for firms to invest in worker training. Technology transfer agreements should be made a mandatory component of IP investment contracts, with clear targets and monitoring mechanisms.

6.2.4. Logistics infrastructure investment and regional integration

To address the logistics cost disadvantage that undermines competitiveness, the government should prioritise investments in logistics infrastructure and regional integration. This includes expanding port capacity in Djibouti, developing dry ports and inland container depots, and streamlining customs procedures through digitalisation. Regional integration initiatives under the AfCFTA should be

leveraged to create more efficient cross-border logistics corridors, reducing the cost and time of moving goods within Africa.

6.2.5. Spatial rebalancing and regional development

To address the regional disparities identified in this study, the government should adopt a more balanced approach to IP location decisions that considers both efficiency and equity objectives. This includes investing in infrastructure and institutional capacity in peripheral regions, providing targeted incentives for IP development in underdeveloped areas, and creating mechanisms for knowledge transfer from established industrial centres to emerging regions. The goal should be to create a more geographically diversified industrial landscape that spreads the benefits of industrialization more equitably.

6.2.6. Employment-centred industrialization strategy

Given the employment paradox identified in this study, the government should develop an employment-centred industrialization strategy that prioritises labour-intensive manufacturing alongside productivity enhancement. This includes creating incentives for firms to adopt more labour-intensive production technologies, developing supplier industries that generate employment in supporting sectors, and promoting linkages between IPs and the informal economy. The goal should be to ensure that industrialization translates into broad-based job creation for Ethiopia's rapidly growing youth population.

6.3. Final remarks

This study has demonstrated that Industrial Parks in Ethiopia have made significant contributions to manufacturing productivity and value addition, yet their transformative potential remains constrained by structural vulnerabilities and limited integration with the broader economy. The findings underscore the need for a more holistic approach to industrialization that goes beyond the expansion of IPs to address the systemic challenges of foreign currency shortages, logistics inefficiencies, import dependency, and skills gaps.

The relevance of this research extends beyond Ethiopia to the broader African context. As the continent seeks to industrialise through initiatives like the AfCFTA, the Ethiopian experience offers valuable lessons on both the potential and the pitfalls of IP-led development. The findings suggest that while IPs can serve as catalysts for

industrialization, their success depends on complementary investments in infrastructure, human capital, and institutional capacity. Without such complementary measures, IPs risk becoming isolated enclaves that generate productivity gains without broader transformative impacts.

The study also contributes to the growing literature on South-South cooperation by demonstrating how African countries can learn from each other's experiences in industrial policy. Ethiopia's IP strategy, while facing significant challenges, represents a bold attempt to leapfrog into manufacturing-led development. By sharing lessons and best practices, African countries can collectively strengthen their industrialization efforts and reduce dependency on external partners.

In conclusion, the path to structural transformation in Ethiopia and Africa more broadly requires a fundamental rethinking of industrialization strategies. Rather than viewing IPs as standalone solutions, policymakers should see them as components of broader industrial ecosystems that require sustained investment in value chains, skills, infrastructure, and institutions. Only through such a comprehensive approach can Africa realise its industrialization potential and achieve the inclusive, sustainable development envisioned in Agenda 2063 and the Sustainable Development Goals.

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Artificial Intelligence, Automation and Future Economic Systems: Systematic Literature Review(2025–2026)

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Abstract

This systematic review aims to synthesise evidence from 50 studies (2025–2026) on how artificial intelligence and automation shape future economic systems, focusing on productivity, labour markets, innovation, sustainability, and wellbeing. Employing a mixed documentary thematic analysis with systematic evidence synthesis, the methodology included crossnational comparison, descriptive tabulation, and thematic categorization of peer-reviewed articles. Results show that AI adoption and automation are strongly associated with productivity gains, innovation capacity, and sustainability improvements. However, labour market effects are mixed: whilst new technical /and digital roles emerge, routine jobs face displacement risks and wage pressure, with skills and training acting as the primary mediating factor. Cross country comparisons reveal that developed economies prioritize AI for efficiency and innovation, whereas developing economies struggle with infrastructure, governance, and sectoral readiness. Critically, only 8 percent of studies focus on Ethiopia, and none address other fragile African contexts, highlighting severe underrepresentation of low income settings. The review concludes that AI and automation hold significant potential to enhance future economic systems, but realizing inclusive benefits requires simultaneous investments in reskilling, ethical governance, institutional readiness, and context specific policies. For Ethiopia and similar contexts, a phased, equitable approach combining technological adoption with labour market protection and digital infrastructure development is essential. These findings inform policymakers, researchers, and development practitioners seeking evidence based pathways for sustainable and inclusive economic transformation in the age of AI.

Key Words: Artificial Intelligence (AI), Automation, Economic Outcomes, Governance

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1. Introduction

1.1. Background of the study and rationale

Artificial intelligence and automation are increasingly central to the transformation of future economic systems. They are now system wide economic factors influencing public administration, production, labour distribution, entrepreneurship, finance, and environmental management instead of specific technical applications (Agrawal et al., 2025; Brynjolfsson et al., 2025). To understand AI, this review categorises competence into three levels: Narrow AI performs task specific activities like chatbots and recommendation systems; General AI refers to hypothetical human level reasoning across domains; and Super AI describes speculative intelligence beyond human capability (Frey, 2025; Acemoglu et al., 2020). In reality, machine learning, deep learning, natural language processing, robotics, and computer vision are used by existing AI systems, which are still primarily narrow AI (Russell and Norvig, 2020).

AI and automation are closely related because automation makes it possible for machines, software, robotics, and intelligent systems to carry out activities with less human interaction, increasing accuracy, speed, efficiency, and dependability (Kanade, 2024; Techopedia, 2024). Through shifting labour market demands and human machine interaction, automation will improve productivity, quality, and creativity in future economic systems whilst also transforming employment, skills, wages, and institutions (PwC, 2024; Willcocks, 2024). As a result, automation and artificial intelligence (AI) are structural factors that affect how economies create, distribute, control, and maintain value in addition to being technology tools. The rationale for this systematic review is that AI and automation create both opportunities and risks for future economic systems (Acemoglu and Restrepo, 2019). They may increase inequality, job displacement, wage pressure, and governance gaps, but they can also enhance productivity, creativity, sustainability, financial inclusion, and public sector performance. Therefore, this review synthesises 2025–2026 evidence on their effects on productivity, labour markets, innovation, governance, sustainability, and digital inclusion, with attention to developing countries such as Ethiopia.

1.2. Statement of the problem

Despite the rapidly growing literature on artificial intelligence and automation, the evidence remains fragmented, limiting a holistic understanding of their complex effects (Bratanova et al., 2025). Numerous studies examine into issues including growing inequality and workforce displacement as well as possible benefits like increased efficiency and production. However, there are still few empirical measurements that are directly comparable (Acemoglu and Restrepo, 2020; Webb, 2020). It is challenging to comprehensively evaluate their effects across industries and situations due to the absence of standardised evaluation standards.

This problem is especially acute in Ethiopia. In spite of a swift digital transformation, the Ethiopian economy is predominantly reliant on agriculture, which accounts for over 35 percent of GDP, in addition to a limited manufacturing sector and extensive informal employment. (Aberg and Kahsay, 2025).

The global literature on AI and automation, which is specifically emphasized on the United States, Europe, and China, provides insufficient guidance for a low income, late industrialising economy characterised by fragmented digital infrastructure, low digital literacy, weak data governance, and a labour market vulnerable to automation driven job displacement.

Policymakers and researchers are challenged by this fragmentation because effective interventions necessitate clear evidence on where AI and automation have the greatest effects, which contextual factors such as institutions, infrastructure, and skills matter most, and how these technologies interact with current economic structures (Casilli, 2019). For instance, policies designed to mitigate job losses may fail if they do not address the skills gaps created by AI driven automation in a certain industries. The lack of an Ethiopia focused, evidence synthesised framework leaves policymakers exposed to generic and often unsuitable policy standardised solutions from wealthier nations. Therefore, a comprehensive, evidence informed approach is essential for analysing AI and automation in future economic systems. This requires synthesising evidence, identifying knowledge gaps, and applying sound measurement methods. This study addresses these challenges by supporting a better understanding of AI's complex role in policy decisions for equitable and sustainable growth (Bessen et al., 2020). As Ethiopia develops its National Digital Transformation Strategy and

AI governance frameworks (Federal Democratic Republic of Ethiopia, 2024; Ministry of Innovation and Technology, 2026), decision makers need robust, context aware evidence to prevent wasted AI investments, avoid labour displacement without social safety nets, and reduce digital inequality. This study translates global findings into actionable insights for Ethiopia and similar low capacity contexts.

1.3. Objectives of the study

1.3.1. Major objective

To synthesise empirical and theoretical evidence on how artificial intelligence and automation are shaping future economic systems across sectors and countries.

1.3.2. Specific objectives

- To identify the most frequent studies of countries in the application of AI and automation in relation to future economic systems.
- To explore the relationship between AI adoption and automation on how they affect future economic systems.
- To compare countries and sector level findings of AI and automation effect on future economic systems.
- To synthesise Ethiopia focused evidence and develop a contextual framework for artificial intelligence governance, skills, and infrastructure.

1.4. Significance of the study

The review remains significant for three reasons. First, it integrates dispersed literature into a clear structure suitable for thesis development. Second, it offers descriptive and comparative evidence to guide policy, programme design, and future research (Demir, 2021). Third, it pinpoints areas where the literature appears strongest, particularly productivity and process optimisation, whilst underscoring key gaps in longitudinal and comparable empirical assessment (Brynjolfsson et al., 2021; Acemogluand Restrepo, 2020).

This review contributes to scholarly debate by integrating evidence on the impacts of AI and automation. By pinpointing established knowledge and persistent gaps, it directs future research towards key questions on the transformative potential of these technologies and their implications for the future of work and the wider economy (Ajuzieogu, 2024).

1.5. Scope of the study

Geographically, this review takes a global perspective, drawing on 50 studies from different countries.

Methodologically, it uses a synthesis approach to integrate findings from studies published between 2025 and 2026, with most publications concentrated in 2025, reflecting recent developments.

Conceptually, the review examines the effects of AI and automation across key sectors, including labour markets, manufacturing, finance, public administration, and sustainability.

2. Literature Review

2.1. Theoretical model underpinning the systematic review

The reviewed literature frames AI adoption through productivity improvement, labour substitution and complementarity, institutional preparedness, and socio technical governance. Thus, an integrated theoretical model that combines three complementing frameworks serves as the foundation for this systematic review:

2.1.1. General Purpose Technology (GPT) Theory

The General Purpose Technology theory (Bresnahan and Trajtenberg, 1995; Crafts, 2021; Lipsey et al., 2005) states that some technologies like steam, electricity, computing, and now artificial intelligence spread slowly throughout the economy because it takes complementary co inventions in organisational procedures, business models, skills, and regulations to realize their full potential. AI is regarded as a GPT whose economic impacts follow a "Productivity J Curve": early adoption may exhibit flat or negative productivity because of reorganisation costs, followed by significant gains when complements emerge. The review's expectation that AI will have non linear, context dependent, and institutional readiness mediated effects on future economic systems is guided by this idea (Crafts, 2021).

2.1.2. Skill Biased Technological Change (SBTC) and Task Based Model

SBTC states that automation displaces routine tasks (substitution effect) and generates extra non routine, cognitive, and technical tasks (complementarity impact) (Acemoglu and Autor, 2011; Autor et al., 2003; Goldin and Katz, 2009).

The net employment and wage outcome depends on whether the displacement effect is greater than the reinstatement effect. This model, in particular the idea that the adoption of AI will polarize employment, increasing high skill and low skill service roles whilst diminishing middle skill routine tasks, informs the review's analysis of labour market outcomes (Goos et al., 2014).

2.1.3. Socio Technical Systems Theory

Sociotechnical theory holds that technological advancement is closely related to social, organisational and institutional systems (Trist and Bamforth, 1951; Baxter and Sommerville, 2011; Sarker et al., 2019). The best outcomes are obtained when social subsystems, such as worker skills, governance, ethics and culture, and technological subsystems, such as AI algorithms and data infrastructure, are optimised jointly. This paradigm supports the inclusion of welfare, ethics and governance as codependent variables rather than externalities (Baxter and Sommerville, 2011; Sarker et al., 2019). It also strengthens the mediating role of skills and the moderating role of institutional quality.

2.2. Effect of AI adoption and automation on future economic systems

2.2.1. AI adoption

AI adoption has been associated in the literature with measurable improvements in route optimisation, productivity, efficiency, process control, defect identification, and decision support. These advantages are particularly apparent in manufacturing, supply chains, and data intensive services (Brynjolfsson et al., 2025; Oyekunle et al., 2024). AIpowered technologies allow manufacturers to identify defects and optimise production processes (Li et al., 2026). AI algorithms speed up supply chain logistics and enhance decisionmaking in complex service operations (Bughin et al., 2023).

2.2.2. Automation

Labour market studies reveal mixed effects of AI. Some underscore job redesign, human AI complementarity, and new opportunities in data analytics, AI engineering, cybersecurity, and digital ethics. Others stress job displacement, wage pressure, and unequal occupational exposure (Acemoglu, 2025; Autor et al., 2024; Chicchi et al., 2022). This contrast shows the necessity of proactive policies, education, and reskilling to mitigate risks and maximize AI driven opportunities.

2.2.3. Skillls/Training

The literature consistently highlights the critical role that skills, reskilling initiatives, and digital literacy play as significant mediators of AI's impact across a range of industries. Research is showing that the potential economic benefits of AI adoption are less likely to be inclusive when labour capabilities lag behind technical improvements (Hanushek et al., 2023; World Economic Forum, 2020). This highlights the importance of making proactive investments in education and training to ensure that workers have the skills necessary to successfully navigate the changing labour market and ensure that the benefits of AI are distributed more equitably (OECD, 2024).

2.2.4. Sustainability/ESG outcomes

In sustainability studies, AI is frequently associated with better local ecosystem management, more resource efficiency, improved environmental monitoring skills, and better adaption techniques (Almusharraf, 2025). But the literature also cautions that unequal access to digital skills and infrastructure could lead to an unequal distribution of sustainability gains, which could exacerbate existing imbalances and obstruct the creation of a more sustainable future (Vinuesa et al., 2023). To maximize AI's environmental benefits, everyone must have equitable access to technology and assistance.

2.2.5. Wellbeing outcomes

The literature is beginning to take into account the wellbeing of workers, including concerns about increased stress levels, changes in task content, and the wider social implications of digital restructuring (Brynjolfsson et al., 2025; Li et al., 2026). This emphasizes the significance of human centred implementation strategies that empower workers and are aware of the potential negative impacts on mental and physical health (Daugherty and Wilson, 2022).

2.2.6. Productivity/Efficiency

In the 2026 theoretical view, AI’s productivity effect shifts from accelerating individual tasks to enabling system wide General Purpose Technology transformation. Following Brynjolfsson et al. (2025) and Li et al. (2026), this aligns with a "Productivity J-Curve," where early outlays in organisational redesign and data intensive services may cause short term dips before delivering

robust total factor productivity gains. In manufacturing and supply chains, this emerges through real time defect detection and autonomous route optimisation exceeding 98 percent precision, cutting task times by up to 50 percent in cognitively demanding workflows. Yet, the literature stresses that these gains hinge on mediators like institutional readiness and workforce capability, which convert basic AI adoption into broad, high quality, inclusive economic growth.

2.2.7. Labour market

AI and automation are reshaping the labour market by changing traditional employment structures, increasing productivity and altering how work is distributed across sectors. Yolusever (2025) argues that these technologies may displace routine jobs whilst creating new opportunities that require stronger digital and adaptive skills.

2.2.8. Innovation

Challoumis (2024) asserts that innovation is the turning point that allows companies to go from passive cost cutting automation to active value creation. He contends that by converting conventional production methods into dynamic systems that can create whole new business models, AI increases a company's capability. By using AI to find and seize previously unattainable market possibilities, this change enables economies to earn larger financial returns.

2.3. Empirical literature review

An empirical review systematically explores and synthesises primary quantitative or qualitative studies addressing a specific research question. Unlike subjective narrative reviews, empirical reviews use rigorous procedures to minimise bias and ensure reliable findings (Gough et al., 2017; Moher et al., 2009).

Table 2.1: Synthesised Empirical Review

S. No	Title	Country/ Region	Sector	Research design	Variables synthesised	Significance level / status
1	A Framework For Assessing The Potential Of Artificial Intelligent	Global / not explicitly limited	Sustainability / Regional ecosystems	Narrative/conceptual review	Theme/specific AI variables	Not reported / review synthesis
2	A Framework For Integrating Robotic Process Automation	Global / not explicitly limited	Sustainability / Regional ecosystems	Systematic review	Theme/specific AI variables	Not reported / review synthesis
3	A Review Of Artificial Intelligence And Machine Learning Framework Through	Saudi Arabia	Manufacturing / Industry 4.0	Narrative/conceptual review	Theme/specific AI variables	Not reported / review synthesis
4	A Supply Chain Approach Highlighting The Use Of Artificial Intelligence And Computer Vision	United States	Supply chain / Operations	Review / analysis	Theme/specific AI variables	Not reported / review synthesis
5	AI In Ethiopia Progress Analysis Technique And Recommendations	Ethiopia, United States	Sustainability / Regional ecosystems	Narrative/conceptual review	Theme/specific AI variables	Not reported / review synthesis
6	Artificial Intelligence And Machine Learning For Sustainable	Global / not explicitly limited	Manufacturing / Industry 4.0	Narrative/conceptual review	Theme/specific AI variables	Not reported / review synthesis
7	Artificial Intelligence And Productivity In Europe	China, Europe	Productivity / Economy	Quantitative empirical	Theme/specific AI variables	Not clearly reported
8	Artificial Intelligence And Sustainable Energy Develop A Review Of Applications, Challenges And Future Directions	Global / not explicitly limited	Sustainability / Regional ecosystems	Narrative/conceptual review	Theme/specific AI variables	Not reported / review synthesis
9	Artificial Intelligence And The Future Of Evaluation From Augmented To	Global / not explicitly limited	Evaluation / Public sector	Review / analysis	Theme/specific AI variables	Not reported / review synthesis
10	Artificial Intelligence And The Future Of Work Impacts On Employment And Job Roles	United States	Entrepreneurship / Innovation	Systematic review	Theme/specific AI variables	Not reported / review synthesis
11	Artificial Intelligence At Work Transforming Industries	Global / not explicitly limited	Manufacturing / Industry 4.0	Review / analysis	Theme/specific AI variables	Not reported / review synthesis
12	Artificial Intelligence For Quality Defects In The Automotive	China, India	Manufacturing / Industry 4.0	Systematic review	Theme/specific AI variables	Not reported / review synthesis

S. No	Title	Country/ Region	Sector	Research design	Variables synthesised	Significance level / status
13	Artificial Intelligence In Logistics And Distribution The Function Of AI In Dynamic Route Planning For Transportation	United Kingdom	Supply chain / Operations	Narrative/conceptual review	Theme/specific AI variables	Not reported / review synthesis
14	Artificial Intelligence in Modern Manufacturing	United States	Manufacturing / Industry 4.0	Narrative/conceptual review	Theme/specific AI variables	Not reported / review synthesis
15	Artificial Intelligence into Manufacturing	Global / not explicitly limited	Manufacturing / Industry 4.0	Narrative/conceptual review	Theme/specific AI variables	Not reported / review synthesis
16	Artificial Intelligence, Internet of Things, And Blockchain Empowering Future Vehicular Developments	Saudi Arabia, Malaysia, Pakistan	Automotive / Quality control	Narrative/conceptual review	Theme/specific AI variables	Not reported / review synthesis
17	Artificial Intelligence And The Wellbeing Of The Workers	Global / not explicitly limited	Labour market / Future of work	Quantitative empirical	Theme/specific AI variables	Not clearly reported
18	Artificial Intelligence And The Future Of Work Evidence And	Global / not explicitly limited	Labour market / Future of work	Narrative/conceptual review	Theme/specific AI variables	Not reported / review synthesis
19	Artificial Intelligence And The New Quality Productive Forces Of Enterprises Digital Intelligence Empowerment Paths And Spatial Spillover Effects	China	Productivity / Economy	Review / analysis	Theme/specific AI variables	Not reported / review synthesis
20	Artificial Intelligence In Geoenergy Bridging Petroleum Engineering And Futureoriented Applications	Global / not explicitly limited	Energy / Sustainability	Narrative/conceptual review	Theme/specific AI variables	Not reported / review synthesis
21	A Scoping Review Of The Future Of Work: Effects Of Artificial Intelligence Automation And Remote Work On Employment Patterns, Skill Demands, And Organisational Dynamics	Global / not explicitly limited	In employment/ work places	Scoping review	Theme/specific AI variables	Not reported / review synthesis
22	Artificial Intelligence In Personalized Nutrition And Food Manufacturing	India, United Kingdom	Manufacturing / Industry 4.0	Narrative/conceptual review	Theme/specific AI variables	Not reported / review synthesis
23	Artificial Intelligence In The Oil And Gas Industry Applications, Challenges, And Future Directions.	Global / not explicitly limited	Oil & gas	Systematic review	Theme/specific AI variables	Not reported / review synthesis

S. No	Title	Country/ Region	Sector	Research design	Variables synthesised	Significance level / status
24	Artificial Intelligence, Recessionary Pressures And Population Health	United States	Productivity / Economy	Review / analysis	Theme/specific AI variables	Not reported / review synthesis
25	Artificial Intelligence Adoption And Productivity	Global / not explicitly limited	Productivity / Economy	Review / analysis	Themespecific AI variables	Not reported / review synthesis
26	Assessing The Impact Of Artificial Intelligence On Russian Labour Market	Global / not explicitly limited	Labour market / Future of work	Review / analysis	Theme/specific AI variables	Not reported / review synthesis
27	Barriers And Enablers To Artificial Intelligence (AI) Adoption In	Global / not explicitly limited	Artificial intelligence / Crosssector	Qualitative empirical	Theme/specific AI variables	Not clearly reported
28	Digital Skills And Youth Empowerment In The 21st	Europe, Africa, Asia	Entrepreneurship / Innovation	Systematic review	Theme/specific AI variables	Not reported / review synthesis
29	Digital Transformation Institutional Quality And Productivity In Subsaharan Africa	United Kingdom, Africa, SubSaharan Africa	Sustainability / Regional ecosystems	Review / analysis	Themespecific AI variables	Not reported / review synthesis
30	Evaluating The Impact Of Artificial Intelligence On	Global / not explicitly limited	Artificial intelligence / Crosssector	Review / analysis	Theme/specific AI variables	Not reported / review synthesis
31	Evolution And Transformation Of Ethiopian Agriculture A Review Of	Ethiopia, Africa, Iran	Sustainability / Regional ecosystems	Narrative/conceptual review	Theme/specific AI variables	Not reported / review synthesis
32	Exploring The Prospects And Challenges Of Artificial Intelligence In	Global / not explicitly limited	Artificial intelligence / Crosssector	Narrative/conceptual review	Theme/specific AI variables	Not reported / review synthesis
33	Genai In Entrepreneurship A Systematic Review Of Generative Artificial Intelligence In Entrepreneurship Research	Global / not explicitly limited	Entrepreneurship / Innovation	Systematic review	Themespecific AI variables	Not reported / review synthesis
34	Generative AI And Jobs	Global / not explicitly limited	Artificial intelligence / Crosssector	Quantitative empirical	Theme/specific AI variables	Not clearly reported

S. No	Title	Country/ Region	Sector	Research design	Variables synthesised	Significance level / status
35	Generative Artificial Intelligence Evolving Technology, Growing Societal Impact, And Opportunities For Information Systems Research.	United States, China	Artificial intelligence / Crosssector	Review / analysis	Theme/specific AI variables	Not reported / review synthesis
36	Impact Of The Artificial Intelligence	United States, China, Europe	Artificial intelligence / Crosssector	Review / analysis	Theme/specific AI variables	Not reported / review synthesis
37	Impact Of Artificial Intelligence On The Job Market And Work Future	Pakistan, United States, China, India	Labour market / Future of work	Review / analysis	Themespecific AI variables	Not reported / review synthesis
38	Impact Of Robots And Artificial Intelligence On Labour	United States, United Kingdom	Artificial intelligence / Crosssector	Narrative/conceptual review	Robot exposure; AI exposure; wage bill; skill demand	Mixed significance; negative main effects and positive interaction
39	Integrating Artificial Intelligence In Ethiopian Education System The Need	Ethiopia	Ethiopia / National development	Narrative/conceptual review	Theme/specific AI variables	Not reported / review synthesis
40	Integratingartificialintelligenceaieducationinethiopiasprimaryandsecondaryschoolsgapsandpolicyrecommendations	Ethiopia, Africa	Labour market / Future of work	Review / analysis	Theme/specific AI variables	Not reported / review synthesis
41	Leveragingartificialintelligencetoenhanceprocesscontrolandimproveefficiencyinmanufacturingindustries	United States	Manufacturing / Industry 4.0	Review / analysis	Theme/specific AI variables	Not reported / review synthesis
42	Technology Advancements Shaping The Financial Inclusion Landscape	United States	Banking / Finance	Scoping review	Theme/specific AI variables	Not reported / review synthesis
43	The Future Of Smart Tax Systems Integrating Artificial Intelligence, Blockchain, And Autonomous Compliance Technologies For Transparent And Efficient Tax Administration	Pakistan, United States, Estonia, Armenia	Tax administration / Public finance	Qualitative empirical	AI, blockchain, autonomous compliance	Descriptive positive effects; inferential significance not reported

S. No	Title	Country/ Region	Sector	Research design	Variables synthesised	Significance level / status
44	The Transformative Role Of Artificial Intelligence In Internal	Malaysia	Internal auditing / Accounting	Systematic review	Fraud detection accuracy; professional skepticism; implementation costs	Substantive but mostly noninferential evidence
45	The Impact Of Artificial Intelligence On Labour Market	Romania	Manufacturing / Industry 4.0	Review / analysis	Automation risk; job creation; reskilling	Scenario based / descriptive, not inferential
46	The Impact Of Artificial Intelligence On The Sustainability Of Regional Ecosystems Current Challenges And Future Prospects. Sustainability	Europe, Africa, Asia, Poland	Sustainability / Regional ecosystems	Scoping review	Theme/specific AI variables	Not reported / review synthesis
47	The Transformative Power Of Artificial Intelligence In Entrepreneurship	Saudi Arabia	Entrepreneurship / Innovation	Quantitative empirical	Decision making; innovation; risk mitigation; competitive advantage	Significant positive for four AI capabilities; automation and customer experience nonsignificant
48	The Impact Of Artificial Intelligence Implementation On Islamic Financial Literacy And Global Economic Changes In The Banking World	Indonesia, Iran	Banking / Finance	Review / analysis	Operational efficiency; accessibility; sharia compliance	Positive review evidence; inferential significance not reported
49	The Impact Of Robots And Artificial Intelligence On Human Resources In The Future	Poland, Turkey	Human resource management	Review / analysis	Theme/specific AI variables	Not reported / review synthesis
50	The Role Of Artificial Intelligence In Enhancing Business Efficiency And Supply Chain Management	United States	Supply chain / Operations	Narrative/conceptual review	Theme/specific AI variables	Not reported / review synthesis

2.4. Research gaps

The major gaps across these 50 reviewed studies are:

- Methodological imbalance: The literature is characterised by conceptual, review-based, and policy studies, whilst robust empirical evidence remains limited, especially longitudinal, multicountry, and experimental research. This offers useful directional insights but weak causal precision.
- Geographical and contextual bias: Low income and fragile African countries, including Ethiopia, Sub Saharan Africa, South Sudan, Sudan, Somalia, and the DRC, are underrepresented. Most evidence comes from developed or rapidly digitalising economies, despite AI effects differing in settings with weak infrastructure, low formal employment, and high informality.
- Analytical fragmentation and understudied mechanisms: Existing studies are fragmented across entrepreneurship, labour,
- finance, and education, with limited integrated analysis. Key factors such as skills, governance, and infrastructure are often discussed theoretically rather than tested statistically.
- Inconsistent scope: Studies use inconsistent concepts and country coverage, limiting cross context comparison, especially in low capacity settings affected by digital inequality, skills gaps, and weak governance.

2.5. Conceptual framework

The study's conceptual foundation provides a concise explanation of the phenomena under investigation and a graphical representation of the examined variables (Moschis, 2024). The conceptual framework justifies the study by showing how AI adoption, automation, and skills readiness affecting future economic outcomes.

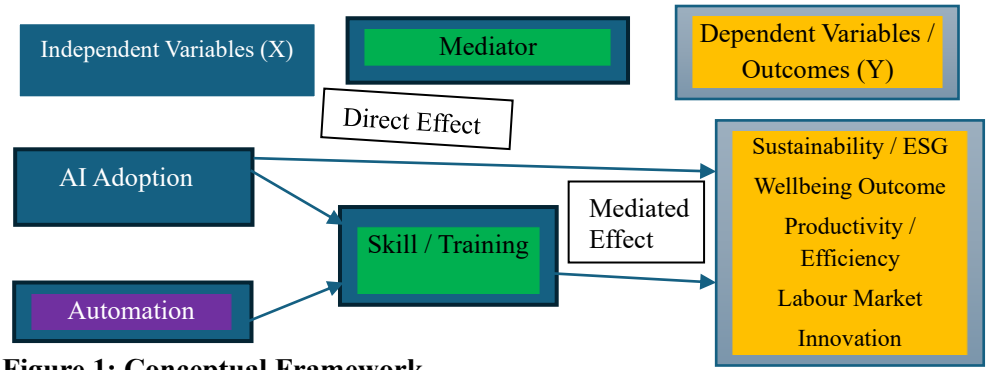


Figure 1: Conceptual Framework

3. Research Methodology

3.1. Research design

This refers to the structured blueprint linking a study's goals and research questions with suitable techniques for data gathering, analysis, and interpretation, guiding implementation to ensure valid, reliable findings (Khan and Jain, 2025; Bougie and Sekaran, 2020). This review focuses on AI, automation, and future economic systems, synthesising fifty peer reviewed articles (mainly 2025–2026). The design combines descriptive review with thematic synthesis, grouping studies by domains labour, entrepreneurship, manufacturing, finance, sustainability, auditing, and public administration and comparing them across country context, sector, method, key variables, tools, and reported findings.

3.2. Research approach

This study employs a hybrid synthesis technique, combining integrative thematic analysis with a systematic documentary review. To ensure transparent identification and filtering of pertinent studies from the corpus, data extraction followed a methodical procedure similar to the first steps of a PRISMA review (Page et al., 2021). However, the synthesis prioritizes interpretive analysis above metaanalysis because to the variety of the included research (qualitative, quantitative, scoping, etc.). According to current standards for synthesizing data in complex and diverse topic domains, this approach enables the analysis of convergence, divergence, and practical significance across several findings (Suri, 2019).

3.3. Sample size and technique

Fifty studies, representing all of the submitted papers, made up the analytical sample for this systematic review. This focused approach is consistent with systematic review best practises for indepth examination of a particular literature base and enables a thorough synthesis of evidence within the study scope (Siddaway et al., 2019). Empirical research reported sample sizes across more than ten nations, however review publications provided article or case counts rather than human participant numbers. Because of this, different studies have different interpretations of sample size (Onwuegbuzie and Hitchcock, 2022).

3.4. Data collection methods

Document based extraction from the full text PDF articles was the method employed for data collecting. First page and abstract level data, such as publication year, country or regional scope, research strategy, sector, sample, key variables, software and primary findings, were recorded for each study. Studies that offered quantitative indicators such as coefficients, percentages, and significance levels in accuracy were designed separately for comparative effect analysis.

3.5. Data analysis techniques

This systematic investigation used a multi stage data analysis approach. First, descriptive tabulation summarised the included studies by year, country, sector, study design, and important themes, providing more coprehensive analysis (Busetto et al., 2020). Next, thematic coding grouped the studies under broad concepts such as labour market transformation, automation, productivity, and AI adoption, enabling recurrent themes and relationships to be identified across the literature (Nowell et al., 2017). Finally, crossnational comparative synthesis examined how the effects of AI and automation vary across-national contexts, with practical interpretation guided by established statistical thresholds for numerical indicators. By combining descriptive, thematic, and comparative analysis, this approach aligns with contemporary best practises for synthesising diverse research findings (Suri, 2019).

3.6. Thematic synthesis procedure

Thematic synthesis is a process for identifying, evaluating, and reporting patterns or themes within qualitative data. It was adapted from reflexive thematic analysis for circumstances such as the synthesis of many research (Braun and Clarke, 2006). The thematic synthesis followed six phases: familiarisation through close reading of all 50 articles; initial coding of findings; aggregation of codes into eight primary analytical macro themes; review of themes against the original sources for accuracy; development of clear operational definitions and theme boundaries; and preparation of narrative summaries and comparative synthesis.

4. Presentation and Findings

4.1. Descriptive statistics

Descriptive statistics were essential to gain an initial understanding of the included studies. Through descriptive tabulation, frequencies were calculated for key characteristics, including country of origin, sector focus, research design, and methods used. This provided an overview of the dataset, revealed literature trends, and highlighted areas of concentration and scarcity.

Table 4.1: Research design frequency

Research design	Frequency	Percent
Narrative/conceptual review	17	34 percent
Review / analysis	17	34 percent
Systematic review	7	14 percent
Quantitative empirical	4	8 percent
Qualitative empirical	2	4 percent
Scoping review	3	6 percent
Total	50	100

Table 4.1 reveals a strong emphasis on review based methods across the examined studies. Narrative/conceptual reviews (17, 34 percent) and general review/analysis papers (17, 34 percent) compose most of the sample, demonstrating a focus on synthesising and interpreting existing knowledge. The smaller percentage of systematic reviews (7, 14 percent) suggests a restricted application of rigorous, predetermined evidence synthesis techniques. The limited number of empirical studies, both quantitative (4, 8 percent) and qualitative (2, 4 percent), highlights the need for more primary research to validate and extend review-based findings. Scoping reviews (3, 6 percent) show ongoing efforts to map the scope and breadth of literature in this rapidly developing field.

4.2. Frequency of countries/regions studied for the future economic system

Table 4.2 emphasises specifically on the country and regional contexts, associated with studies on AI, automation, and the future economic systems. The pattern suggests a strong global framing, followed by substantial attention to the United States and a smaller concentration on Africa and Ethiopia.

Table 4.2: Frequency of countries studied on future economic system

Country/Region	Frequency	Percent
Global / not explicitly limited	13	26 Percent
United States	10	20 Percent
Africa	5	10 Percent
Ethiopia	4	8 Percent
China	4	8 Percent
Europe	3	6 Percent
India	3	6 Percent
United Kingdom	3	6 Percent
Saudi Arabia	2	4 Percent
Asia	2	4 Percent
SubSaharan Africa	1	2 Percent

Table 4.2 reveals non country specific studies dominate future economic system literature at 26 percent, followed by the US at 20 percent, showing a focus on global or highly industrialized contexts. Africa accounts for 10 percent, Ethiopia and China 8 percent each growing but limited attention to developing economies. Europe, India, and the UK each have 6 percent, Saudi Arabia and Asia 4 percent, whilst Sub Saharan Africa is lowest at 2 percent. Overall, research is unevenly distributed, favoring global and advanced economies, leaving developing regions, especially Africa, significantly underexplored.

4.3. Comparative analysis by country/Region

Table 4.3 contrasts how automation and artificial intelligence are influencing the economy of a few chosen nations. The table demonstrates widespread consensus regarding opportunities for efficiency and productivity. It emphasises how crucial local factors like organisational maturity, infrastructure, legal frameworks, and talents are.

Table 4.3: Comparable findings across country and regional contexts

Country / scope	Domain	Comparable finding
Romania	Labour market / economy	AI may automate about 12 percent of high risk jobs creating new roles in analytics, AI engineering, cybersecurity, and digital ethics; reskilling is essential.
United Kingdom	Labour market / wages	Robot and AI exposure are negatively associated with wage bill growth; robot exposure hits lower skilled groups hardest .AI pressure rises with education and income.
Saudi Arabia	Entrepreneurship	AI capabilities in decision making, innovation, risk mitigation and competitive advantage significantly improve entrepreneurial success; automation and customer experience are not directly significant.
Malaysia	Internal auditing	AI improves fraud detection and automation. but creates concerns around professional skepticism, implementation failure and skills gaps.
Indonesia	Islamic banking / finance	AI improves efficiency, accessibility, risk assessment, and personalization. Adoption must remain compliant with Sharia principles and data security requirements.
Pakistan / Estonia / Armenia / Singapore / South Korea / United States	Smart tax systems	AI, block chain, and autonomous compliance tools improve fraud detection, transparency, and compliance, but legacy systems, legal uncertainty and skill gaps remain as barriers.
Ethiopia	Education / digital transformation	AI offers strong potential for education and digital inclusion. Infrastructure, literacy, and governance constraints remain decisive.
Global	Financial inclusion	Traditional digital finance technologies expand access. AI offers stronger personalization, fraud detection, and adaptive support for underserved groups.
Global	Sustainability / ecosystems	AI strengthens monitoring, adaptation, and resource efficiency across local ecosystems, yet may deepen technological inequality without equitable governance.

As demonstrates in Table 4.3 Automation and AI have various effects across countries and industries, posing both opportunities and difficulties. AI may impede wage growth, particularly for lower skilled workers (United Kingdom), but it may

also automate certain jobs whilst creating new ones, necessitating reskilling initiatives (Romania). AI increases entrepreneurial performance in Saudi Arabia, but it has less of an immediate impact on customer satisfaction. AI improves fraud detection (Malaysia, Pakistan/Estonia/Armenia/Singapore/South Korea/United States), increases efficiency and personalization in banking (Indonesia, Global), and supports international sustainability initiatives. To lessen technological inequality, however, professional skepticism, skill gaps, infrastructure constraints, legal ambiguities, and equitable governance must be addressed (Ethiopia, Malaysia, Pakistan/Estonia/Armenia/Singapore/South Korea/United States, Global).

4.4. Effect of AI adoption and automation on future economic systems

A synthesis of 50 examined papers, as shown in Table 4.4, indicates that skills are the primary mediating element influencing the results of AI adoption and automation, with context specific impacts. When used properly, automation and artificial intelligence (AI) often increase production, efficiency, sustainability, and innovation. They enhance operations, speed, accuracy, quality, cost effectiveness, prediction, monitoring, and decision making. They can improve work quality and provide digital or technical jobs, but they can also increase job instability, replace mundane tasks, and extend inequality without worker preparedness. These consequences on wellbeing and labour markets are mixed. The most powerful mediator between automation, AI adoption, and future economic consequences is skills and training. Training lowers the danger of displacement, facilitates adaptation for employees, businesses, and institutions, and transforms AI into benefits for all. Thus, policy must address not just adoption but also reskilling, upskilling, digital literacy, ethical governance, infrastructure, and worker protection. This approach enables AI and automation to support sustainable development, labour market resilience, innovation, and inclusive economic transformation.

Table 4.4: Summary of Thematic Pathway

Pathway	Direction of Effect	Mediation Strength	Policy Implication
AI Adoption → Sustainability/ESG	Positive; improves resource use, monitoring, and sustainability decisions.	Moderate to strong	Promote AI for ESG, climate, energy, and sustainable development.
AI Adoption → Wellbeing	Mixed; improves services and work quality but may create stress or inequality.	Strong	Apply human centred AI, ethical rules, and worker support.
AI Adoption → Productivity/Efficiency	Strongly positive; improves decisionmaking, prediction, and operational efficiency.	Moderate to strong	Invest in AI skills, infrastructure, and sector-based adoption.
AI Adoption → Labour Market	Mixed; creates new jobs but may replace routine work.	Strong	Expand reskilling, upskilling, and labour-transition policies.
AI Adoption → Innovation	Positive; supports entrepreneurship, competitiveness, and new solutions.	Moderate	Support AI startups, R&D, and innovation hubs.
Automation → Sustainability/ESG	Positive but conditional; reduces waste and improves efficiency but may increase energy use.	Moderate	Encourage green and energy efficient automation.
Automation → Wellbeing	Mixed; reduces repetitive tasks but may increase job insecurity.	Strong	Link automation with training and worker protection.
Automation → Productivity/Efficiency	Strongly positive; increases speed, accuracy, quality, and cost efficiency.	Moderate	Promote smart manufacturing, RPA, and technical training.
Automation → Labour Market	Mixed; reduces routine jobs but creates technical and digital roles.	Strong	Strengthen vocational, digital, and lifelong learning programmes.
Automation → Innovation	Positive; supports new business models and process improvement.	Moderate	Support industrial modernization and technology transfer.
AI Adoption → Skilll/Training → Outcomes	Positive mediated effect; training improves the benefits of AI.	Strong	Integrate AI literacy and digital skills into education and workplaces.
Automation → Skilll/Training → Outcomes	Positive mediated effect; training reduces displacement risks and improves adaptation.	Strong	Connect automation investment with reskilling and workforce transition.

5. Discussion

Objective 1: To identify the most frequent countries studied in the application of AI and automation in relation to future economic systems.

The findings reveal that research on AI, automation, and future economic systems is unevenly distributed across countries and regions. Global or non-country specific studies dominate the literature, whilst developing regions remain less represented. Africa accounts for 10 percent, whilst Ethiopia and China each account for 8 percent (Gamble & Hewlett, 2026). Europe, India, and the United Kingdom each represent 6 percent, whereas Saudi Arabia and Asia each account for 4 percent. Sub Saharan Africa is the least represented category, with only 2 percent of the reviewed studies. This shows that existing scholarship gives more attention to global and advanced economy contexts, whilst Ethiopia, Africa, and SubSaharan Africa remain underexplored despite challenges related to infrastructure, digital literacy, governance capacity, and inclusive technology adoption.

Objective 2: To explore the relationship between AI adoption and automation and how they affect future economic systems.

In line with Acemoglu et al. (2024), Autor (2024), and Yolusever (2025), the findings show that automation and the adoption of AI will play a significant role in future economic transformation, affecting labour market structure, productivity, efficiency, innovation, sustainability, and institutional performance. Artificial intelligence (AI) enhances data processing, prediction, decision making, personalization, fraud detection, and monitoring, whilst automation boosts speed, accuracy, operational control, quality, and cost efficiency. However, effects are mixed. Romania shows AI may automate 12 percent of high risk jobs whilst creating roles in analytics, AI engineering, cybersecurity, and digital ethics. The UK indicates robot and AI exposure negatively associate with wage bill growth, especially for lower skilled workers. Thus, benefits depend strongly on skills, training, institutional readiness, and governance mechanisms.

Objective 3: To compare country level and sector level findings on the effects of AI and automation on future economic systems.

Country and sector level findings show different AI and automation impacts. In Saudi Arabia, AI improves entrepreneurship through decision making, innovation, risk mitigation, and competitiveness, though automation and customer experience show no direct significance. In Malaysia, AI enhances fraud detection and auditing

automation but raises concerns about professional skepticism, implementation failures, and skills gaps. In Indonesia, AI boosts efficiency, accessibility, risk assessment, and personalization in Islamic banking, yet must comply with Sharia and data security rules. Smart tax regulations in Pakistan, Estonia, Armenia, Singapore, South Korea, and the US improve fraud detection, transparency, and compliance, but face barriers from legacy systems, legal uncertainty, and skills gaps. These results align with Challoumis (2024) and Liang et al. (2025).

Objective 4: To synthesise Ethiopia focused evidence and develop a contextual framework for AI governance, skillls, and infrastructure.

The Ethiopia focused findings reveal that AI can support education, digital transformation, inclusion, and national development. Nevertheless, infrastructure limitations, low digital literacy, poor governance capacity, and limited institutional readiness remain major constraints, consistent with Aberg and Kahsay (2025), GSMA (2025), and World Bank (2024). Thus, Ethiopia's main problem is not only AI adoption but also AI readiness. A contextual framework should link AI adoption and automation with governance, skills, and infrastructure. In this framework, skills and training mediate the link between technology adoption and future economic outcomes, helping Ethiopia achieve productivity, innovation, sustainability, employment resilience, and inclusive development. This is consistent with Brynjolfsson et al. (2025) and Wilson and Daugherty (2022).

5.1. Implications for future economic systems

The findings imply that readiness, inclusion, and governance should take precedence above simple adoption in AI policy. As research continues to concentrate on advanced economies, Ethiopia and emerging countries require context-specific initiatives that address infrastructure, digital literacy, institutional capacity, and equitable access. To lessen displacement and foster new digital occupations, robust reskilling, upskilling, and transition programmes are necessary due to mixed employment and welfare consequences. Governments should address legal ambiguity, data security, legacy systems, and skills shortages whilst promoting appropriate AI use in finance, auditing, taxation, education, and sustainability. Success for Ethiopia necessitates an integrated framework of digital infrastructure, skills development, and AI governance, with training acting as a mediator between adoption, automation, and inclusive results.

6. Conclusions and Recommendations

6.1. Conclusions

The findings summarise that AI adoption and automation are pillar forces shaping future economic systems through productivity, efficiency, innovation, sustainability, financial inclusion, fraud detection, public sector performance, and labour-market transformation. However, evidence reveals uneven research distribution, with greater emphasis on global and advanced economies, whilst Ethiopia, Africa, and Sub Saharan Africa remain underrepresented. The effects are mixed: AI creates opportunities in entrepreneurship, finance, auditing, taxation, education, and sustainability, but also raises risks of job displacement, wage pressure, skills gaps, technological inequality, and governance challenges.

In general, ready conditions skills, training, infrastructure, institutional capacity, and ethical governance are just as important as adoption. Building a contextual AI framework with a focus on digital infrastructure, skill development, and governance is Ethiopia's top objective. By boosting institutional preparedness, increasing equitable digital access, and enhancing human capital, such a framework can connect the use of AI to inclusive outcomes. In order to guarantee sustainable and equitable growth, future economic transformation must coordinate AI with reskilling, upskilling, responsible regulation, infrastructure investment, and inclusive innovation.

6.2. Recommendations for policy makers

Enhancing a national AI and automation strategy aligned with Ethiopia’s priorities in education, agriculture, finance, taxation, manufacturing, public services, and sustainability. The strategy should include AI governance, ethical regulation, data protection, accountability, transparency, inclusive access, and social protection. Policy makers should also invest in internet, electricity, cloud services, cybersecurity, public data platforms, AI literacy, digital skills, reskilling, upskillling, data analytics, and digital ethics, since skills and training are key to inclusive AI outcomes.

6.3. Recommendations for researchers

Conduct more Ethiopia and Africa focused empirical studies on AI and automation, as these contexts remain underrepresented. Future research should use quantitative, qualitative, and mixed method approaches to assess effects on productivity, employment, wages, education, public services, financial inclusion, and

sustainability. Researchers should also develop and test context specific AI readiness and governance models covering infrastructure, digital literacy, institutional capacity, legal frameworks, data governance, and sector specific barriers.

6.4. Recommendations for Ethiopia context

Ethiopia should view AI and automation as part of a broader economic transformation agenda, not only as technologies. Adoption should promote national development, job creation, education reform, public sector modernization, and sustainability. Ethiopia should invest in reskilling and upskilling for new roles in data analytics, cybersecurity, digital finance, smart agriculture, AI supported services, and digital public administration. Implementation should be phased and inclusive, prioritizing education, agriculture, health, taxation, banking, and public services, whilst ensuring strong governance, affordable connectivity, innovation ecosystems, university industry collaboration, and protection for vulnerable groups.

7. Limitation of the studies

The unequal distribution and structure of the examined literature, which concentrates on global or advanced economy contexts whereas Ethiopia, Africa, and SubSaharan Africa are still underrepresented, limits this study. Causal interpretation and accurate assessment of AI and automation effects are hampered by the fact that many reviewed papers are conceptual, narrative, or review based, with little empirical support and ambiguous statistical significance levels. Since the study relies on secondary data, it does not include primary evidence from Ethiopian institutions, workers, firms, or policymakers. Moreover, differences across countries, sectors, and research designs create comparability challenges, and the proposed Ethiopia focused framework remains conceptual until validated through surveys, interviews, case studies, or statistical analysis.

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Human Capital, Labour Markets, and the Future of Administrative Work in Addis Ababa's Public Administration: A Qualitative Framework for Practice and Future Research

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Abstract

This paper asks how human capital development, labour market functioning, and digital transformation interact inside Addis Ababa's public administration, and builds a theoretical framework to answer that question. Using a qualitative, literature-based research design an integrative synthesis of academic research, government and multilateral reports, and informal conversations with people who work in or close to the city administration it develops what I call the Capacity Interdependence Framework. The framework's central claim is that administrative capacity is not the sum of three independent investments in human capital, labour market alignment, and digital tools, but the product of how well those three domains are aligned with one another.

From this framework, three connecting mechanisms and seven testable propositions are derived, along with a practical roadmap that administrators can use to diagnose their own position and sequence reform, even ahead of formal empirical testing. This paper's contribution is conceptual and practical rather than empirical: it offers a clearer map of how these three domains interact, a starting point for acting on that map, and a concrete agenda for the future research needed to test it rigorously.

Keywords: Human Capital Theory, Labour Market Dynamics, Digital Transformation, Public Administration, Addis Ababa, Urban Governance, Qualitative Research, Theory Building Introduction

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1. Introduction

1.1. Background and context

Addis Ababa sits at an awkward and interesting point in its development. It is Ethiopia's political and administrative capital, home to the African Union and a dense cluster of diplomatic missions, and it is growing fast more than 5 million residents, with an annual growth rate around 4 percent (World Bank, 2016; UN-Habitat, 2024). That growth puts real pressure on the institutions responsible for running the city, at exactly the moment those institutions are also being asked to modernise.

Ethiopia's broader economy grew at roughly 9 percent a year for much of the two decades before the Covid-19 pandemic, much of it channelled into infrastructure, education, and institutional capacity (World Bank, 2023). The country's Homegrown Economic Reform Agenda frames structural transformation, private-sector development, and stronger governance as the pillars of that growth going forward (National Planning Commission, 2024), and the public sector is meant to be a central actor in delivering it. The pandemic itself was something of a forcing function: like governments everywhere, Addis Ababa's administration had to move services online quickly, and in doing so found out, in a fairly unforgiving way, where its digital infrastructure and digital skills actually stood (UN, 2021; UNDP, 2022).

Demographics add another layer. Ethiopia's population is very young a median age of about 19 (UNDP, 2024) and Addis Ababa draws a disproportionate share of the country's most educated young people. That is good news for the labour supply in principle, but it also means the public administration is competing directly with private firms and NGOs for the same small pool of digitally fluent, analytically trained workers, while trying to reconcile generational differences in expectations about pay, technology, and career progression.

The 2025 Ethiopia Human Capital Forum, convened jointly by the government and the World Bank, put this plainly: human capital is described as the country's most powerful engine of growth, with roughly 60 percent of public spending now directed toward it (Ministry of Finance, 2025). The city administration has its own version of this ambition a smart-city strategy targeting 2030, organised around six pillars of digitalisation, and a large-scale digital skills programme, branded the Coders Initiative, that has registered several hundred thousand young people, with a substantial share reportedly completing training (Addis Ababa City Administration, 2024, 2025). What is much less clear, and what this paper is ultimately about, is how

well any of that investment is translating into the administration's actual, day-to-day capacity to plan, hire, retain, and deploy the people it needs.

1.2. Problem statement

The concern motivating this paper is easy to state and hard to resolve. Addis Ababa's public administration is being asked to do more deliver services to a fast-growing population, absorb new technology, implement an ambitious reform agenda with a workforce whose skills profile, recruitment pipeline, and career structures were largely designed for a different era. Existing assessments point to real gaps in digital, analytical, and conceptual skills relative to what a modern, technology-enabled public administration requires (World Bank, 2016; Mengesha and Common, 2007). Recruitment is slowed by bureaucratic process and weak advertising of vacancies; selection procedures have limited ability to predict who will actually perform well on the job (Krishnan and Shaorshadze, 2013); and retention is a particular problem for specialised staff IT, finance, technical roles who have more outside options than generalist administrators do.

Compensation structures compound this. Job grades in much of the civil service were set by decree and have not kept pace with either inflation or private-sector pay, and rigid budget and staffing rules limit how flexibly departments can hire or redeploy people even when the underlying need is clear. Technology adoption, meanwhile, is proceeding unevenly some departments have moved a long way toward digital service delivery, others are still largely paper-based which risks entrenching a digital divide inside the administration itself, on top of the one it is trying to close for residents. None of this is unique to Addis Ababa. But there is surprisingly little systematic, publicly available analysis of how these pieces human capital, labour market functioning, and digital transformation actually interact in this specific setting, which is the gap this paper tries to address.

1.3. Purpose and contribution of this paper

This paper has one central aim: to build a theoretically grounded, internally consistent account of how human capital development, labour market dynamics, and digital transformation interact inside a mid-sized African city administration, stated precisely enough to be tested and, just as importantly, precise enough to be acted on. It is a theory-building paper rather than a hypothesis-testing one, and that distinction runs through everything that follows; the propositions in Section 3.3 are candidate claims derived from theory, not confirmed results.

The contribution is threefold.

1. It draws together three literatures
    - Human capital theory
    - Labour market segmentation in developing-country public sectors,
    - The literature on automation and skills-biased technological change that are usually discussed separately, and asks what an integrated framework looks like when applied to municipal government in a context like Addis Ababa's.
2. It translates that framework into practical guidance; a diagnostic starting point and a phased approach that administrators can begin using before any formal empirical testing is complete.
3. It sets out a concrete research agenda testable propositions, the data collection they would require, and a proposed instrument for the empirical work this paper does not itself attempt.

1.4. Scope and approach

This is a qualitative, literature-based conceptual study. It draws on published academic research, government and multilateral reports, and a small number of informal conversations with people who work in or close to Addis Ababa's city administration, and uses that material to build and reason through an integrated theoretical framework. It does not involve a fielded survey, structured interviews conducted under a research protocol, or a quantitative dataset the propositions in Section 3.3 are theoretical claims, derived from the literature and the framework, intended for future empirical testing rather than presented as findings.

That scope is a deliberate choice rather than an incidental one. Qualitative, theory-building research has a long and well-established place in the social sciences precisely because not every useful contribution takes the form of a tested hypothesis. Sometimes what a field needs first is a better-specified account of how its variables are likely to relate to one another a map precise enough that future data collection can be designed around it, rather than gathered in the hope that a pattern will emerge. That is the role this paper tries to play, and Section 5 sets out the qualitative methodology behind it in full.

1.5. Structure of the paper

Section 2 sets out the paper's objectives. Section 3 states the research questions and the theoretical propositions that follow from them. Section 4 reviews the literature across human capital theory, labour market dynamics in urban African contexts, and digital transformation. Section 5 sets out the qualitative research design. Section 6 synthesises the available evidence on workforce capacity, labour market functioning, and technology adoption in Addis Ababa. Section 7 presents the paper's central contribution an integrated theoretical framework linking the three domains and translates it into a practical diagnostic tool. Section 8 sets out an implementation guide for practitioners who want to begin acting on the framework. Section 9 discusses the framework in relation to existing theory, and Section 10 concludes with a future-research agenda.

2. Objectives

2.1. Overall objective

The overall objective of this paper is to develop a theoretically grounded framework explaining how human capital development, labour market functioning, and digital transformation interact within Addis Ababa's public administration, and to specify that framework in a form that can guide both near-term practice and future empirical testing.

2.2. Specific objectives

- To synthesise existing, citable evidence on workforce composition, skills gaps, recruitment and retention, and technology adoption in Addis Ababa's public administration.
- To integrate human capital theory, labour market segmentation theory, and the literature on automation and skills-biased technological change into a single conceptual model appropriate to a mid-sized developing-country city administration.
- To translate that model into a set of specific, falsifiable propositions suitable for testing by a future study.
- To design a feasible qualitative research methodology, including a proposed survey instrument, that a future empirical study could use to test the framework directly.

- To translate the framework into practical guidance that administrators can begin acting on ahead of formal empirical validation.
- To draw preliminary, appropriately hedged implications for policy and practice from the framework, distinguishing clearly between what is supported by existing evidence and what remains a theoretical proposition.

3. Research Questions and Theoretical Propositions

3.1. Primary research question

How do human capital development, labour market functioning, and digital transformation interact within Addis Ababa's public administration, and what theoretical framework best accounts for that interaction?

3.2. Secondary questions

- What does existing, citable evidence suggest about the state of human capital, skills, training, and workforce composition in Addis Ababa's public administration?
- What institutional and labour-market conditions plausibly shape recruitment, retention, and motivation in this context, according to the wider literature on public-sector labour markets in developing economies?
- How might digital transformation interact with existing human capital and labour market conditions to either narrow or widen capacity gaps within the administration?
- What would a rigorous empirical test of these relationships require, and what could administrators reasonably act on before that testing is complete?

3.3. Theoretical propositions

The propositions below are derived from the theoretical framework developed in Section 7, and organised around the three literatures reviewed in Section 4. Each is a reasoned, literature-grounded claim that this paper argues is plausible and worth testing not a finding, but a candidate claim stated precisely enough for a future study to operationalize and test directly.

- **P1.** Skills gaps in Addis Ababa's public administration are not uniform: they are concentrated in specific competency domains particularly digital and analytical skills and vary systematically by function and administrative level, rather than being evenly distributed across the workforce.
- **P2.** Existing workforce planning and human capital development systems in the administration are structured around short-term, reactive needs rather than anticipated future skill requirements, and this reactive orientation is itself a measurable predictor of persistent skills gaps.
- **P3.** Labour market functioning in the public administration sector is constrained less by an absolute shortage of qualified candidates and more by institutional friction compensation structures, procedural delays, and weak signaling between the administration and the labour market that filters out or discourages otherwise qualified applicants.
- **P4.** Digital transformation is proceeding unevenly across departments in ways that track existing resource and skill advantages, such that digitalization is more likely to widen than narrow capacity gaps within the administration in the absence of deliberate redistributive investment.
- **P5.** Departments and units with stronger human capital development practices (systematic training, clearer career paths) will show measurably better labour market outcomes lower voluntary turnover, faster time-to-hire for specialized roles than those without, independent of overall resourcing levels.
- **P6.** Organizational culture specifically, risk-averse norms and a preference for established procedure mediates the relationship between technology availability and technology adoption, such that access to digital tools alone is insufficient to predict their effective use.
- **P7.** Interventions that address human capital development, labour market friction, and digital transformation simultaneously will produce larger gains in administrative capacity than interventions addressing any single domain in isolation, because the three domains are interdependent rather than additive.

Section 7 develops the theoretical logic behind each of these propositions in more depth, and Section 10.3 sets out what testing them would actually require.

4. Literature Review

This review is deliberately selective. Rather than surveying every strand of the human capital and public administration literatures, it focuses on the specific theoretical resources this paper draws on to build its framework in Section 7, and is organized accordingly.

4.1. Human capital theory and public administration

The theoretical starting point is human capital theory, in the tradition of Schultz (1961) and Becker (1964). Schultz's core move was to treat education, training, and health not as consumption but as investment spending that builds productive capacity and pays off over time, in the same way physical capital does. Becker (1964) then formalized and extended this, drawing a distinction that matters a great deal for public administration specifically: general human capital, valuable to almost any employer, versus firm- or sector-specific human capital, valuable mainly within a particular organizational context. Public administrations invest heavily in the latter knowledge of specific regulations, procedures, and institutional history which is one reason losing an experienced mid-level civil servant cost more than replacing them with someone of equivalent general qualifications might suggest.

Coleman (1988) and Bourdieu (1986) pushed the concept further, arguing that human capital does not operate in isolation from social capital the networks, trust, and shared norms that determine whether individual skill actually translates into organizational performance. This matters here because a great deal of the commentary on public-sector reform in developing economies (Andrews, 2013; Booth, 2014) suggests that skills gaps and institutional dysfunction are mutually reinforcing: weak institutions fail to develop or retain skilled staff, and the resulting skills shortage further weakens institutional capacity, in a pattern that is hard to break from either end alone.

Ingraham, Joyce and Donahue (2003), working from extensive case-study evidence on U.S. federal agencies, made an argument that has travelled well beyond that context: management matters, and human capital management specifically is one of the strongest predictors of government performance they identified. Government organizations differ from private firms in ways that complicate this multiple, sometimes conflicting mandates, political oversight, and accountability structures that private firms do not face (Perry and Wise, 1990; Ingraham and Getha-Taylor, 2004) but the underlying claim, that workforce quality is not incidental to public-

sector performance but central to it, is the theoretical anchor for this paper's first proposition.

4.2. Labour market dynamics in urban African contexts

Public-sector labour markets in African cities operate under conditions that most classical labour economics was not built to describe. Fox, Senbet and Simbanegavi (2016) document how youth employment across Sub-Saharan Africa is shaped less by an absence of educated workers and more by mismatches between what education systems produce and what employers, public and private, actually need, and between formal-sector wage expectations and what formal-sector employers, particularly cash-constrained governments, can offer. Rodrik (2016) adds a structural point: many developing economies are industrializing later and less than earlier developers did, which changes what kinds of jobs are actually available for a growing educated urban population, and pushes more of that population toward services and public employment than classical development models anticipated.

For Ethiopia specifically, Krishnan and Shaorshadze (2013) is a useful reference point on the mismatch between technical and vocational training output and actual labour market demand, and Mengesha and Common (2007) offer one of the few detailed accounts of public-sector capacity reform inside Ethiopian ministries finding, notably, uneven results even within the same reform programme, a caution against assuming any single intervention will work uniformly across a large and heterogeneous administration. Chen (2012) is relevant here too less because Addis Ababa's civil service is informal, it is not, but because it is a reminder that a large share of the urban labour market the administration competes with for skilled workers operates by different rules entirely, which complicates any assumption that public-sector wages simply need to track private formal-sector benchmarks.

4.3. Digital transformation and the future of work

The automation literature is where this paper's third theoretical strand comes from. Frey and Osborne (2017) is the reference point most people reach for, with their probabilistic estimates of which occupations are susceptible to computerization, but Autor (2015) is arguably more useful for a paper about public administration specifically, because his central argument is that automation displaces tasks, not whole jobs, and that the net effect on employment depends heavily on which tasks within a role are automatable and which are not. Applied to a civil service, this suggests the relevant question is not “which jobs will disappear” but “which parts of

which jobs will change," and what that implies for the skills the remaining, non-automatable parts of those jobs will demand.

Mergel, Edelmann and Haug (2019), drawing on expert interviews across several governments, define digital transformation in the public sector as something broader than digitizing existing paper processes it involves genuine changes to how organizations work and how they relate to the people they serve. Hanna (2016) and the OECD's own work on digital government (OECD, 2020, 2021) both make a point that is easy to state and harder to act on: technology adoption in government is gated by organizational and human factors at least as much as by hardware and connectivity. This is the theoretical basis for this paper's sixth proposition, that organizational culture mediates the relationship between having digital tools and actually using them well.

4.4. Workforce planning and public sector reform

The CIPD's workforce planning framework (CIPD, 2018) and the OECD's comparative work on strategic workforce planning in government (OECD, 2021) both converge on a similar diagnosis public-sector organizations are frequently good at operational HR administration and weak at forward-looking capacity planning, which leaves them reactive to skills shortages rather than anticipating them. Deloitte (2019) and McKinsey (2020) make similar points from a private-sector consulting vantage point, with the caveat that their evidence base leans heavily toward OECD governments one reason this paper is cautious about assuming their prescriptions transfer directly to a context like Addis Ababa's without adaptation.

4.5. Toward a conceptual framework

Taken together, these three literatures point in a consistent direction without quite meeting in the middle. Human capital theory explains why workforce quality matters for performance but says little about the institutional frictions that determine whether investment in that workforce actually happens. Labour market theory explains those frictions but treats technology mostly as background noise. The automation and digital transformation literature explain how technology reshapes work but is largely silent on the institutional and human capital conditions that determine whether a given administration can absorb that change well or badly. Section 7 of this paper is an attempt to build the connective tissue between these three bodies of work, specifically for the case of a mid-sized, resource-constrained city administration a context none of the foundational texts above was written with directly in mind.

5. Methodology

5.1. A qualitative, theory-building design

This paper follows a qualitative, theory-building research design. Rather than testing hypotheses against a fielded dataset, it works inductively and interpretively from existing literature and secondary sources toward an original conceptual model an approach with a long-established place in the social sciences, particularly where the more pressing need is a better-specified account of how a set of variables relate, ahead of the fieldwork required to test that account.

Concretely, the design has two parts. The first is a structured synthesis of secondary evidence: published academic literature, multilateral and government reports, and city administration communications, read critically and cross-checked against each other where possible. The second is theory construction using that synthesis, together with the three literatures reviewed in Section 4, to build an integrated conceptual model and derive specific, testable propositions from it.

5.2. Data sources

To be precise about what this paper draws on:

- Published academic literature on human capital theory, labour economics, and digital transformation, cited throughout and listed in the References section.
- Publicly available reports and strategy documents from the Addis Ababa City Administration, the Ethiopian government, and multilateral organizations (World Bank, UNDP, UN, OECD, ILO, ITU), used for contextual figures and for the administration's own stated goals and self-reported programme figures attributed to those sources and presented as their claims, not independently verified by this paper.
- A small number of informal conversations with individuals who have worked in or closely with Ethiopian public administration, which shaped my thinking about which questions were worth asking and which theoretical framing felt right. These were not conducted under a formal research protocol, were not recorded or systematically coded, and are not cited as data or used to support any specific factual claim. Where a general impression from these conversations informs the discussion, it is flagged explicitly as such.

No survey was administered, and no dataset supporting regression or other inferential statistics was assembled. This is a qualitative synthesis, not a quantitative study, and its claims should be read accordingly as theory, not as results

5.3. A Proposed instrument for future research

Appendix A sets out a survey instrument developed alongside this framework, intended for future field validation of the propositions in Section 3.3. It is offered as a deliverable in its own right: built from validated items in the workforce planning and human capital literature and adapted to this context, ready for a future study to pilot and field after the cognitive interviewing that any instrument requires before use.

5.4. Analytical approach

The analytical work in this paper is qualitative and interpretive: reading the literature and available reports for patterns, tensions, and gaps, and using those to build and stress-test the framework in Section 7. Where the paper reports a specific figure a percentage, a count, a growth rate it is because that figure comes from a cited source, and the citation is given at the point of use. Where the paper makes a claim about how these dynamics likely play out inside the administration without a specific citable source, it is phrased as an inference or a proposition, not as a finding, and that distinction is maintained deliberately throughout.

5.5. Trustworthiness and reflexivity

For a qualitative synthesis of this kind, trustworthiness rests less on sampling procedure and more on transparency about sourcing and on intellectual honesty about the limits of the exercise. I have tried to flag disagreements in the literature where they exist rather than picking the source that best fits the argument, and to be explicit about where my own position writing without institutional access to administrative data, working within the scope a single qualitative researcher can reasonably cover shapes what could and could not be examined here.

5.6. Ethical considerations

Because this paper does not involve primary data collection from human subjects, it does not require, and did not seek, institutional ethics board approval, and it makes no claim to have obtained one. The informal conversations referenced in Section 5.2

were conducted on the basis of a general, verbal understanding with the individuals involved that our discussion might inform my thinking on this topic; no identifying information about them appears anywhere in this paper, and no direct quotation or specific claim is attributed to any of them. Should the future study proposed in Section 10.3 proceed, it would require full ethics board approval prior to any data collection, along with the informed consent, confidentiality, and risk-mitigation protocols appropriate to research involving public employees, sketched at a high level in Appendix B as a starting point for that future protocol.

6. Synthesis of Available Evidence

This section pulls together what can actually be said, on the basis of citable sources, about workforce capacity, labour market functioning, and digital transformation in Addis Ababa's public administration, stated at the level of confidence the evidence allows.

6.1. Workforce composition and skills

The Addis Ababa City Administration is a large employer by any regional standard, though this paper cannot independently verify the precise headcount often cited in public communications, and treats figures in the low hundreds of thousands as an approximate order of magnitude rather than a confirmed number. What is better documented is the direction of the skills gap, the World Bank's Ethiopia Urbanization Review (World Bank, 2016) and Mengesha and Common's (2007) case-study work on public-sector capacity reform in Ethiopian ministries both describe a workforce whose formal qualifications have grown over time but whose practical digital, analytical, and project-management competencies have not kept pace with the demands of a modernising service-delivery agenda. Neither source offers a single administration-wide statistic both instead describe the gap qualitatively, department by department and this paper follows their lead rather than inventing a precision the underlying evidence does not have.

On the training side, the city administration's own Coders Initiative reports registering approximately 338,000 young people for ICT skills training, with around 200,000 reported as having completed training at the time of the most recent progress report available (Addis Ababa City Administration, 2025). These are the administration's own self-reported programme numbers; this paper has no independent means of verifying completion rates or the depth of skills acquired, and

treats the figures as evidence of stated investment and programme scale rather than of workforce-wide skill improvement, since it is not established what share of programme participants are current or future public administration employees as opposed to the wider youth population.

6.2. Labour market dynamics

The general pattern described in the labour economics literature on African public sectors recruitment slowed by procedural friction, selection tools with limited predictive power, and retention problems concentrated among specialised staff with strong outside options is consistent with what Krishnan and Shaorshadze (2013) document for Ethiopia's technical and vocational training pipeline more broadly, and with the general findings summarised in Fox, Senbet and Simbanegavi (2016) on youth labour markets across the region. Compensation structures set by decree, rather than adjusted regularly against inflation or private-sector benchmarks, are a documented feature of many African civil services and a plausible driver of the retention pattern described above, though this paper does not have administration-specific compensation data to confirm the magnitude of any gap in Addis Ababa specifically.

6.3. Digital transformation

The Addis Ababa smart-city strategy commits the administration to six pillars of digitalisation by 2030 (Addis Ababa City Administration, 2024), which signals clear intent at the policy level. The broader digital government literature (Mergel, Edelmann and Haug, 2019; OECD, 2020) consistently finds that stated digital strategies and actual, department-level adoption diverge considerably, with adoption depending heavily on local leadership, existing IT capacity, and staff comfort with new tools rather than on the strategy document itself. There is no administration-wide technology adoption dataset available to this paper that would allow a department-by-department comparison for Addis Ababa specifically; what can be said is that uneven adoption, tracking existing resource advantages, is the pattern this literature would predict, and Section 7 builds that expectation into the theoretical framework as Proposition 4.

6.4. What this synthesis does and does not establish

Read together, these sources establish that Addis Ababa's public administration faces documented pressure on digital and analytical skills, structural friction in its labour

market, and uneven digital transformation all consistent with the broader regional and sectoral literature. They do not establish precise magnitudes specific to this administration, a causal ordering between these three dynamics, or which interventions would work best. That gap between what is documented and what would need to be tested is exactly what the framework in Section 7 is built to address.

7. The Capacity Interdependence Framework

This section is the paper's central contribution. Its aim is to do something the underlying literature has not quite done: connect human capital theory, labour market segmentation, and the theory of skills-biased technological change into a single account of how a resource-constrained city administration's capacity actually evolves over time. The framework is offered as a starting point for both empirical testing and practical action, not as a finding in itself.

7.1. Why a new framework is needed

Each of the three literatures reviewed in Section 4 explains part of the picture and is largely silent on the rest. Human capital theory (Schultz, 1961; Becker, 1964) explains why investing in workforce skills should improve organizational performance, but treats the decision to invest as relatively unproblematic as though organizations simply choose their optimal level of training once they understand its returns. Labour market segmentation theory, as applied to African contexts (Fox, Senbet and Simbanegavi, 2016; Rodrik, 2016), explains why that investment decision is not unproblematic at all institutional friction, compensation rigidity, and weak signalling between employers and workers routinely prevent organizations from hiring or retaining the people their human capital strategy says they need but this literature has little to say about digital transformation specifically. The automation and digital transformation literature (Autor, 2015; Frey and Osborne, 2017; Mergel, Edelmann and Haug, 2019) explains how technology reshapes the tasks within jobs, but generally assumes a labour market and a human capital pipeline flexible enough to adjust an assumption that does not hold well in a public administration with rigid job grades and slow-moving procurement and hiring rules.

None of the three literatures, on its own, explains a pattern that shows up repeatedly in the descriptive material reviewed in Section 6: an administration that is investing visibly in digital skills training at scale (the Coders Initiative) while apparently continuing to experience skills gaps and adoption problems at the department level.

That pattern is not a contradiction it is exactly what you would expect if training investment, labour market friction, and technology adoption are interdependent rather than each operating on its own track. The framework below is an attempt to model that interdependence explicitly.

7.2. The capacity interdependence framework

The framework proposed here which, for lack of a better name, I am calling the Capacity Interdependence Framework rests on a simple starting claim: an administration's effective capacity at any point in time is not a sum of three independent inputs (human capital, labour market functioning, digital tools) but the product of how well those three inputs is aligned with each other. A high level of investment in any one domain, without corresponding movement in the other two, produces little improvement in effective capacity, and can in some cases make existing gaps more visible and more damaging rather than closing them.
The framework has three core components and three connecting mechanisms.

Component 1: Human capital stock and flow
This is the standard human capital component the skills, qualifications, and tacit institutional knowledge held by the current workforce (the stock), and the rate at which that stock is being renewed through hiring, training, and attrition (the flow). Following Becker's (1964) general/specific distinction, the framework separates general human capital (portable digital and analytical skills) from administration-specific human capital (procedural and institutional knowledge), because the two respond very differently to the labour market and technology mechanisms described below.

Component 2: Labour market alignment
This component captures how well the administration's recruitment, compensation, and retention practices are aligned with the labour market it actually competes in not an abstract national labour market, but the specific pool of digitally skilled, analytically trained young workers in Addis Ababa who also have private-sector and NGO options. Alignment here is a matter of degree: an administration can be well aligned for general administrative roles, where it may offer job security and status that competitors do not, while being poorly aligned for specialised technical roles, where private-sector pay differentials are largest and hardest for a fixed public pay scale to match.

Component 3: Digital transformation readiness

This component is deliberately not just "technology adoption." Following Hanna (2016) and the OECD's digital government work, it is modelled as having three sub-elements that must move together for adoption to actually change how work is done: infrastructure (hardware, software, connectivity), workforce capability (the digital skills of the people using the infrastructure, drawing on Component 1), and organisational culture (leadership support, tolerance for the temporary productivity loss that accompanies any real process change, and willingness to deviate from established procedure).

7.3. The three connecting mechanisms

The framework's real claim is not the three components above those are fairly standard but the mechanisms that connect them, because these are what generate testable, non-obvious predictions.

Mechanism A: The training-retention trap. Training that builds general, portable human capital (digital and analytical skills of the kind valued across the whole labour market) increases a worker's outside options at least as much as it increases their value to the current employer. Where labour market alignment (Component 2) is weak where the administration cannot match what those newly portable skills are worth elsewhere training investment can increase rather than decrease turnover among the very staff it was meant to retain. This is the theoretical basis for Proposition 3, and it is also the likeliest explanation, pending actual testing, for why large-scale digital skills training and persistent digital skills gaps can coexist: some share of the people trained may be the people most likely to leave.

Mechanism B: Uneven readiness compounding. Because digital transformation readiness (Component 3) depends on infrastructure, workforce capability, and culture moving together, departments that start with an advantage in any one of these tend to pull ahead on all three, rather than lagging departments catching up. A department with stronger existing IT infrastructure attracts or retains more digitally capable staff (via Component 1), which in turn makes leadership more willing to tolerate the disruption of adopting new tools (feeding Component 3's culture element), which further improves the case for infrastructure investment. This compounding dynamic is the theoretical basis for Proposition 4 the prediction that digital transformation widens rather than narrows internal capacity gaps without deliberate intervention and it implies that administration-wide digital strategies that

do not specifically target lagging departments will, almost mechanically, increase internal inequality in capacity even while raising average capacity.

Mechanism C: Specific human capital as a stabilizer. Administration-specific human capital procedural knowledge, institutional relationships, familiarity with how things actually get done does not transfer to outside employers the way general skills do, and so does not trigger Mechanism A. This is the theoretical basis for Proposition 5: departments that build career paths and development practices combining general skill-building with the accumulation of institution-specific knowledge, rather than generic training alone, should retain staff more effectively, because they are increasing a form of human capital that raises internal value without proportionally raising external options.

7.4. A description of the framework's structure

A future version of this paper, produced with visualization tools, would present this as a diagram: three component boxes (Human Capital Stock and Flow; Labour Market Alignment; Digital Transformation Readiness), connected by three labelled arrows representing Mechanisms A, B, and C, feeding into a single outcome box labelled Effective Administrative Capacity, with a feedback loop running from that outcome box back to Component 1, since administrative capacity itself shapes future budget for training and hiring. Described in words: capacity is not a straight sum of the three components but an outcome that depends on the state of all three connecting mechanisms simultaneously, and the framework predicts that interventions targeting a single component in isolation more training alone, a pay reform alone, or a digitalization push alone will systematically underperform interventions that address at least two components at once. That is the logic behind Proposition 7.

7.5. How the framework maps to the propositions

- P1 (uneven skills gaps) follows from Component 1's stock/flow structure interacting unevenly with Component 2 across functions and levels.
- P2 (reactive workforce planning) follows from a flow of training and hiring decisions that responds to Component 3 readiness gaps as they appear, rather than anticipating Mechanism B's compounding dynamic.
- P3 (institutional friction over absolute shortage) follows directly from Component 2 as defined here.
- P4 (uneven digital transformation widening gaps) follows from Mechanism B.

- P5 (better human capital practices predicting better labour market outcomes) follows from Mechanism C.
- P6 (culture mediating technology adoption) follows from Component 3's culture sub-element.
- P7 (combined interventions outperforming single-domain ones) follows from the framework's central claim that capacity is a function of alignment across all three components, not a sum of independent inputs.

This mapping is itself a contribution, independent of whether the propositions turn out to be correct: it shows that a future study does not need to test seven unrelated claims but rather needs to establish the strength of three specific mechanisms, from which the seven propositions largely follow. That is a more efficient and more theoretically coherent research design than treating them as seven independent hypotheses.

7.6. Applying the framework in practice

The framework is not only a research tool. Because each component and mechanism is defined in terms an administrator could recognise in their own department, it can also serve as a diagnostic lens ahead of, or alongside, formal testing. Table 1 sets out a simple set of questions that translate each component into something a manager or HR lead could assess directly, without needing survey data.

Table 1: Diagnostic questions by framework component

Component	Diagnostic question	Signals of weak alignment	Signals of strong alignment
Human Capital Stock & Flow	Do we know, department by department, which skills are actually scarce versus which are just talked about as scarce?	Training decisions follow trends or provider availability, not documented gaps.	Skills gaps are mapped by function and level, and hiring and training flows track them.
Labour Market Alignment	If our best specialist received a competing offer tomorrow, could we match it or even come close?	Pay scales and promotion paths haven't moved in years relative to the outside market.	Compensation and career paths are reviewed regularly against a defined comparator set.
Digital Transformation Readiness	When we roll out a new system, does leadership expect a temporary drop in output or treat any slowdown as failure?	New tools are provided but rarely used as intended; adoption stalls after launch.	Infrastructure, training, and leadership tolerance for disruption move together.

Section 8 turns these diagnostics into a phased approach for acting on what they reveal.

8. From Framework to Practice: An Implementation Guide

The steps below are offered as a starting point for practice, not a proven programme. They follow directly from the framework in Section 7 and should be read as hypotheses about what is likely to work worth acting on where the cost of trying is low, and worth testing formally where it is not.

8.1. A phased approach

Phase 1: Diagnose (0–3 months). Use the questions in Table 1, department by department, to identify where the three components are most out of alignment. This does not require new data collection: most administrations already hold enough institutional knowledge, sitting with HR staff and department heads, to answer these questions honestly if asked directly and given room to be candid.

Phase 2: Pilot (3–9 months). Select one or two departments and bundle at least two components into a single intervention, rather than rolling out a training programme, a pay adjustment, or a digital tool in isolation. Section 8.2 sets out four concrete levers to combine.

Phase 3: Scale and monitor (9–24 months). Track outcomes the current reporting does not: post-training retention specifically within the administration, department-level tool usage over time, and whether early movers are pulling further ahead of laggards rather than laggards catching up. Redirect investment toward departments falling behind, rather than distributing it evenly.

8.2. Four practical levers

Pair training investment with retention mechanisms

Digital skills training that is not paired with a retention mechanism a pay adjustment tied to newly certified skills, a defined promotion pathway, or a short service-commitment period risks training staff for the private sector rather than for government. In practice, this means evaluating the Coders Initiative and similar programmes not only by completion numbers but by a specific, trackable metric: what share of completers are still with the administration twelve and twenty-four months later. That figure can be captured with existing HR records; it does not require new data infrastructure to start measuring.

Target digital investment at lagging departments deliberately

An administration-wide digitalisation strategy that allocates resources evenly, or on a competitive basis, will tend to advantage departments that are already ahead. In practice, this means building a weighted allocation formula into the smart-city rollout one that gives lagging departments a larger share of early investment, even at some cost to average adoption speed rather than assuming a rising tide lifts all departments equally.

Invest in institution-specific as well as general human capital

Career development that builds institutional knowledge alongside general digital skills structured internal mobility, mentorship pairing newer and longer-serving staff, and deliberate documentation of institutional processes is a retention tool that does not require compensation reform to work. In practice, this could start as something

as modest as a mentorship pairing scheme, piloted first in whichever departments Phase 1 identifies as highest-turnover.

Sequence reforms as bundles, not a single-domain pipeline

Reform efforts that bundle a training component, a labour market or compensation adjustment, and a digital tooling change for the same target group will outperform reforms that roll out sequentially by domain. In practice, this means asking, before any single reform is approved: does this move at least two of the three components at once? If not, it is worth asking what it would take to bundle it with something already planned.

9. Discussion

9.1. What this paper contributes

The contribution of this paper is a framework, not a finding. That is a deliberately narrow claim, but it is one this paper can stand behind fully. The Capacity Interdependence Framework in Section 7 integrates three literatures that are rarely brought together explicitly for a case like Addis Ababa's, and does so in a way that generates specific, falsifiable predictions and practical guidance rather than a general observation that "these things are all connected," which would be true but not especially useful.

9.2. Relationship to existing literature

The framework's closest relatives are the workforce planning literature (CIPD, 2018; OECD, 2021) and the digital government readiness literature (Hanna, 2016; Mergel, Edelmann and Haug, 2019), both of which describe similar components separately without formally modelling the mechanisms connecting them. The training-retention trap described in Mechanism A has an analogue in general human capital theory's long-standing observation that firms underinvest in general training relative to the social optimum because they cannot fully capture its returns (Becker, 1964); this paper's contribution is to apply that logic specifically to a public administration context, where compensation rigidity, rather than simple underinvestment, is the more likely binding constraint.

9.3. Boundary conditions

The framework is built with a mid-sized, resource-constrained, urbanising African city administration in mind, and its assumptions rigid public pay scales, a fast-growing pool of competing private and NGO employers, uneven existing IT infrastructure may not hold in other settings. It should not be assumed to transfer directly to national-level civil services, to smaller municipalities with less labour market competition, or to public administrations with more flexible compensation systems, without adaptation and testing in those specific settings.

9.4. What would change the framework

The framework would need revision if a future study found, for instance, that training completion and retention were positively rather than negatively correlated even in departments with weak compensation alignment which would suggest Mechanism A is dominated by some other factor, such as strong non-pecuniary attachment to public service, not currently built into the model. It would also need revision if digital transformation readiness turned out to be driven primarily by individual leadership at the department-head level rather than by the more structural factors in Component 3, which would suggest a much larger role for personnel decisions than the current framework allows for. Both are testable claims, and both are exactly the kind of finding that would make the framework better rather than simply proving it wrong.

10. Conclusion and Future Research Agenda

10.1. Summary

This paper set out to understand how human capital, labour market functioning, and digital transformation interact in Addis Ababa's public administration. What it offers is a critical synthesis of existing evidence, a theoretical framework the Capacity Interdependence Framework built to be tested rather than presented as already confirmed, and a set of practical steps administrators can act on ahead of that testing. Nothing in this paper should be read as an empirical finding about Addis Ababa's public administration specifically; Sections 7 and 8 should be read as a reasoned, literature-grounded proposal and a starting point for practice, both awaiting further testing.

10.2. Contribution to theory

The paper's contribution is the integration itself: showing that seven apparently separate propositions about skills gaps, labour market friction, digital transformation, and organisational culture can be derived from three underlying mechanisms connecting human capital, labour market alignment, and digital transformation readiness. That reduction from seven claims to three mechanisms is a more parsimonious and more testable theoretical structure than treating them as independent hypotheses, and it is offered as this paper's main addition to the literature reviewed in Section 4.

10.3. A research agenda for future, adequately resourced studies

Testing the three mechanisms in Section 7.3, rather than all seven propositions independently, is a tractable research design, though still a genuine undertaking. A future study would need the following, at minimum:

Institutional partnership. A formal data-sharing agreement with the Addis Ababa City Administration for de-identified HR administrative data — headcount, turnover by department, training participation and completion, time-to-hire — which would on its own resolve much of the current uncertainty about basic workforce figures.

A funded, small research team. At minimum a principal investigator, two to three trained enumerators for survey administration, and a research assistant for qualitative coding, sustained over a realistic 12-to-18-month timeline.

A survey testing Mechanism A specifically. A design that tracks a cohort of digital skills training participants over 18 to 24 months, comparing retention rates against a matched group in departments with different compensation and promotion structures — the design that would most directly test the training-retention trap.

A department-level comparative study for Mechanism B. Case studies of three to five departments at different points on the digital transformation readiness spectrum, examining whether early advantages in infrastructure, workforce capability, and culture do in fact compound over time as the framework predicts, or whether some departments manage to catch up regardless.

Qualitative work on institution-specific human capital. A set of 15 to 20 in-depth interviews focused specifically on career development practices and their relationship to retention, to test Mechanism C.

Ethics approval and institutional affiliation, secured before any of the above begins, appropriate to research involving public employees and administrative data.
This is an ambitious agenda, but a genuinely achievable one for a funded team with institutional backing.

10.4. Concluding remarks

Addis Ababa's public administration is being asked to modernise quickly, with a workforce, pay structure, and technology base that were largely built for a different era. That gap will not close through investment in any single domain alone. The framework offered here is a way of thinking about why and a starting point, however provisional, for administrators who need to act now and for researchers who want to test these ideas properly. I would welcome hearing from either.

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Appendix A: Proposed survey instrument for future research

The instrument below was developed alongside the framework in Section 7, for future field validation of the propositions in Section 3.3. It would require translation, cognitive interviewing, and pilot testing with a small sample before use, consistent with standard instrument-development practice.

Section A: Background information

- Gender: Male / Female
- Age band: Under 30 / 30–39 / 40–49 / 50–59 / 60+
- Highest education level: Secondary or below / Diploma or Certificate / Bachelor's / Master's / PhD
- Years of service: 0–5 / 6–10 / 11–20 / 20+
- Administrative level: Entry / Middle Management / Senior Management
- Department or function, and sub-city (open text)

Skills self-assessment

Respondents rate their own skills on a 1–5 scale (Very Poor to Excellent) across: technical/functional skills, digital skills, analytical and data skills, managerial skills, and adaptive/change-readiness skills. This directly operationalises Component 1 of the framework in Section 7.2.

Training and development

Participation in training in the past 24 months (type, provider, duration), perceived relevance and effectiveness, and self-reported barriers to participation. Combined with administrative training records, this section is designed specifically to support the retention-tracking design described in Section 10.3 for testing Mechanism A.

Labour Market Perceptions and Intentions

Satisfaction with compensation, career prospects, and work environment; perceived alternative employment options outside the administration; and stated intention to remain over the next 12 and 36 months. This operationalises Component 2.

Technology Use and Organisational Culture

Frequency and confidence of use of specific digital tools currently in use in the respondent's department; perceived leadership support for new ways of working; and perceived tolerance for mistakes made while learning new systems. This operationalises Component 3, including its culture sub-element.

Appendix B: Outline ethics protocol for a future study

This is a starting outline, to be developed into a full protocol and submitted for institutional ethics review before any primary data collection begins, as noted in Section 5.6. It reflects standard practice for research involving public employees and administrative data, not a description of procedures used in preparing this paper, which did not involve primary data collection from human subjects.

- Written or recorded verbal informed consent, in Amharic and English, explaining the study's purpose, voluntary participation, and the right to withdraw at any time without penalty.
- Removal of identifying information from all data files, use of participant codes rather than names in any analysis output, and secure, access-limited storage of all raw data.
- A clear explanation to participants of the limits of confidentiality, and a referral pathway to appropriate support if a participant discloses significant distress during an interview.
- Formal ethics board approval from an appropriate institutional review body, and a separate data-access agreement with the Addis Ababa City Administration, both secured prior to fieldwork.

Between Rights and Reality: Social Inclusion of Women with Disabilities in Ethiopia

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Abstract

Gender, disability, and social inclusion in Ethiopia represent deeply interconnected dimensions that shape the nation's pursuit of social justice. Despite Ethiopia's progressive constitutional guarantees, the 1993 National Policy on Women, and commitments to international conventions such as CEDAW, the lived realities of women and persons with disabilities reveal persistent exclusion and inequality. This paper critically examines the gap between legal frameworks and practice, focusing on the compounded vulnerabilities of women and disabilities that face intersecting barriers rooted in patriarchal norms, harmful traditional practices, and the disproportionate effects of conflict and displacement. Findings indicate that inaccessible infrastructure, limited data disaggregation, weak policy enforcement, and prevailing social stigma hinder equitable participation in education, employment, and decision-making. In conflict-affected areas, women and disabilities experience heightened risks of violence and exploitation, with minimal protection under existing laws such as Proclamation No. 568/2008. Customary dispute resolution systems and patriarchal attitudes further marginalize them, limiting access to justice and leadership opportunities. The study underscores the need for transformative, inclusive governance that integrates gender equality and disability inclusion as core principles of development. Hence, enforcing legal protections, strengthening data systems through intersectional approaches, and reconstruction and development programs should be co-designed with women and disabilities. Moreover, multi-stakeholder collaboration among government, civil society, and NGOs is vital to sustain advocacy and accountability. Ultimately, advancing social justice in Ethiopia requires dismantling systemic and attitudinal barriers while fostering an enabling environment that guarantees accessible services, equitable participation, and empowered representation for all marginalized groups.

Keywords: Gender, disability, Social inclusion, Legal frameworks, Practice and Ethiopia.

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1. Introduction

1.1. Background of the study

Gender equality, disability rights, and social inclusion are central to contemporary development discourse, grounded in the broader principles of social justice and human rights. Social justice emphasizes equitable access to resources, opportunities, and participation for all individuals, regardless of gender or disability status. In developing contexts such as Ethiopia, however, entrenched socio-cultural norms, economic disparities, and institutional limitations continue to reinforce unequal power relations. Women and persons with disabilities remain among the most marginalized groups, often facing restricted access to education, employment, healthcare, and public decision-making spaces. Addressing these inequalities is therefore not only a moral imperative but also a prerequisite for sustainable and inclusive development (UNDP, 2021; World Bank, 2020).

Ethiopia has made notable policy and legal commitments toward promoting gender equality and disability inclusion. The Constitution of the Federal Democratic Republic of Ethiopia guarantees equality before the law and prohibits discrimination based on sex, disability, and other social identities. Complementary frameworks such as the National Policy on Women (1993) and international conventions including the Convention on the Elimination of All Forms of Discrimination against Women (CEDAW) and the Convention on the Rights of Persons with Disabilities (CRPD) further reinforce the country's commitment to inclusive governance and human rights protection (FDRE, 1995; FDRE, 1993; United Nations, 1979; United Nations, 2006). These frameworks establish a strong normative foundation for advancing social justice.

Despite these commitments, a persistent gap exists between policy provisions and lived realities. Structural barriers such as inaccessible infrastructure, limited enforcement of laws, weak institutional capacity, and inadequate data systems continue to hinder effective implementation. For instance, the Right to Employment of Persons with Disabilities Proclamation No. 568/2008 aims to ensure equal employment opportunities; however, its impact has been constrained by limited enforcement mechanisms and low awareness among employers (FDRE, 2008; ILO, 2010). This implementation gap underscores the need to critically assess how legal frameworks translate into practice.

The challenges are further compounded at the intersection of gender and disability. Women with disabilities experience multiple and overlapping forms of

discrimination, resulting in heightened vulnerability to poverty, exclusion, and limited life opportunities. Compared to men with disabilities and women without disabilities, they face greater barriers in accessing education, economic resources, and leadership roles. These disparities are reinforced by deep-rooted patriarchal norms and societal stigma surrounding disability, which collectively restrict their agency and participation. An intersectional approach is therefore essential to fully understand and address these layered inequalities (WHO & World Bank, 2011; UN Women, 2018).

Socio-cultural factors also play a critical role in perpetuating exclusion. Patriarchal systems often limit women's decision-making power and control over resources, while harmful traditional beliefs contribute to the stigmatization of disability. In many rural areas, the lack of accessible infrastructure, assistive technologies, and inclusive services further isolates persons with disabilities. These structural and attitudinal barriers interact to sustain cycles of marginalization and inequality (Jones et al., 2018; Ethiopian Human Rights Commission, 2020).

Moreover, conflict and displacement in Ethiopia have intensified existing vulnerabilities. Humanitarian crises disrupt social services and exacerbate risks of gender-based violence, particularly for women and girls with disabilities. Evidence shows that humanitarian responses frequently overlook disability inclusion and gender sensitivity, resulting in unequal access to relief and recovery interventions. This highlights the urgent need to integrate inclusive approaches into peace building and humanitarian programming (UN Women, 2022; International Disability Alliance, 2019).

Given these challenges, there is a critical need to examine the intersection of gender, disability, and social inclusion in Ethiopia to better understand the gap between policy commitments and practical realities. Existing studies often address gender or disability in isolation, with limited attention to their interconnected nature. This study is therefore intended to provide an integrated, intersectional analysis that captures the compounded experiences of women with disabilities and other marginalized groups. By doing so, it seeks to generate evidence that informs more inclusive policies, strengthens implementation mechanisms, and promotes equitable participation in development processes. Ultimately, the study aims to contribute to advancing social justice by identifying practical pathways for dismantling systemic barriers and fostering inclusive governance in Ethiopia.

1.2. Objective of the paper

1.2.1. General objective

The paper intended to examine the intersection of gender, disability, and social inclusion towards social justice in Ethiopia.

1.2.2. Specific objectives

- To analyze the gap between legal and policy frameworks and their practical implementation in addressing gender equality, disability rights, and social inclusion in Ethiopia.
- To investigate the social, cultural, and structural barriers that limits the participation of women and persons with disabilities in education, employment, and decision-making processes.
- To identify inclusive governance strategies and policy interventions that strengthens gender equality, disability inclusion, and multi-stakeholder collaboration to advance social justice in Ethiopia.

2. Theoretical framework of the paper

The paper adopts a multi-theoretical framework, while the primary theory (core framework) is intersectionality theory, and the supporting theories are social justice theory and social model of disability. Together, these theories enable the study to explain how overlapping inequalities affect women and persons with disabilities (Intersectionality); justify the importance of equitable participation and rights-based governance (Social Justice); and identify structural and environmental barriers causing disability exclusion (Social Model of Disability).

2.1. Intersectionality theory

Intersectionality theory is the most suitable central theory as this study focuses on overlapping forms of marginalization gender, disability, and social exclusion. The theory explains how different social identities interact to produce compound discrimination and inequality. In Ethiopia, women with disabilities experience layered disadvantages caused by gender norms, disability stigma, poverty, and conflict-related vulnerabilities. These intersecting identities create unique barriers to education, employment, and decision-making participation that cannot be fully understood through a single-axis analysis of gender or disability alone. Therefore, intersectionality provides a comprehensive framework for examining how multiple

systems of inequality operate simultaneously within Ethiopian social structures and institutions (Shakespeare, 2018).

For example, Ethiopian studies show that women with disabilities face double discrimination: gender inequality within patriarchal systems and disability-based marginalization within social and institutional environments. These intersecting inequalities influence their access to justice, social services, and leadership opportunities. Intersectionality theory therefore allows the study to analyze how social norms, legal systems, and development policies affect women and persons with disabilities differently depending on the interaction of their identities (Shakespeare, 2018; WHO & World Bank, 2011).

2.2. Social justice theory

While intersectionality explains how inequalities overlap, social justice theory explains why addressing these inequalities is necessary for equitable development and governance. Social justice emphasizes fairness, equal rights, and equitable distribution of opportunities in society. Ethiopia's constitution and legal frameworks promote equality and non-discrimination; however, the persistence of gender and disability inequality indicates a gap between legal guarantees and lived realities. Social justice theory helps frame the study's focus on equitable participation, inclusive governance, and equal access to services as fundamental requirements for national development and democratic accountability (Sen, 2009). This theory supports the study's objective of identifying policy and governance pathways that can reduce structural inequalities and strengthen inclusive development.

2.3. Social model of disability

The social model of disability complements the above theories by explaining how disability-related exclusion arises from social, institutional, and environmental barriers rather than individual impairments. In Ethiopia, barriers such as inaccessible infrastructure, limited inclusive education systems, weak enforcement of disability laws, and social stigma prevent persons with disabilities from fully participating in society. The model highlights the need to transform social structures and institutional systems to promote inclusion and accessibility (Barnes & Mercer, 2010).

This theory is particularly relevant when examining policy implementation gaps, including the Right to Employment of Persons with Disability Proclamation No. 568/2008, which aims to protect employment rights but remains weakly enforced in practice.

3. Methodology: Systematic Review Approach

This study employed a systematic literature review methodology to critically examine the intersection of gender, disability, and social inclusion in Ethiopia and identify pathways toward social justice. A systematic review allows synthesizing existing empirical and theoretical evidence in a transparent, replicable, and comprehensive manner. Unlike traditional narrative reviews, systematic reviews follow structured procedures for identifying, selecting, evaluating, and analyzing relevant studies. This approach is particularly useful for policy-oriented research because it integrates findings from multiple sources to generate evidence-based insights for decision-making (Barbara Kitchenham, 2004; David Moher et al., 2009). In the context of Ethiopia, where research on gender, disability, and social inclusion is scattered across disciplines, a systematic review provides a coherent understanding of existing knowledge and policy gaps (Jones et al., 2018).

The systematic review followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, which provide internationally recognized standards for conducting and reporting systematic reviews. The PRISMA framework ensures methodological transparency by outlining stages such as identification, screening, eligibility assessment, and inclusion of studies. Using this framework helps minimize bias in the selection process and enhances the reliability of the findings. Applying PRISMA in social science research has become increasingly common in studies examining gender equality, disability inclusion, and development policies, particularly in developing countries (Moher et al., 2009; UN Women, 2021).

3.1. Data sources and search strategy

To identify relevant literature, a comprehensive search was conducted across multiple academic databases and institutional repositories. These included Google Scholar, Scopus, Web of Science, JSTOR, PubMed, and African Journals Online, as well as reports from international organizations such as United Nations Women, World Bank, International Labour Organization, and United Nations Development Programme. The search strategy used combinations of keywords including gender equality, disability inclusion, social justice, women with disabilities, inclusive governance, and Ethiopia. This strategy ensured a broad yet targeted collection of peer-reviewed articles, policy reports, and institutional publications relevant to the Ethiopian context (World Bank, 2020; UNDP, 2021).

3.2. Inclusion and exclusion criteria

Clear inclusion and exclusion criteria were established to ensure the relevance and quality of the selected studies. Studies were included if they:

- Focused on gender equality, disability rights, or social inclusion in Ethiopia.
- Were published between 2000 and 2024 to capture contemporary policy developments.
- Were peer-reviewed articles, policy reports, government documents, or publications from reputable international organizations.

Studies were excluded if they:

- Did not focus on Ethiopia or Sub-Saharan Africa.
- Addressed gender or disability without reference to social inclusion or policy implications.
- Were opinion pieces without empirical or analytical evidence.

This selection process ensured that the review captured credible and policy-relevant research addressing the intersection of gender and disability in Ethiopia (Jones et al., 2018; WHO & World Bank, 2011).

3.3. Data analysis and synthesis

The collected literature was analyzed using thematic analysis, which involves identifying recurring themes and patterns within qualitative and policy-oriented research. Themes were organized around key areas including legal frameworks, socio-cultural barriers, institutional challenges, and inclusive governance strategies. Thematic synthesis enabled the integration of findings from diverse sources to highlight the structural and intersectional challenges faced by women and persons with disabilities in Ethiopia. This analytical approach is widely used in systematic reviews addressing social justice and development issues because it facilitates the interpretation of complex socio-political phenomena (Thomas & Harden, 2008; UN Women, 2022).

4. Findings of the Study

This section presents the key findings of the study on gender, disability, and social inclusion in Ethiopia, with particular emphasis on the intersectional challenges faced

by women and persons with disabilities. The findings are derived from the analysis of relevant policy documents, institutional reports, and scholarly literature examining the implementation of gender equality and disability inclusion frameworks in Ethiopia. The analysis is guided by the study's objectives, which focus on assessing the status of gender equality and disability inclusion, identifying the key barriers affecting social participation, and exploring pathways toward achieving social justice through inclusive governance and policy implementation.

4.1. Status of gender equality and disability inclusion in Ethiopia

The findings reveal that although Ethiopia has made notable policy commitments to gender equality and disability inclusion, significant disparities remain in the practical realization of these rights. The Ethiopian Constitution guarantees equality before the law and explicitly protects women and persons with disabilities from discrimination. In addition, policies such as the National Policy on Women and the National Plan of Action on Persons with Disabilities aim to promote inclusion and equal participation. However, evidence from national and international reports indicates that policy implementation remains inconsistent, particularly at regional and local levels where institutional capacity and resources are limited. As a result, women and persons with disabilities continue to experience unequal access to education, employment, health services, and political participation. These findings highlight a persistent gap between legal frameworks and the lived experiences of marginalized groups in Ethiopia (FDRE, 1995; Ethiopian Human Rights Commission, 2020; UNDP, 2021).

The study also found that the intersection of gender and disability significantly intensifies social exclusion. Women with disabilities face compounded discrimination due to both gender-based inequalities and disability-related stigma. This intersectional disadvantage manifests in lower educational attainment, higher unemployment rates, and limited representation in community leadership structures. Research indicates that women with disabilities in Ethiopia are among the most economically marginalized groups, often excluded from income-generating opportunities and social protection programs. Social stigma and misconceptions about disability further restrict their participation in community life, resulting in isolation and limited access to information and services. These findings emphasize the importance of applying intersectional frameworks that address both gender inequality and disability inclusion simultaneously rather than treating them as separate issues (WHO & World Bank, 2011; UN Women, 2018).

4.2. Gender-related challenges affecting social inclusion

The findings indicate that entrenched patriarchal norms and harmful traditional practices remain significant barriers to gender equality in Ethiopia. In many communities, cultural expectations continue to prioritize male authority in decision-making, limiting women's access to leadership positions, property ownership, and education. These social norms often reinforce gender roles that restrict women's participation in economic and political spheres. The situation is further exacerbated for women with disabilities who may be perceived as dependent or incapable of contributing productively to society. Such attitudes discourage families and communities from investing in their education or employment opportunities, thereby perpetuating cycles of marginalization and poverty (Jones et al., 2018; UN Women, 2022).

Another major challenge identified in the study relates to limited accessibility and inclusive infrastructure. Many public institutions, including schools, health centers, and government offices, are not adequately designed to accommodate persons with disabilities. Lack of ramps, accessible transportation, assistive technologies, and inclusive learning materials significantly restricts the participation of persons with disabilities in education and employment. The findings also reveal that inclusive education policies have not been fully implemented across many parts of Ethiopia, particularly in rural areas where resources are scarce. Consequently, children with disabilities especially girls are more likely to drop out of school or remain excluded from formal education systems. This exclusion limits their opportunities for economic independence and social mobility later in life (ILO, 2010; World Bank, 2020).

Furthermore, the findings show that conflict and humanitarian crises have intensified the vulnerabilities of women and persons with disabilities in Ethiopia. Armed conflicts and displacement have disrupted social support systems, weakened institutional protection mechanisms, and increased the risk of gender-based violence. Women and girls with disabilities face heightened risks of exploitation, abuse, and neglect during humanitarian emergencies due to limited access to protection services and legal support. In conflict-affected regions, humanitarian programs often fail to adequately consider the specific needs of persons with disabilities, leading to further exclusion from relief and recovery initiatives. These findings underscore the need for inclusive humanitarian responses that integrate gender and disability

considerations into all stages of emergency planning and implementation (International Disability Alliance, 2019; UN Women, 2022).

4.3. Institutional and policy implementation gaps

The study also identified significant institutional and policy implementation gaps that hinder effective gender and disability inclusion in Ethiopia. Although various laws and policies exist to protect the rights of marginalized groups, enforcement mechanisms remain weak. For example, the Right to Employment of Persons with Disability Proclamation No. 568/2008 was designed to promote equal employment opportunities and prohibit workplace discrimination. However, many employers remain unaware of the provisions of the law or fail to implement reasonable accommodation measures for employees with disabilities. Limited monitoring and enforcement by regulatory institutions further reduce the effectiveness of such policies (FDRE, 2008; Ethiopian Human Rights Commission, 2020).

Another key finding relates to the lack of reliable disaggregated data on gender and disability. Data systems in Ethiopia often fail to capture the complex intersections between gender, disability, poverty, and geographic location. Without accurate and comprehensive data, policymakers face challenges in designing targeted interventions and monitoring progress toward inclusive development goals. The absence of disability-disaggregated data in national surveys and administrative records also limits the visibility of persons with disabilities in development planning. Strengthening data collection systems through intersectional approaches is therefore essential for evidence-based policymaking and effective program implementation (UNDP, 2021; World Bank, 2020).

The findings further highlight the role of customary dispute resolution systems in shaping access to justice for women and persons with disabilities. In many Ethiopian communities, traditional institutions play a significant role in resolving conflicts and disputes. While these systems can provide accessible and culturally relevant mechanisms for conflict resolution, they may also reinforce patriarchal norms that disadvantage women and marginalized groups. Women with disabilities often face barriers in accessing formal legal systems due to physical inaccessibility, financial constraints, and social stigma. As a result, they may rely on informal justice mechanisms that do not adequately protect their rights or ensure fair outcomes. Addressing these challenges requires reforms that integrate human rights principles into both formal and customary legal systems (Ethiopian Human Rights Commission, 2020; UN Women, 2018).

4.4. Pathways toward social justice and inclusive development

The findings emphasize the importance of transformative governance approaches that integrate gender equality and disability inclusion as core components of development planning. Effective implementation of legal frameworks requires stronger institutional capacity, improved coordination among government agencies, and increased accountability mechanisms. Strengthening enforcement of existing laws and policies can help ensure that the rights of women and persons with disabilities are protected in practice. In addition, targeted capacity-building programs for public institutions can improve awareness and implementation of inclusive policies (UNDP, 2021; World Bank, 2020).

Another key pathway identified in the study is the active participation of women and persons with disabilities in decision-making processes. Inclusive governance requires that marginalized groups be meaningfully involved in designing, implementing, and monitoring development programs that affect their lives. Participation not only empowers marginalized communities but also enhances the effectiveness and sustainability of development initiatives. Civil society organizations, advocacy groups, and organizations of persons with disabilities play a crucial role in promoting accountability and ensuring that the voices of marginalized populations are represented in policy discussions (International Disability Alliance, 2019; UN Women, 2022).

Finally, the findings highlight the importance of multi-stakeholder collaboration in advancing social justice in Ethiopia. Partnerships among government institutions, civil society organizations, international development partners, and local communities are essential for addressing complex social inequalities. Such collaborations can support advocacy, resource mobilization, and knowledge sharing that strengthen inclusive development efforts. By dismantling systemic barriers and promoting accessible services, equitable participation, and empowered representation, Ethiopia can make significant progress toward achieving social justice for women and persons with disabilities (UNDP, 2021; World Bank, 2020).

4.5. Summary of findings

The findings reveal that although Ethiopia has established progressive legal and policy frameworks aimed at promoting gender equality and protecting the rights of persons with disabilities, substantial gaps remain between policy commitments and practical implementation. Structural inequalities, socio-cultural norms, and limited

institutional capacity continue to hinder the effective realization of inclusive development. Women and persons with disabilities frequently encounter multiple and intersecting forms of discrimination that restrict their access to education, employment, healthcare, and participation in decision-making processes. These challenges are particularly pronounced for women with disabilities, who face compounded disadvantages due to both gender inequality and disability-related stigma (FDRE, 1995; UNDP, 2021; World Bank, 2020).

Furthermore, the findings highlight that systemic barriers such as inaccessible infrastructure, weak enforcement of legal protections, and insufficient disability-disaggregated data significantly undermine efforts to promote inclusive development. In many cases, public services and institutions remain inadequately equipped to address the needs of persons with disabilities, particularly in rural and conflict-affected areas. These limitations not only restrict access to opportunities but also reinforce patterns of social exclusion that prevent marginalized groups from fully participating in economic, social, and political life (ILO, 2010; WHO & World Bank, 2011).

The analysis also reveals that conflict, displacement, and humanitarian crises have intensified the vulnerabilities of women and persons with disabilities in Ethiopia. In conflict-affected regions, women and girls with disabilities are exposed to heightened risks of violence, exploitation, and limited access to justice and protection mechanisms. These circumstances underscore the need for integrated approaches that address gender equality and disability inclusion as interconnected dimensions of social justice and sustainable development (UN Women, 2022).

Overall, the findings provide important insights into the structural, institutional, and socio-cultural factors that shape gender and disability inclusion in Ethiopia. By examining these dynamics through an intersectional lens, the study contributes to identifying practical pathways for strengthening inclusive governance, improving policy implementation, and promoting equitable participation for marginalized groups in the country's development processes.

5. Discussion

The findings of this study reveal persistent gaps between Ethiopia's legal frameworks and the lived realities of women and persons with disabilities, highlighting the complex interplay between gender, disability, and social inclusion. Despite progressive policies such as the National Policy on Women (1993), the Constitution

(1995), and the Right to Employment of Persons with Disability Proclamation No. 568/2008, implementation remains inconsistent, particularly at the local and regional levels where institutional capacity and resources are limited (FDRE, 1995; FDRE, 2008). This discrepancy underscores the well-documented policy-practice gap in Ethiopia, where legal guarantees are not always translated into tangible benefits for marginalized populations (Ethiopian Human Rights Commission, 2020). The study's findings demonstrate that the persistence of socio-cultural barriers patriarchy, harmful traditional practices, and disability stigma interacts with systemic weaknesses to sustain exclusion and inequality. These results align with intersectionality theory, which emphasizes that multiple social identities, such as gender and disability, intersect to create compounded disadvantage (Crenshaw, 1989; WHO & World Bank, 2011).

The study highlights that women with disabilities are among the most marginalized groups in Ethiopia, experiencing multiple forms of discrimination that limit access to education, employment, and leadership opportunities. These findings are consistent with existing research showing that women with disabilities face higher poverty levels, limited educational attainment, and reduced social participation compared to both men with disabilities and women without disabilities (Jones et al., 2018; UN Women, 2018). In line with the theoretical framework of social inclusion, which emphasizes equitable participation and access to resources, the study confirms that structural and attitudinal barriers significantly hinder the empowerment of these groups (Sen, 2000; World Bank, 2020). For example, inaccessible public infrastructure and limited assistive technologies restrict mobility and participation, while patriarchal norms and social stigma reduce the likelihood of women with disabilities being considered for leadership roles or economic opportunities. This intersectional disadvantage demonstrates the necessity of integrated policy approaches that consider gender and disability simultaneously rather than in isolation.

Conflict and displacement were identified as critical factors that exacerbate vulnerabilities. In conflict-affected regions of Ethiopia, women and persons with disabilities experience increased risks of violence, exploitation, and social exclusion. Humanitarian and reconstruction programs frequently fail to address the specific needs of these populations, often due to insufficient data, lack of inclusive planning, and weak enforcement of protective laws (International Disability Alliance, 2019; UN Women, 2022). This finding aligns with previous research indicating that humanitarian responses in Ethiopia have historically underrepresented women and persons with disabilities, despite their heightened vulnerability during crises (Kaleab,

2025). The discussion underscores the importance of intersectional data collection, which not only disaggregates information by gender and disability but also considers context-specific factors such as displacement, rurality, and socioeconomic status. Without such data, policies risk being generic and failing to reach the most marginalized populations.

The study also critically examines institutional and legal challenges. While Ethiopia's legal instruments such as Proclamation No. 568/2008 are designed to safeguard rights, weak enforcement mechanisms and limited institutional capacity impede their effectiveness. Employers often lack awareness of legal requirements, and regulatory bodies are under-resourced to monitor compliance effectively (FDRE, 2008; ILO, 2010). Customary dispute resolution systems, although culturally important, sometimes reinforce patriarchal norms that disadvantage women and persons with disabilities, limiting their access to justice and fair conflict resolution (Ethiopian Human Rights Commission, 2020). These findings suggest that legal reforms alone are insufficient; transformative governance requires both institutional strengthening and societal attitudinal change to ensure equitable participation.

Finally, the findings emphasize pathways toward social justice through inclusive governance and multi-stakeholder collaboration. Empowering women and persons with disabilities requires meaningful participation in the design, implementation, and monitoring of development and reconstruction programs (UNDP, 2021; World Bank, 2020). Civil society organizations, NGOs, and organizations of persons with disabilities play a vital role in bridging gaps between policy and practice, advocating for accountability, and ensuring representation in decision-making processes (International Disability Alliance, 2019). Inclusive governance approaches, rooted in social inclusion and intersectionality frameworks, advocate for policies that dismantle systemic barriers while fostering environments that guarantee accessible services, equitable opportunities, and empowered representation. This integrated approach is critical for achieving sustainable social justice in Ethiopia.

In summary, the discussion demonstrates that advancing gender equality and disability inclusion in Ethiopia requires a holistic approach that simultaneously addresses legal, institutional, socio-cultural, and conflict-related barriers. Intersectional analysis provides a lens for understanding compounded vulnerabilities and informs targeted interventions. The study's findings emphasize that social justice cannot be achieved through legal frameworks alone; it necessitates structural reforms, attitudinal change, data-informed policymaking, and collaborative governance that prioritize the voices and needs of marginalized populations.

6. Conclusion

This study demonstrates that while Ethiopia has progressive legal frameworks for gender equality and disability inclusion, significant gaps persist between policy and practice. Women and persons with disabilities continue to face compounded vulnerabilities due to patriarchal norms, harmful traditional practices, inaccessible infrastructure, weak policy enforcement, and limited disability-disaggregated data. Conflict and displacement exacerbate these inequalities, increasing the risk of violence, exploitation, and social exclusion. Intersectional barriers restrict equitable participation in education, employment, leadership, and decision-making processes. Achieving social justice in Ethiopia therefore requires not only legal protection but also transformative governance that dismantles systemic and attitudinal barriers, promotes inclusive services, and ensures meaningful representation of marginalized groups.

7. Recommendations

Strengthen Legal Enforcement and Institutional Capacity: Ensure effective implementation of existing laws, such as Proclamation No. 568/2008, through enhanced monitoring, accountability mechanisms, and capacity building for public institutions.

Promote Intersectional Data Collection: Develop robust gender and disability disaggregated data systems to inform evidence based policymaking and inclusive program design.

Enhance Inclusive Infrastructure and Services: Invest in accessible public facilities, inclusive education, assistive technologies, and healthcare services to reduce participation barriers for persons with disabilities, particularly women.

Address Socio-Cultural Barriers: Implement awareness campaigns and community engagement programs to challenge patriarchal norms and stigma associated with disability, promoting social acceptance and empowerment.

Inclusive Participation in Decision-Making: Actively involve women and persons with disabilities in designing, implementing, and monitoring development, reconstruction, and humanitarian programs.

Foster Multi-Stakeholder Collaboration: Encourage partnerships among government, civil society, NGOs, and local communities to sustain advocacy, accountability, and inclusive development initiatives.

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Impact of Teff Row Planting on Rural Household Income: Evidence from Merhabete Woreda, Amhara Region, Ethiopia

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Abstract

Teff has the largest value in terms of both production and consumption in Ethiopia and the value of the commercial surplus of teff is second to coffee. This study aims at analysis of the impact of teff row planting on rural household income in case of Merhabete woreda, Amhara Regional state, Ethiopia. Primary data has been used with mixed methods approach, combining qualitative and quantitative data-collection tools: household survey, key informant interviews and Focus Group Discussion. To measure the impact of participation in row planting for the rural household teff income the researcher used an ESR model and the first stage decision (whether to participate or not) was estimated using the probit model. Variables include tropical livestock unit (TLU), family size, and Home distance, Land size, level of education, Training, contact extension agents, Membership in social network and Neighbor user in row planting significantly affect teff row planting technology. The endogenous switching regression technique allows us to control for unobserved factors, such as confidence, the farmer's motivation and ability, which are likely to affect both participation in row planting and the outcome of interest. On average teff income of participant group obtained (10946.15) 20.75% higher than non- participant groups. Therefore, it is better to encourage row planting technology adoption because the results of this study signify that teff row planting technology, increase both the teff yield and income of adopters.

Key words: Row planting, Endogenous switching regression model, teff income, cost benefit analysis

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1. Introduction

Ethiopia is fundamentally an agrarian country and agriculture is Ethiopia's most important sector, crucial for the country's food security and the livelihoods of its people. The sector is the largest contributor to the overall economy and is fundamental to Ethiopia's overall development. Despite the dominance of traditional smallholder farmer in the sector, increased engagement with mid and large-scale private sector partner has brought new technologies and improved market linkages (Tarkalson, King, Bjorneberg, & Taberna Jr, 2011). Agriculture is the mainstay of the Ethiopian economy and contributes 32% of the country's gross domestic product (GDP), more than 70% of the total exports and employment absorption in the country (Bruns, 2011).

Despite of its contribution to the national GDP by large, agriculture in Ethiopia is subsistence. Smallholder farmer are cultivating 95% of their farmland using mostly traditional farming practices and inadequate improved technology be found in the low productivity Ethiopian agriculture(Giziew & Mebrate, 2019)). Due to this reason, food insecurity and poverty are prevalent in the country. Therefore, agricultural sector needs improved agricultural technologies, which can enhance the productivity of the sector and reduce poverty.

Achieving agricultural productivity growth will not be possible without developing and disseminating yield-increasing technologies (Negussie, 2020). Yield enhancing agricultural technologies either may be improved crop varieties or improved production technologies. Modern farming methods matter for smallholder agricultural productivity and food security. Adoption of improved agricultural technologies has been associated with higher earnings and lower poverty (SUN et al., 2024).

Farmers give value for its straw as source of animals feed, especially during the dry season teff straw, besides being the most appreciated feed for cattle, it is also used to reinforce mud and plaster the walls of tukuls and local grain storage facilities called *gottera*. Its origin is thought to be Ethiopia, where it emerged as a grain crop for human consumption between 4000 B.C. and 1000 B.C. (Fikire & Asefa, 2023). Compared to other cereals, teff is considered a lower risk crop as it can withstand adverse weather conditions. It is the most widely adapted grain crop compared to any other cereal or pulse crop in the country and it can be stored for long period without quality deterioration and quantity decline (Mehta, 2024).

Despite the significance of the crop, yields or productivity are relatively low (around 1.2 t/ha) which is lower than the average yields of other cereal crops; maize (3.1t/ha); rice (2.8t/ha); wheat (2.1t/ha) and high loss rates (25-30%) both before and after harvest) reduce the quantity of grain available to consumer by up to 50%. One of the reasons for the low yield is ineffective sowing methods, high seed rate and poor grain management. Most farmers practice the traditional sowing method by broad casting of the small seed, which creates excess crop density and increases competition among plants for nutrients, water, sunlight and C^{O}_{2}. Moreover, broadcasting methods requires additional seed rate compared to row planting method thus increases input cost of production. Traditionally, farmer broadcast the seed using a rate of 25-50 kg per hectare (Giziew & Mebrate, 2019).

In Ethiopia, teff is a major staple food with excellent nutritional value (high protein and fiber content, complex carbohydrates and gluten free). It accounts for 11-15% of all calories consumed and 23% of urban food consumption. It has the largest value in terms of both production and consumption in Ethiopia and the value of the commercial surplus of teff is second only to coffee (Graterol, Elmore, & Eisenhauer, 1996). More than 6 million households‟ life depend on the production of teff covering the largest agricultural area of the country than any other types of grain, however the amount of production is not as much as its production coverage and value (Quintana-Ashwell et al., 2022).

The teff production system used by the majority of farmer is very backward and traditional, which is planting seed by hand at high seed rates. This impedes teff yields because of high amount, uneven distribution of the seeds makes weeding difficult and increased competition with weeds and other teff plants lower nutrient uptake by the individual teff plant this result in the reduction of teff yield at the harvesting period (Lyon et al., 2009). In response to this Row planting of Teff seed is considered to be superior compared to the traditional broadcasting method because a reduced seed rate, decreases competition between the seedlings for water and nutrients (Tamirat, 2020).

The adoption of agricultural innovation in developing countries attracts considerable attention because it can provide the basis for increasing production and income. The adoption of more efficient farming practices and technologies is enhancing agricultural productivity Amhara, Ethiopia. Small-scale farmers‟ decisions to adopt or reject agricultural technologies depend on their objectives and constraints as well as cost and benefit accruing to it (Liu, Song, Liu, & Zhu, 2012). According to Bureau of Agriculture and Rural Development (BoARD), Row planting technology was

introduced in 2010/2011 at farm level in Amhara in order to increase crop productivity and incomes for small-scale farm household. However, its impact on merhabete was not known and no effort had been made to evaluate the program and its activities hence creating an information gap that needed to be filed (Mossie, 2022).

In addition to above reason, from the review there is also methodological gap in which the previous research measures the impact only based on observed factor covariates by using propensity score matching, Hackman selection model as well as inverse probability weight model and difference indifference method (Mihretie et al., 2021) in Ethiopia. However, in reality, many determinant of teff row planting are unobserved factors which mainly affect the probability to participate or not such as motivation, confidence or faithful of the government, ability of the participant and soon. Therefore, to capture the impact of teff row planting by considering such unobserved factors makes the estimation relatively to efficient; the Endogenous Switching Regression model is applied in this study. Therefore, the general objective of the study is to evaluate impact of teff row planting on rural household teff income with the following three specific objectives.

To identify determinant factors of row planting technology in teff production
To evaluate cost and benefit difference of row planting technology with broadcasting.
To analyze impact of teff row planting technology on rural household teff income.

2. Literature Review

This section attempts to provide definitions and basic concepts regarding row planting, review on empirical findings in previous studies and conceptual framework of the study related with row planting and the constraints of technologies.

2.1. Basic concepts and definitions

Row planting is defined as planting with space, involves the growing of plants on a plot of land with sufficient space between each of the plants, so that they can develop their roots, and shoots more fully. By reducing the seed rate and planting in rows, it was found that farmer could potentially double their *teff* yields. Unfortunately, a host of factor, including a lack of modern planting technologies, limited agricultural extension resources and a resistance to adopting practices that seem counterintuitive has in the past resulted in low adoption rates for these types of technologies. However, the federal and regional infrastructure has been strengthened in recent year

to tackle many of these challenges. As such, during the main planting season of 2011, the Ministry of Agriculture, the Agricultural Transformation Agency and the Regional Bureaus and extension system initiated a large scale trial of these new technologies (Vandercasteelen, Regassa, Minten, & Taffesse, 2018).

2.2. Teff production and its importance

Teff (the scientific name of teff is *Eragrostis teff* (Zucc.) is one of the most important native cereal grain species in Ethiopia both in terms of production and consumption. It has accounted for one-third of the cultivated area and one-fifth of the total production of all cereals grown in Ethiopia (Vandercasteelen, Dereje, Minten, & Taffesse, 2014). In Ethiopia, teff is mainly produced in vast areas of Amhara and Oromia and the total area covered by teff was 1,014,268 ha and 1,289,405 ha respectively and also with smaller quantities in SNNP and Tigray (CSA., 2011). There are 19 major teff producing zones in the country. The major teff producing zones in Amhara region are; East Gojam, West Gojjam, North Gonder, South Gonder, North Wollo, South Wollo, Norh Shoa and Awi zone. In Oromia region the major teff producing zones include the East Shewa, West Shewa, South West Shewa, North Shewa, East Wallaga, Horo Guduroo Wallaga, Jimma, Illubabor and Arsi Zone (Yang et al., 2017).

The length of growing period (LGP) ranges from 60 to 180 days (depending on the variety and altitude) with an optimum of 90 to 130 days. Teff is cultivated widely covers around 31 percent of the total annual acreage and 21 percent of the total grain production. A total production of

4.42 million tons is harvested from over a 3.02 million hectare of land. During the last 19 years the area coverage of teff showed a 59 percent increment (from 1.9 million ha in 1994 to 3.02 million ha in 2013) more than any other cereal crops. During the same period, production of teff increased from 1.86 in 1994 to 4.43 million metric ton, which is about 138 percent, while its productivity rose from 0.98 ton/ha to 1.46 ton/ha, which is almost a 50 percent increment (Zhai, Long, Taylor, Weckler, & Wang, 2020).

Teff is one of the consumable cereal crops in Ethiopia having multiple uses. Its most important use is to prepare injera (a flatten bread or pancake) which is the most popular food in the country. It is also used to prepare Anebaberro, “tella” and strong alcoholic traditional liquor *areke.* In recent times, western world is starting to use teff to prepare functional and/or gluten free food, products like teff breakfast cereals,

extruded products, teff waffles, teff banana bread, composite breads, pasta, malt drinks, cookies, biscuits and cakes. Another potential application of teff includes utilization in manufacturing of cosmetics and drugs (Zheng et al., 2022).

Row planting methods relatively resist lodging incidence than the broadcast sowing method. The benefits of row planting are increased yield and reduced seed cost, while labor costs are higher. It is assumed that the use of other inputs such as fertilizer is the same when implementing either row planting or broadcasting. Row planting requires additional labour for seeding and farmers need to construct rows and carefully sow the seeds in them (Oplinger & Philbrook, 1992).

Teff has contribution to the economy on production, creation of employment opportunity, consumption and access to foreign currency. Besides its use for consumption by over 50 million Ethiopians it is also exported abroad in the form of "injera" and brings foreign currency. The production of teff covers around 22 percent of area coverage, which is estimated around 3.02 million hectares and it produced by around 6.42 million households. The total production of teff valued as 4 billion USD in 2013/2014 which is the highest value in the country. On the other hand, the wholesale price of teff is higher than other crops. As a result, it attracts farmers for further production (Lanier et al., 2004).

There are two major types of teff farming practices in Ethiopia, which are; broadcasting and row planting. Teff planting with broadcasting method is considered as a traditional teff farming practice and it has a number of disadvantages like it need much amount of seed rate, reduces the productivity computation of soil nutrients and alike (Dusabumuremyi, Niyibigira, & Mashingaidze, 2014). By row planting or transplanting the seeds, land management and especially weeding can also be done more readily and the incidence of lodging is reduced. Row planting method is increased teff productivity, it requires small amount of seed rate but in reality it is labor intensive and requires mechanization issues due to the size of the seed is too small (De Bruin & Pedersen, 2008).

The efficient implementation of technologies to lead to higher yield benefits and lower labor costs over time requires some learning over time as the farmer get more familiar with the technology. The farmer were more intensively trained and assisted by extension agents on the correct implementation of the row planting technology. Implementing row planting becomes considerably more profitable for teff producer. Various teff planting techniques in more supervised and controlled settings found teff

yield increases under row planting at least twice those obtained when traditional broadcasting was used (Bruns, 2011).

2.3. The relation between technology adoption and productivity

Technology adoption is one way to increase the level of productivity. Different researchers used different methods and indicated adoption of new technology has a positive and significant impact on productivity. For instance, (Giziew & Mebrate, 2019) used difference in difference shows that full technology adopters got higher yield than non-adopter and partial adopters did. (Graterol et al., 1996), using a multinomial endogenous switching model found out those full package technology adopters got better income than both partial technology adopters and non-adopters; partial adopters got better income than non-adopters did. Likewise, using a multinomial endogenous model (Gulluoglu, Bakal, & Arıoglu, 2016) reported that on average, adopters of a combination of SAPs (Sustainable Agricultural Practices) had between 43% and 75% more income than non-adopters, with the package of improved maize and residue retention having the greatest income effect.

A study undertaken in Arsi zone with the objective of evaluating the impact of improved wheat adoption on the productivity of wheat through PSM and used the probit model to calculate the determinants of technology adoption (Negussie, 2020). He used cross sectional data and according to his study, education has significant and negative relation with the adoption decision of improved wheat. On the other hand, livestock ownership, sex of the household (when the leader of the house is male), wheat rust disease resistance had a significant and positive relation with the adoption decision of improved wheat varieties. Furthermore, the result of PSM shows that adopters of improved wheat are more productive than non-adopters. The income of improved wheat adopters is higher than non-adopters by 35 to 50 percent.

(Quintana-Ashwell et al., 2022), used stochastic Trans log to study the technical efficacy of improved teff and he used Cabb-douglas production function to evaluate the impact of high yielding variety on productivity. According to his study result, adoption of high yielding variety increases the productivity of teff by 10 percent. In addition, technical efficiency of sampled farmer who adopt a high yield variety was found to be 75percent. This shows that the productivity of teff could further increase by 25 percent, if the farmers could improve their technical efficiency. The level of technical efficiency is positively and significantly related with human capital (education, technical training, and cooperative membership), age, family size and gender.

(Raza et al., 2019) studied on the impact of multiple SAP adoption on the income of maize producing farmers in Southern Ethiopia by using multinomial endogenous switching model. Mohammed used 340 maize pots form Sidama Zone as a sample. According to his study result socio-economic factors, access to information, credit institution and plot characteristics determine the adoption decision of multiple SAP practices. His study also shows multiple SAP technology adoption have positive and significant impact on the income of maize farmers.

(Liu et al., 2012) studied about the yield and net benefit cost of different teff sawing method in Bedelle and Dhidhessa districts. The study compares the economic return from four methods, namely hand broadcasting method, ATA machine broadcasting method, row planting and transplanting method were evaluated. The yield obtained from the row planting was 42 percent higher than hand broadcasting method.

From the aforementioned literature, it is apparent that most of the studies proved as adoption of agricultural technology has a positive and significant effect on productivity. The rate of adoption is also determined by household's characteristics, farm characteristics, social and institutional framework. It is also comprehendible that most of these studies tend to evaluate the impact of single technology adoption on productivity by using PSM and OLS method. While farmers, most likely adopt more than one technology with the presence of interaction with their adoption decision. Besides, OLS method couldn't show the real impact of technology adoption on productivity since technology adoption decision has self-selection an endogeneity problem which make the OLS estimation biased.

The result of PSM also could not show the pure impact of technology adoption on productivity, since adoption decision is highly influenced by unobserved factors like skill, knowledge and other unobserved factors, which could not handle by PSM. Beside to this most of studies which evaluate the impact of multiple technology adoption on productivity give more focus on evaluating the impact of agricultural technologies on the outcome variable. However there is minimal literature which evaluates the impact of multiple technology adoption on the productivity of teff. To fill this gap the current study was done, these studies evaluate the impact of row planting technology adoption on household teff income by using endogenous switching regression model. Unlike PSM and OLS this model control for endogeneity problem which arise from both observed and unobserved factors.

Generally teff row planting technology is affected by a multitude of factors including both psychological and other situational factors. The conceptual framework for this

study was developed based on the theoretical models of technology in the previous sections. In the conceptual framework the different factors supposed to affect farmers‟ adoption behavior particularly those which contribute to the variations in application level of row planting among farmers were considered and teff yield from broadcasting and row planting with its input cost. The framework (Figure 1) emphasized mainly on the relationship of the explanatory variables with the dependent variable.

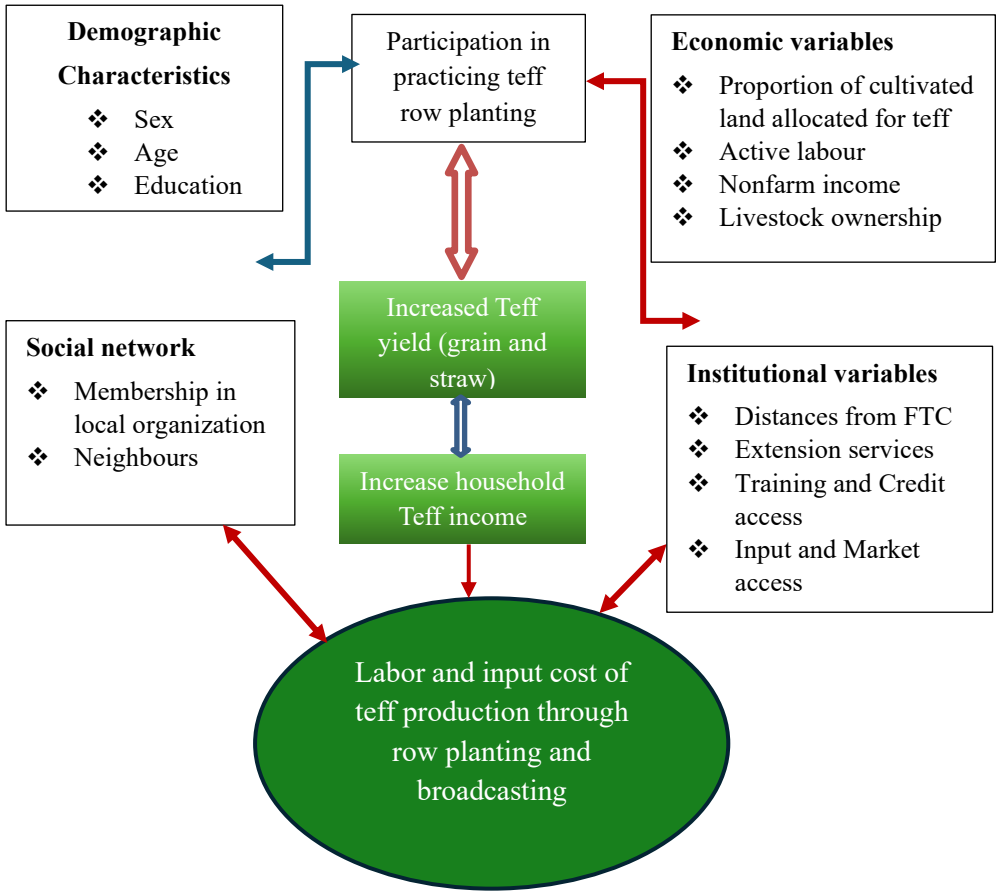


Figure 1. Conceptual framework

Sources: Own compilation based on literature

3. Methodology

This chapter presents description of the study area where the study is conducted, method of data collection including sources and type of data, sample size and sampling technique, method of data analysis and description of variables including the influence of independent variables on dependent variables.

3.1. Description of the study area

This study was carried out in north Shewa. There are 26 woreda in North Shewa zone. From these, the study was conducted on Merhabete Woreda. It is one of the Woreda in the Amhara region of Ethiopia and bordered on the south by Ensaro, on the west by the Oromia Region, on the north by Mida Woremo, on the east by Menz Keya Gebreal and on the southeast by Moretna Jiru. It is located 184km far from the capital city of Ethiopia which Addis Abeba. The Jamma River defines this woreda's southern and eastern boundaries, and its tributary the Qechene defines its western and northern part. Alem Ketema is the administrative center of this Woreda and other towns include in this woreda include Fetra. According to the woreda Finance and Economy Development office (2014), total population of 117,169, of whom 59,388 are men and 57781 are women.117,169, of whom 59,388 are men and 57781 are women.

Merhabete has an area of 1,058.19 square kilometer, a population density of 119.54, which is greater than the Zone average of 115.3 persons per square kilometer. A total of 29,916 households were counted in this woreda, resulting in an average of 4.23 persons to household and 29,075 housing units. The 1994 national census reported a total population for this woreda of 98,930 in 20,161 households, of whom 50,184 were men and 48,746 were women; 8,977 or 9.07% of its population were urban dweller. The largest ethnic group reported in Merhabete was the Amara (99.78%) and Amharic was spoken as a first language by 99.8%. The majority of the inhabitants practiced Orthodox Ethiopian Christianity, with 99.63% reporting that as their religion. The most commonly produced crops in this woreda are annual crops such as Teff, Sorghum, Wheat, Barley and bean as shown below in Figure 2.

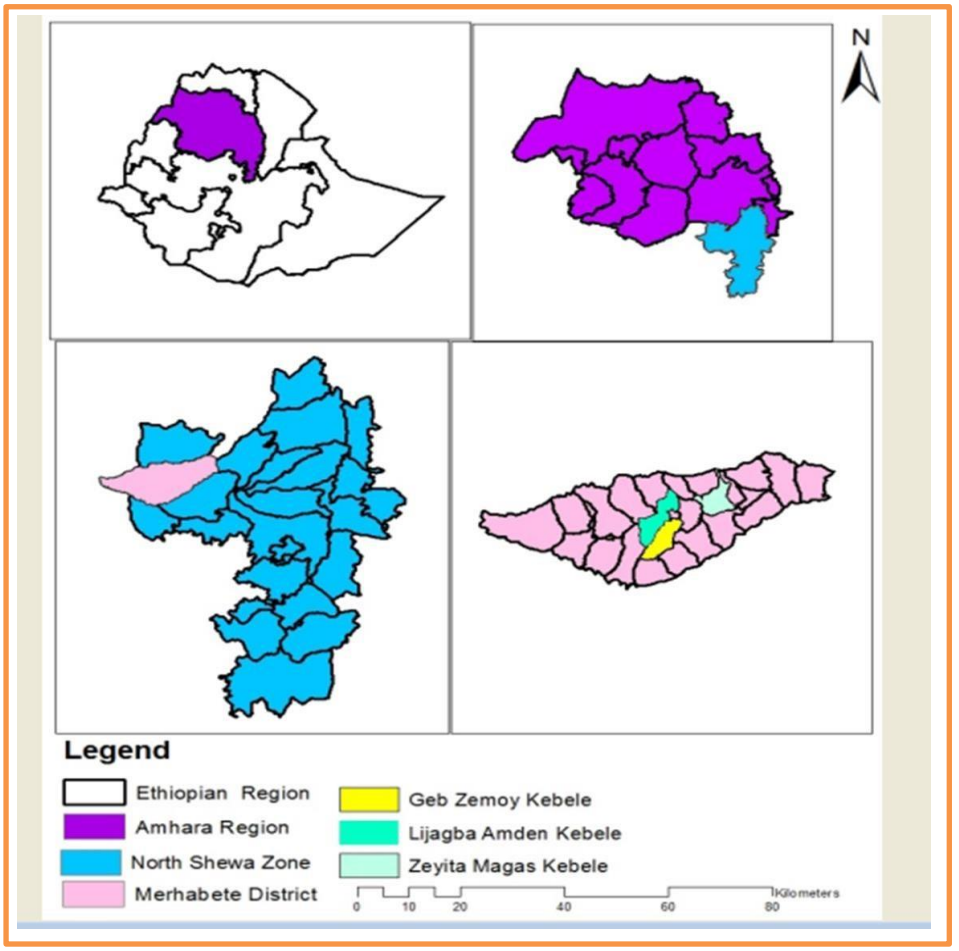


Figure 2: Location of the study area
Source: Drawn by using GIS

3.2. Method of data collection and sources of data

In this study, both primary and secondary data sources were used. From the primary data, both qualitative and quantitative data were collected from sampled households through interview schedule. Moreover, the study also used Focused Group Discussions (FGD), Key Informant interview (KII), Transact walk to supplement the data obtained using interview schedule. The questionnaires pre-tested before using the actual data collection in order to redesign the mode of it and find out the simplest way to collect data as well as to reduce the duplication of the question. Before the administration of formal survey, pilot survey was administered with enumerators, who have got training about how to collect the data. This helps to pretest the

developed questionnaire before starting the real or actual data collection system then the questionnaire were modified accordingly, which can reduce the unwanted questions from the questionnaire and to fit with the existing situation of the area under study. Secondary data was collected from different offices such as, North Shewa Zone and Merhabete Woreda offices of agriculture and from different official documents.

3.3. Sample size and sampling technique

This study was carried out in Merhabete woreda, where planting in line of teff is practiced widely and better than other woreda's in the administrative zones. To select sample respondents from the woreda, multi-stage sampling technique was employed. Before selecting household heads to be included in the sample, teff grower household heads of each rural kebele were identified in collaboration with experts from the program of crop production and protection of woreda offices of agricultural development, kebele leader, key informants and development agents of the respective rural kebele.

In the second stage from 24 kebeles three kebeles were selected based on their potential in teff row planting. Then households were stratified in to two strata, those households who use row-planting technology and those farmers who practice the traditional farming system. Then the sample respondents from each stratum were selected by using proportional sampling technique. Based on this multi stage sampling process a total of 230 households from all the 80 user and 150 nonuser of row planting were selected on proportional sampling basis from 3 Kebeles Namely (Lijagba Amden, Zeitamagas and Gebzemoy) of Merhabete woreda (Figure 3).

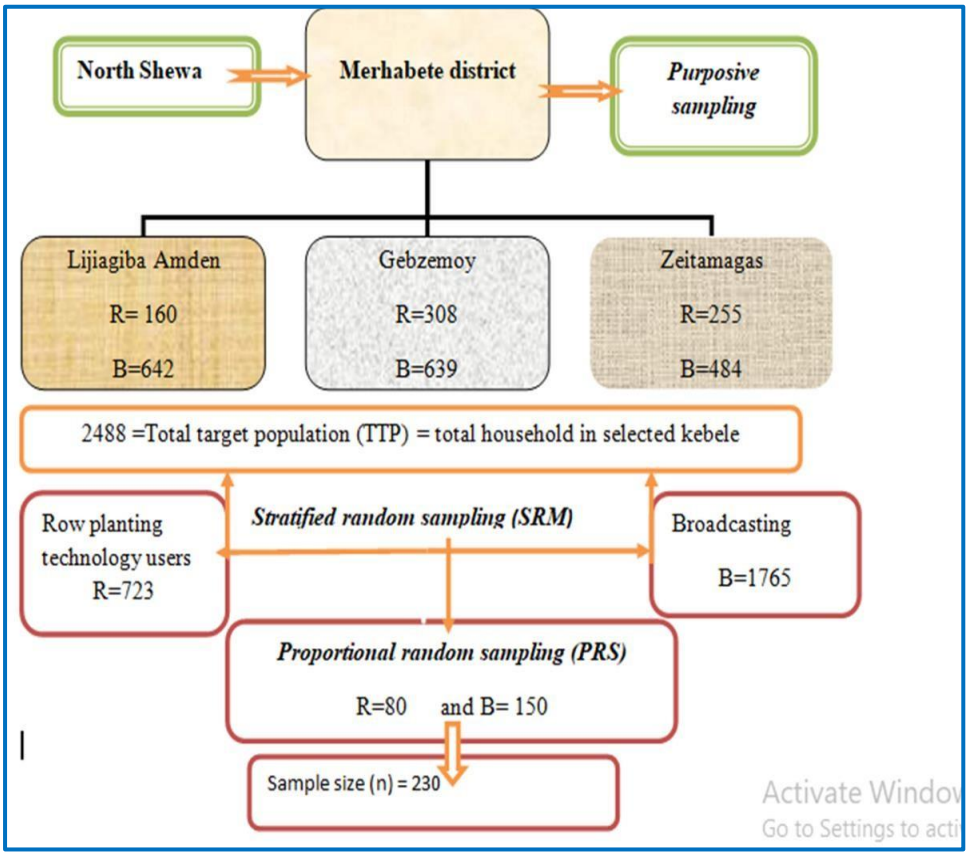


Figure 3: Sampling techniques and sample size determination

3.4. Sample size determination

In this study, to determine sample size, different factors such as research cost, time and human resource have been taken into account and the sample size is determined using finite correction factor formula.

$$n = \frac{Z^2 pq}{e^2}$$

Where,
n = sample size, Z = the confidence interval in standard error units
p = estimated proportion of success, q = (1-p) or estimated proportion of failure
e = the desired level of precision

To calculate a representative sample for proportions by assuming the maximum variability, which is equal to 29% (p =0.29) and taking 95% confidence level with ±0. 0586% precision, the calculation for required sample size was calculated as follows:

$$n = \frac{(1.96)^2 * 27 * 71}{(0.586)^2} = 230$$

Therefore, from the total household 230 respondents were selected and he sample contains both users and non- users of row planting.

3.5. Methods of data analysis

The main techniques to analyze the data were descriptive statistics, inferential statistics and econometrics model. The descriptive statistics were applied to discuss the situation of row planting, while the econometric analysis was used to analyze the impact of row planting of teff on household income by using Endogenous switching regression model and probit model were used to know the factor that affect the row planting. Qualitative analysis or qualitative narration was employed to analyze the results of focus group discussion and key informant interview.

The econometrics analysis is performed with the application of Endogenous Switching Regression Model (ESRM). In ESR model there are two stages, first the decision to use row planting (selection equation) is modeled by standard limited dependent variable models and second the outcome variables are then estimated separately for each group (as technology user and non-user), conditional on having the selection equation. Therefore, the selection equation is a dichotomous choice, where a smallholder farmer decides to use row planting when there is a positive perceived difference between having the technology and not having the technology. Consider a farm household i that faces a decision on whether or not to use row planting. Let the indicator variable be Ti taking a value of 1 for households who decided to use technology and otherwise. This leads to two possible states; a decision to use row planting (Ti=1) and not to use row planting (Ti=0).

Let‟s denote the benefits to the household of using row planting (U1)) and the benefits of the household not using row planting (U0). Under a non-random utility framework, a rational farm household will choose to use technology if the benefit of adoption is positive i.e. U1> U0 or U1- U0>0. Conditional on households‟ decision to use row planting denoted by a selection function (Ti), there are two potential

outcomes to the two population units: the outcome of the row planting user ($Y1$) and the outcome of the non- user ($Y0$). This can be put in a potential outcome framework as:

$$\text{Yi} = (1 - \text{Ti})\text{Yoi} + \text{TiY1i} \quad Yi = \begin{cases} Y1i \; if \; Ti = 1 \\ Y0i \; if \; Ti = 0 \end{cases}$$

The gain from the intervention is provided as $Y1 - Y0$. Hence, taking a simple difference and averaging cannot give the effect of the intervention, causing a „missing data" (Gozubenli, Kilinc, Sener, & Konuskan, 2004). Endogenous Switching Regression model have two procedures. In order to estimate the impact first, we have to know the farmer's decision to use row planting then we can establish actual and counterfactual outcomes.

Average Treatment for Treated (ATT): is the difference between the outcomes of the treated observations as a result of treatment and the outcome if they had not been treated (Gulluoglu et al., 2016). The average treatment effect on the treated (ATT) and untreated (ATU) were computed by comparing the expected values of the outcome of the row planting user and non- user households in actual and counterfactual scenarios. The estimates from endogenous switching regression allow for the computing of the expected values in the real and hypothetical scenarios: Following model estimation, Stata allows calculation of the following conditional expectations (Feng et al., 2019).

Actual expected outcome: for users

$$\text{E[Y1i|T = 1; x]} = \beta 1\text{X1i} + \sigma 1\rho 1 f(\beta)/F(\beta \text{Zi}) \qquad \textbf{(1)}$$

Actual expected outcome: for non-users

$$[Y0i \; |T = 0; x] = \beta_0 \qquad X0_i \; _ \; \frac{\sigma 0 \rho 0 (\beta Z_i)}{\{1 - (\beta Z i)\}} \qquad \textbf{(2)}$$

Counter factual expected outcome: for users

$$[Y \; |T = 0; x] = \beta \; X \qquad _ \; \frac{\sigma 1 \rho 1 (\beta Z i)}{\{1 - (\beta Z i)\}} \qquad \textbf{(3)}$$
$$0 \;\; 1i$$

Counter factual expected outcome: for non-users is

$$E[Y0i|T = 1; x] = \beta 1X0i + \sigma 0\rho 0f(\beta Zi)/F(\beta Zi) \quad \textbf{(4)}$$

Equation (Eq. 4) and (5) represent the actual expectations observed from the sample, while (Eq. 6) and (7) are the counterfactual expected outcomes. Given the above formulation, the following mean outcome difference can be calculated and compared. The expected change of Row planting users that means the average effect of treatment on the treated (ATT) is computed as the difference between Eq. (4) and (6):

$$\text{ATT} = [Y1i|T = 1; x1i] - [Y1i|T = 0; x1i] \quad \textbf{(5)}$$

Similarly, the expected change in the non-users, the effect of the treatment on the untreated (ATU) is the difference between Eq. (5) and (7):

$$ATU = [Y0i|T = 1; x0i] - [Y0i|T = 0; x0i] \quad \textbf{(6)}$$

The treatment effects can be differentiated from the heterogeneity effect because the presence of unobservable characteristics. Therefore, "the effect of base heterogeneity" $BHu$for the group of households that decided to use row planting is defined as the difference between (Eq.4) and (Eq.7):

$$BHu = [Y1i|T = 1; x] - [Y0i|T = 1; x] \quad \textbf{(7)}$$

Similarly, "the effect of base heterogeneity" BHN for the group of households that decided not to use row panting is defined as the difference between (Eq.5) and (Eq.6)

$$BHN = [Y1i|T = 0; x] - [Y0i|T = 0; x] \quad \textbf{(8)}$$

Finally, the effect called "transitional heterogeneity" (TH), estimates whether the effect of having row planting is larger or smaller for households that use row planting or for the households that did not use in the counterfactual case that they did use. It is the difference between (Eq.8) and (Eq.9), i.e. (ATT) minus (ATU)

$$TH = \text{ATT} - \text{ATU} \quad \textbf{(9)}$$

3.6. Description of variables and working hypotheses

The description of variables is presented below (Table 1) with expected income on the dependent variable.

Table 1: Summary of independent variables and their expected effect on the dependent variable.

No	Variables	Definition	Measurement	Expected effect on DV	
				Participate in teff row planting	Household income
1	Sex	Sex of household head	Dummy	+/-	+/-
2	Age	Age of household head	Continuous	+/-	+/-
3	Edctlevel	Education level of household head	Dummy	+	+
4	Adltlbr	Active labour force	Continuous	+	+
5	Landsize	Cultivated land size	Continuous	+/-	+
6	Tlu	Tropical livestock unit	Continuous	+	+
7	Extenserv	Provision of extension services	Dummy	+	+
8	Credtaccss	Access of credit	Dummy	+	+
9	Training	Training about row planting	Dummy	+	+
10	Nonfrmincm	Nonfarm income	Continuous	+	+
11	Neighbor	Neighbor application	Dummy	+	
12	Dist acftc	Home distances from FTC	Continuous	+/-	
13	membership	Membership for social capital	Dummy	+ +	
14	Mkt acceses	Access of market information	Dummy	+ +	

4. Result and Discussion

4.1. Descriptive analysis

Education is one of a crucial factor in influencing the decision to adopt new technology. This is attributed to the fact that household heads that can read and write would be expected to better visualize the benefits of technology suggesting creates awareness and helps for better innovation and invention. In the study area, from the total sample households, greater proportion of household heads (52.6%) were literate at least they can read and write (47.4%) were illiterate; they couldn't read and write (table 2). The comparison by row planting reveals that, 27.50 % of RP user and 58% RP of non-user were illiterate whereas, 72.50% of RP user and 42 % non- user were literate. The chi square result reveals that in terms of education level of household there was significance differences between two groups.

Credit obtain either in the form of cash or non-cash form from governmental or non-governmental organization is the main source of finance for poor farmer to purchase input and ultimately to adopt new technology. The main source of credit in the study area is micro finance institute Amhara Credit and Saving Institution (ACSI). Moreover, non-formal credit sources includes; relatives, friends, local money lender, local community insurance (Idir) or rotating savings and credit associations (Equb) are also providing micro credit services to the community. In case of credit, utilization purposively for teff producer the survey result revealed that 78.26% of the sample households were not utilized formal credit due to various reasons, while 21.74 % of the sample households take credit. The comparison by user in row planting disclosed that about 32.50 % user and 16% non-user take credit. From user about 67.50 % of the sample respondents and from the non -user 84 % households said that they don't want credit (because of self -reliance) and the rest complained about high interest rate.

Extension service refers to advice, training, demonstration, distribution of input and gives greater technical support for smallholder farmer. In the study area, the extension service given by development agents happened to have positive and significant effect on the probability of a household decision to use row planting. From the total sample households 57 % had extension service, while the remaining 43% does not have (Table 2.). When we compare user and non-user households „majority of the user households get support from extension agents when compared to non -user. According to the survey about 97.5 %user and 35.33% non -user obtained extension service. About 78 treated group and 53 control groups consult

extension agents whenever they need technical advice related with farming activity. From the respondent about 2.5 % of the user but, applied this technology by the help of information gathering from neighbor regarding with the purpose of RP that is income generation and 64.67 % non –user reply they do not get extension service recognizing the technology. There was a significance difference between two groups with respect to extension contact.

Access to market information is a determinant of sustainability and profitability of agricultural produce. Distance to the nearest market is another important influencing variable because markets are main source of information. The nearest to the market, frequency of contact that the smallholder farmer maintains with it can may influence the user of new technology. In addition it is the center where purchase of inputs and the farmers sale to their products. The survey result indicated that from the total respondents 53.48% get access to market and 46.52% had not get it. 52.50% and 54.00 had not get market access for user and non-user respectively. But 47.5% and 46% had get market access for user and non -user respectively.

Table 2: Summary of descriptive statistics for discrete variables by row planting

Variables Categories		user (N=80)	Non-user (N=150)	Companied	x2-value
		Freq. (%)	Freq. (%)	Freq. (%)	
Sex HH	0=female	13(16.25)	34(22.67)	47(20.43)	1.3212
1=male		67(83.75)	116(77.33)	183(79.5)	
Edctlevel	0=illiterate	22(27.50)	87(58.00)	109(47.39)	19.4669***
1=litrate		58(72.5)	63(42)	121(52.61)	
Neighbour	0= not friend	48(60)	103(68.67)	135(58.70)	17.6850***
1=have friends		32(40)	47 (31.33)	95(41.30)	
Mktacceses	0=no	42(52.5)	81(54)	123(53.48)	0.0472
1=yes		38(47.50)	69(46)	107(46.52)	
Training	0=no	12(15)	115(76.67)	127(55.22)	80.236***
	1=yes	68(85)	35(23.33)	103(44.78)	
Membership	0=no	13(16.25)	83(55.33)	96(41.74)	32.7730***
	1=yes	67(83.75)	67(44.67)	134(58.26)	
Credit	0=no access	54(67.5	126(84)	180(78.26)	8.3490***
	1=access	26(32.5)	26(16)	50(21.74)	
Extenserv	0=no access	2(2.5)	97(64.67)	99(43.04)	82.2466***
	1=access	78(97.5)	53(35.33)	131(56.96)	

Note: *, ** and *** represent significance at 0.1, 0.05 and 0.01 levels respectively. Source: Computed from own survey data

4.1. Comparison of the level and source of income

Agriculture and non-agricultural activities were the source of income in the study area. Planting of teff in row is expected to increase farm income. Mostly, in the study area, cash crops such as teff, vegetables, fruits, oil seeds and others are growing. The t-test reveals that user of row planting technologies has a significant difference between two groups with different source of income. The survey result revealed that the mean of other crop income of the user was ETB 2712.072 higher than non-user. (Table 3)

Livestock is important source of income in the study area. The mean sale of livestock and livestock products of user was ETB 3868.694 higher than non-user. Similarly, non-farm activities are also the source of income in the study area. Non-farm activities were (like livestock trade, carpenter, etc.). The mean annual non-farm income of the user was ETB 1191.975higher than the corresponding figure of non-user. The mean annual income of teff crop 12816.82 higher than non- user. Finally, the row-planting user had ETB 20589.56 higher total annual mean income compared to non-user. The mean difference between the two groups with respect income was significance differences between two groups. Hence, the descriptive result analysis suggests that the RP user households have earned more income on average than the non-user.

Table 3: Household income: mean comparison results

Income gain from	User N=80)	Non-user (N=150)	Combined	Difference	t-value
	Mean	Mean	Mean	Mean	
Livestock and	9991.587	6122.893	7468.526	3868.694	-2.0899
Livestock product	(1123.736)	(269.0063)	(443.9112)	(898.2538) ***	
Teff income	52278	39461.18	43919.2	12816.82	-3.0418
	(1607.528)	(1373.23)	(1128.276)	(2217.197) ***	
Other crop income	13850.03	11137.95	12081.28	2712.072	-3.1362
	(383.3792)	(338.7992)	(271.3491)	(541.9876) ***	
Nonfarm income	4131.475	2939.5	3354.1	1191.975	
	(266.5874)	(285.6261)	(211.077)	(437.078)**	-1.9713
Total income	80251.09	59661.52	66823.11	20589.56	
	(2035.704)	(1501.591)	(1368.937)	(2537.333)***	-5.7806

Note: the attics *** represent significance at <1% levels and the values in the parenthesis are standard errors of the mean.

A very high labor cost gap between the two teff seeding methods was exhibited on seeding, weeding and threshing activities. Through broadcasting method since most of the area of the farm land was covered by seed with minimum opening space left as a result weeds had less chance of growing due to this, difficult to weed and compute the crop nutrients and reduce the teff yield. While with the application of row planting method large open space intervals of the farm land left between row lines which aggravated the germination of high amount of weed growth suitable for weeding and easy to differentiate from teff and consequently reduces computation of crop nutrients as a results of this increases teff yield. From the review the labor input for weeding is expected to decrease as row planting should make weeding easier (Mossie, 2022) and (Mehta, 2024).

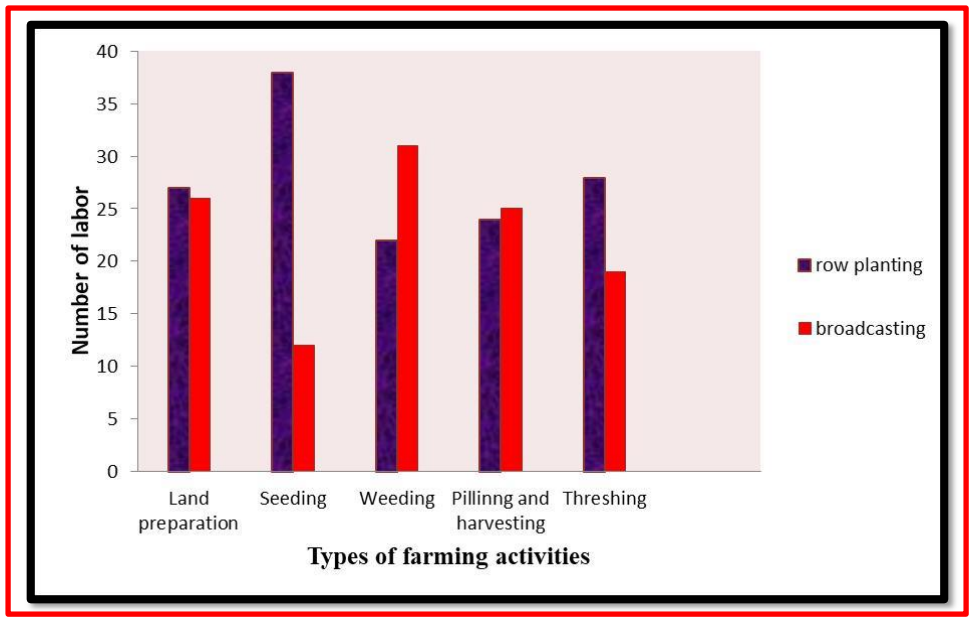


Figure 4: Utilization of labor in row planting and broadcasting

The total labor requirements for row planting are significantly higher than for broadcasting. The total labor input to produce teff crop when the seed is broadcast 113 person labor, while Implementing row planting is require an additional total labor input of 26 person which is 139 person. The total labor cost of row planting is 11815 birr per hectare while broadcasting method of teff production requires a total of 9605 birr per hectare for production labor cost. The labor cost of row planting method is by 18.7% larger than the traditional broadcasting method of teff

cultivation, as the result traditional teff production method has less labor expense mainly on threshing and seeding farm activities while teff production through application of row planting method requires high labor cost on the same farming practices. Hence, in conclusion due to its high labor cost farmers, with low purchasing power and small household size were not willing to adopt row planting method of teff production (Figure 4).

4.1.1. Teff grain and straw yield through row planting and broadcasting

Teff grain productivity partly and mainly depended on the type of production system applied. In broadcasting method of planting the average teff grain yield obtained per hectare of land was 14.99 quintals /ha and through row planting production technology on average 24.3 quintals/ha. This was much better than the amount of yield achieved through broadcasting method. According to the data obtained from focus group discussion, the yield of teff straw produced through broadcasting in quantity was much less than that of produced through row planting method, although due to its high quality for animal fodder and construction material. It accounts for 45 man load (ML) straw locally *chid* and from row planting 61 man load straw were obtained per hectare. The amount of teff straw yield achieved through row planting was very high in quantity but its value was very low compared to that produced using broadcasting.

From this data, it can be concluded that yield of teff grain produced through row planting technology is much higher than that produced through the traditional broadcasting method while yield of teff straw obtained through row planting technology is much higher in quantity than it is produced through broadcasting method. However, in terms of quality teff straw produced by using broadcasting method is more valuable in its usage for livestock fodder and construction material than that of produced using row planting.

Finally, the total labor cost of both row planting and broadcasting teff production technologies shows significant difference, it means that in terms of labor cost the application of row planting technology is very expensive. This has negatively affected the farmers‟ user level of this new modern teff production technology. This appears on the very beginning of farm practice, therefore farmers easily loss hope in its application and also the input cost difference between the two technologies also significantly difference. From the group discussion results the respondents said that except the labor cost, row planting is profitable than broadcasting method. The output

of row planting technology is much higher than broadcasting method, if it is properly applied except the amount of teff straw production quality.

4.2. Econometric results

4.2.1. Factors affecting participation of teff row planting

In this study probit model was formulated. It is used to find out the main determinants of smallholder farm households‟ decision to use row planting. We treat results concerning teff crop income at household level as well as the socio economic, demographic and other factors that affect the teff crop income behavior of households. The parameter estimates of the probit model provide only the direction of the effect of the independent variables on the dependent variable estimates do not represent the actual magnitude of change or probabilities. Thus, the marginal effect from the probit, which measures the probability of being user with respect to a unit change in an independent variable, was computed using the mfx stata command. The estimates of user decision show a good fit with over 77% of the observation correctly predicted.

The output for the probit model shows that user of row planting equation shows that nine variables determine the probability of participating in row planting technology. Variables include tropical livestock unit, adult labor, home distance from FTC, land size, level of education, training about row planting (Training), membership in social institution, contact extension agents and neighbor user in row planting significantly affect the row-planting user as stated by (Mehta, 2024. The marginal effect results provided in table 4 below shows that, Teff row planting technology is labor-intensive method of production; households with large productive labour size were able to provide more number of labor assistance from the family member and this result agrees with the findings of (Negussie, 2020) and (Mihretie et al., 2021). Because of this among the user of the newly introduced teff seeding technology most of them had large family size. Adult labor has statistically significant effect on the decision to use row planting. Moreover, the coefficient is positive indicating adult labor increases the probability of being row-planting user (Giziew & Mebrate, 2019).

Training is one of the most essential extension methods used to transfer information, knowledge and skills for improving traditional farm management practices. Based on the information displayed on farmer who adopt row planting on farm size received training on preparation and application of water plastic bottle seeder obtain training about the technology in the FTC (Mihretie et al., 2021) and (Mehta, 2024). Therefore,

user has better number of access to training in application of plastic seed. Thus, farmers who have adopted in training about the management and application of new technologies are more likely adopt the technology than those who are not adopted in training. In this study, there is a significance difference between user and non-user. This result is supported by the findings of (Giziew & Mebrate, 2019) and (Negussie, 2020).

Farmers experience on extension service and access to updated information leads the probability of adopting new technology, since they can use the resources wisely with proper management of input for better production and productivity(Yang et al., 2017). Moreover, this finding is the same with frequent contact with extension has a positive and significant relation with the adoption decision of farmers (Lyon et al., 2009).

Livestock holding in TLU had positive and significant effect on the probability of household's decision to use row planting. In this study, the results indicated that if the household head have many TLU makes him or her possible to participate in row planting of teff crop. The main reasons are household head that have many TLU obtain high income. It has positive contribution to households participating in row planting of teff as stated by (Zheng et al., 2022).

Respondents having friends and neighbors who are users of row planting is a good way to get information and support on technology adoption. The farmers who have neibours adopt in row planting increase the user in row planting relative to those who did not have yet. It is statically significant at 5% significance level. The farmers have neibours influences of row planting. From the review, in any technology user process, peer effects work in three major ways: 1, individuals gain profit from acting like friends/neighbours, 2, individuals gain knowledge of the benefits of the technology from their friends and 3, and individuals learn about how to use a new approach from (Gulluoglu et al., 2016). The farmers who far from the FTC decrease the use of row planting because of longer distance not attained training about row planting. When household's home is closer to the farmers training center the probability of participating in row planting technology increases. From the result, we can conclude that those households who are situated in nearby places do quickly decide to participate in the program because the extension contact is better. The results of focus group discussion the respondents told that the distance of FTC is far from the house of farmer decrease user in new technology as stated by the result of (Janovicek, Deen, & Vyn, 2006).

In this study education is statistically and positively significance for row planting. The household heads that can read and write would have better visualization to the benefits of technology suggesting creates awareness and helps for better innovation and invention. Similarly, the previous studies found positive relationship between education and user of technologies (Lyon et al., 2009). The regression analysis shows that the literate households were better participating in row planting of teff.

In this study land size significantly affect the application of row planting, means that the farmers who have small land size and suitable setting of land, increase the application of row planting. Because row planting technology appropriate for suitable setting of land. The respondents told that having small land size with suitable setting increase the use of row planting technology and improve their production. Due to the case of labor intensiveness, the farmers who have large land size with small adult labor of poor farmers negatively affect the user of row planting. This study is in line with (Mehta, 2024), quality of land has positive and significant relation with the adoption decision of agricultural technology (Figure 4).

Table.4: Estimation results of probit model and its marginal effect

Variables	Probit estimation coefficient(s.e)	Marginal effects(Dy/dx)Coefficient (s.e)
Nibours	.5266958(.1730414)***	.0759712 (.03171)**
Mktacceses	.0468471 (.3659088)	.0067736 (.05309)
Exteservice	2.800148(.6594686)***	.41123544 (.08005)***
Distacftc	-.0384512 (.0157908)**	-.0055462(.00306)*
Nonfarm	.0000218 (.0000157)	3.14e-06 (.00000)
Training	1.782574(.430694)***	.3161488 (.11052)***
Membership	1.406401(.4352375)***	.188265(.07951)**
Landsize	.5714012(.176794)***	.0824196(.04206)**
Famsize	.3796815(.1417681)***	.0547657 (.02886)*
Edctlevel	1.165026 (.427101)***	.17027(.08199)**
Tlu	1.132264(.3046165)***	.1633191(.07694)**
Sex	.204811 (.4444152)	.0271051(.05447)
Age	.0134177 (.0312572)	.0019354(.00449)
Cons	-8.397058(2.84464)***	-9.67856(1.932164)***
LRchi2(15)=229.88	Number of Obs=230 Prob > chi2 =000	
Pseudo R2 = 0.7735 Log Likelihood=33.66		

Note: the attics *, **, and *** represent significance at 10%, 5%, and <1% levels respectively and the values in the parenthesis are standard error of mean.

The membership of household heads in local organizations like edir, equb had a positive influence on the farm households decision to adopt on row planting technology (due to incensement of society relationship, exchanging and sharing of information about the new technology. In this study membership in social capital, positively and statistically affect the user in row planting (Raza et al., 2019).

The impact of teff row planting on household income

The main objective of this study is to show if there is any considerable contribution and impact of row planting on household income. To this end, teff income was one of the indicators of this study; estimated using the selection equation as bases of separation across the two groups of households (users and non-users). The estimation was carried out by using ESR model with full information likelihood (FIML) procedure presented in (Table 4).

The results of the selection equation are reported in the section of the output headed "select". The results of the teff income (Y) regression in the row planting technology (RPT) user farmer are reported in the "lnY_1" section and the (Y) regression in the non- user farmer is output in the "lnY_0" section. The variables sigma, /lnsl, lns0, /rl, and /r0 are supplementary parameter R used in the maximum likelihood procedure. Sigma 1 and Sigma 0 are the square-roots of the variances of the residuals of the regression part of the model and lnsig is its log; whereas rho_l and rho_0 are the transformations of the correlation between the errors from the two equations. As the result shown in Table 5, the likelihood ratio test result suggests that the three equations are jointly dependent, providing evidence of indigeneity that needs to be controlled in the model specification of teff income equations.

An important question is whether farm households that use the row planting technology (RPT) gained benefits in terms teff income (estimating impact of RP). The expected average teff income (E (Y1|T = 1)) are ETB 52151.45, while the non-user of RP average teff income (E (Y0|T= 0)) are ETB 39462.94.The observed difference in income between households who use and do not use RPT was ETB 12688.51 ((a) - (b) in Table 4.9). Hence, the average teff income to user for the average treatment effect on treated (ATT) is ETB 10818.99per year. However, this simple comparison is misleading because it does not account for other unobserved factor that RP may have affected the outcome variables (teff income). Hence, to account for the potential unobservable effect on the outcome variable is included, which adjusts the „base heterogeneity (BHn) and gives the differences in expected household teff income. With the counterfactual condition that, the non-user of RP

placed in the user status BHn=BH1=ETB 10946.15 (in Table 6); the households would be expected to earn teff income ETB 10946.15 teff income on average. This result agrees with the findings of researches conducted by (Mehta, 2024; Tamirat, 2020; Vandercasteelen et al., 2014; Vandercasteelen et al., 2018)

Table 5: Full information maximum likelihood (FIML) estimates of the ESR model.

Outcome equation(Teff income)						
Independent Variables	**Non-Participant of RPT(Y0) Coefficients(SE)**		**P>|z|**	**Participant of RPT(Y1) Coefficients(SE)**		**P>|z|**
Inland	.9935997	.0061626	.000	.0450647	.0350502	.0199
Tlu	.0027869	.0016401	.089	.1052351	.0172253	.000
Me	.0011488	.0007677	.135	.0035427	.0068485	.605
Agsqre	-.0000962	.0002103	.0647	-.0189702	.0033825	.000
Cons	8.978208	.0176566	.000	11.10615	.2368965	.000
/lns0 | -4.221987.	057952	-72.85***		sigma0 | .0146695	.0008501	
/lns1 | -2.300463	.0798182	-28.82***		sigma1 | .1002124	.0079988	
/r0 | .6225984	.2289232	2.72***		rho0 | .5529346	.158933	
/r1 | .9282042	.4562044	2.03**		rho1 | .7297555	.2132559	
Number of obs = 230	Prob > chi2 = 0.0000 LR test of indep. eqns.chi2 (2) = 6.29 Prob > chi2 = 0.0431					
Log likelihood = 474.54937	Wald chi2 (4) = 146650.23					

Note: the attics *, **, and *** represent significance at 10%, 5%, and <1% levels respectively and the values in the parenthesis are standard errors of the mean (SE).

Similarly, with the counterfactual condition that the user households placed to non-user status in RPT is equal to BH2= 1869.519 in Table 5. the households would be expected to earn teff income ETB 1869.519 less teff income on average but the t-value is not statistically significant hence there is no significant difference in teff income for non- user households and their counterfactuals. Under the first counterfactual conditions, the user households perform better than non-user household's does. These differences reflect systematic sources of variation between the two groups that could not be fully captured by the observable variables in the model specifications. Information regarding user status alone does not explain households‟ performance in the outcome indicators (Y-income). This result is

supported by the findings of (Fikire & Asefa, 2023; Gozubenli et al., 2004; Gulluoglu et al., 2016; Mehta, 2024) and (Mehta, 2024).

Table 6: Average expected teff income for user and non-user of row planting technology

	User[2]	Non- user[3]	
User Households in RPT	(a) 52151.45 (1560.78)	(c) 41332.46 (1633.34)	ATT =10818.99(2259.166)***
Non-User HH in RPT	(d) 41205.3 (1075.998)	(b)39462.94 (1375.661)	ATU = 1742.361 (1746.487)
Heterogeneity effects	BH1 = 10946.15 (1862.658)***	BH2 1869.519 (2230.014)	= TH = 9076.629

Note: TH= ATT- ATU = BH1- BH2

Notes: The attics; *** represent significance at <1% level and the values in the parenthesis are standard error of the mean

From the above table (a) and (b) represent observed expected teff income; (c) and (d) represents counter factual expected teff income.

Overall, the results suggest that non-user farmer achieve significantly lower teff income than user farmer. Furthermore, using relative figures, that is, non-user, farmer have approximately on average 24.08% (ETB 12688.51) lower teff income per year than user households, without considering the unobserved factor. However, with considering unobserved factor non-user, approximately on average 20.75% lower teff income per year than user. That means with considering unobserved factor user, approximately on average (10946.15)20.75% higher teff incomes per year than non-user households. This result is supported by (Mehta, 2024; Mossie, 2022; Negussie, 2020) but contradicts with the findings of (Quintana-Ashwell et al., 2022).

5. Conclusion and Recommendation

5.1. Conclusion

This study aims at analysis of the impact of teff row planting on rural household income in case of Merhabete woreda, Amhara Regional state, Ethiopia. A total of 230 households (80 users and 150 non-users) were used to collect the data with

survey questionnaire to generate the necessary variables. A mixed methods approach was employed, combining qualitative and quantitative data-collection tools: household survey, expert and key informant interviews, Focus Group Discussion (FGD). To capture the impact of the RPT on household income (teff income) were evaluated at a market price during the survey period). The first stage decision (whether to participate or not) was estimated using the probit model. To measure the impact of participation in RP for the rural household teff income the researcher used an ESR model, which considers selection bias associated with the endogeneity of program participation as well as self-selection often encountered in most program evaluations.

The result shows that the estimation of participation decision show a good fit with over 77% of the observation correctly predicted. Variables include Tlu, family size, and home distance from FTC, Land size, level of education, Training, contact extension agents, Membership in social network and Neighbor user in row planting significantly affect teff row planting technology. The finding of the study also shows the estimated coefficients of correlation between the participation equation and the outcome equations (teff income) were statistically significant. This implies that bias would have resulted in the income function had it been estimated without correcting for selection bias associated with program participation in the study. The endogenous switching regression technique allows us to control for unobserved factors, such as confidence, the farmer's motivation and ability, which are likely to affect both participation in RP and the outcome of interest. On average teff income of participant group is (10946.15)20.75% higher than non-participant groups.

5.2. Recommendation

Based on the results of this study, the following points are presented as recommendations in order to improve the use of row planting and revenue gained from row planting technology in the process of teff production.

- It is better to encourage row planting technology adoption because the results of this study signify that teff row planting technology, increase both the teff yield and income of adopters.
- The most important problem in practicing teff row planting is its labor requirement for teff planting and threshing is higher. Thus, immediate demonstration of available technologies and practices that help reduce work burden on farmers is essential. These include testing and promotion of

technologies such as effective types of row seeder and thresher machine it will minimize the costs of planting, threshing and increase teff yield.

- DAs should provide farmers with more practical trainings under farmers‟ direct participation in the demonstration centers.
- The availability of the education, active labor forces, suitable land size and home closer distances to the farmer training distances measures into the picture of technology adoption, therefore, could enhance the number of adopters and the cropped area under row planting technology. Hence, expansion in the technology adoption would consequently result in substantial agricultural productivity and income on a sustainable basis.

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Potential Capacity and Challenges of Economic Growth in Ethiopia Under Macroeconomic Instability

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Abstract

The leading sector of an economy and macroeconomic stability are crucial guiding principles of economic growth and development in a broader context. Having this assertion, we aim at investigating the economic growth in Ethiopia under macroeconomic instability spanning over the period 1992-2024 using a non-linear asymmetric autoregressive distributed lags (NARDL) model. In this dynamic context, empirical findings of the study indicate that there are statistically significant effects of the growth rate of the agricultural sector on economic growth both in the downward and upward movements. There is also a bi-directionally Granger causality between the economic and agriculture growth rates in the positive upward movement direction. This entails the nonlinear asymmetric model explicitly revealing the effects of the main driving factors from the positive movement. However, macroeconomic instability has an adverse effect on economic growth. Therefore, based on the findings, we recommend emphasizing the need for more efficient resource allocation to agriculture with greater focus on strengthening the sector as an essential primary driver of growth leading to ensuring sustained economic growth and development in Ethiopia. Furthermore, by reducing macroeconomic instability, the government can also achieve targeted economic growth in the long run. With improved access to technology and better agricultural policies aiming to boost the agriculture sector's contribution to overall economic growth as it offers great potential for creating jobs and increasing value-added exports.

Key words: Economic Growth; Non-linear Asymmetry; NARDL; Agriculture Sector
JEL Classification: C10, E62, F62

1

1. Introduction

One of the most striking insights into economic growth is an examination of whether a country understands the benefits and utilizes its economic resources. Ethiopia has significant potential resources for sustaining economic growth that leads to development. The potential growth could be driven by a massive young workforce as the country is one of the most populous nations next to Nigeria in Africa. It may possibly present increased productivity when adequate jobs and skills training are provided. Nowadays Ethiopia has a very "large number and dynamic segments of young population that has untapped potential to double, triple; even quadruple in production and productivity of the agricultural and manufacturing sectors"(EEA, 2021:2). In addition to human resources, Ethiopia possesses immense natural resources endowment including extensive agricultural land, a variety of large livestock and precious minerals like gold, growth potentially may perhaps be considered if they are utilized effectively and the already historical track record of high economic growth. High growth rate in Ethiopia averaging about 10 percent per annum during 2004-2019 was supported by large public investments in infrastructure according to African Development Bank (2022). The public investments in physical infrastructure such as energy generation from the Grand Ethiopian Renaissance Dam (GERD), and establishment of several industrial parks have laid a foundation for future industrialization making economic sustainability, by attracting foreign direct investment towards the country. On top of these, the UN (2024) Technical and Statistical Report enlightens that Ethiopia has made significant socioeconomic progress in the past two decades through public-led investments in economic and social infrastructure.

Economic structural transformation and sectoral diversification are key priorities for sustaining economic growth. The ongoing "homegrown" economic reforms, a transition to a more flexible exchange rate system and efforts to modernize monetary policy aim at stabilizing the economy is another sort of growth promise in Ethiopia. These entail unlocking external financing of the economy from the partners such IMF, World Bank and other international organizations. The sectoral diversification in the process of growth leads to a gradual economic status shifting from an agriculture-dominated to industry, then, services sector. There is evidence that countries become rich by diversifying activities beyond agriculture products through structural transformation, so the speed of structural transformation does matter. For instance, the reallocation of productive inputs from agriculture to other sectors

between 1950 and 1962 resulted in a significantly outperformed GDP of the U.S over the United Kingdom (Denison, 1967). The structural change played an important role in driving economic growth dynamics of OECD including the U.S (see Caselli & Coleman, 2001; Peneder, 2002; Dietrich, 2012) is another indicator. Nevertheless, the Ethiopian economy has undergone a structural change differently, with a declining trend in the contribution of agriculture to GDP and the industrial sector remains unchanged while the growth of the economy has been led by the service sector since 1991.

Despite certain dynamism, the pace of growth has gradually slowed in recent years due to overlapping shocks from internal conflict and instability, the COVID-19 pandemic and global geopolitical tensions. The growth itself in Ethiopia has been driven by the expansion in services and a boom in construction, with the contribution of agriculture to GDP and employment creation continuously declining, but the contribution of manufacturing to overall growth and employment has remained low (African Development Bank, 2022). Even though Ethiopia's economy grew at a double-digit rate over the period 2003 – 2017, several challenges emerged include stagnant in export capacity, high debt relative to GDP, massive youth unemployment, and rampant inflation rate have put into question on the possibility of sustaining the growth rate and transitioning the country into a middle-income (Mengistu, 2021).

Political and macroeconomic stabilities are extensively recognized as fundamental determinants of sustainable economic growth. However, potential capacity of the Ethiopian economy to grow has been severely constrained by these stabilities. For instance, the challenges posed by macroeconomic instability acts as a significant preventive in realizing growth sustainability could be primarily through persistent high inflation, chronic foreign exchange shortages and high government debt distress relative to GDP (see Meno, Sheikh, & Mosissa ,2025; Mengistu, 2021). Even though Ethiopia has implemented various institutional reform initiatives aimed at fostering economic growth, the progress and rate of acceleration have not been associated with fostering a sustainable economy. Sustainability possibly will be implemented and succeeded on the ground of economy-wide productive capacities, diversification, value-addition and achievement of the overall structural economic transformation. However, macroeconomic and sectoral policies couldn't prioritise structural economic transformation, and competitiveness as tools for ensuring sustainability progress towards long-term consistent with the objectives of the 2030 Agenda for Sustainable Development and the African Union's Agenda 2063 (UN 2024). The macroeconomic mismanagement and political instability adversely influences

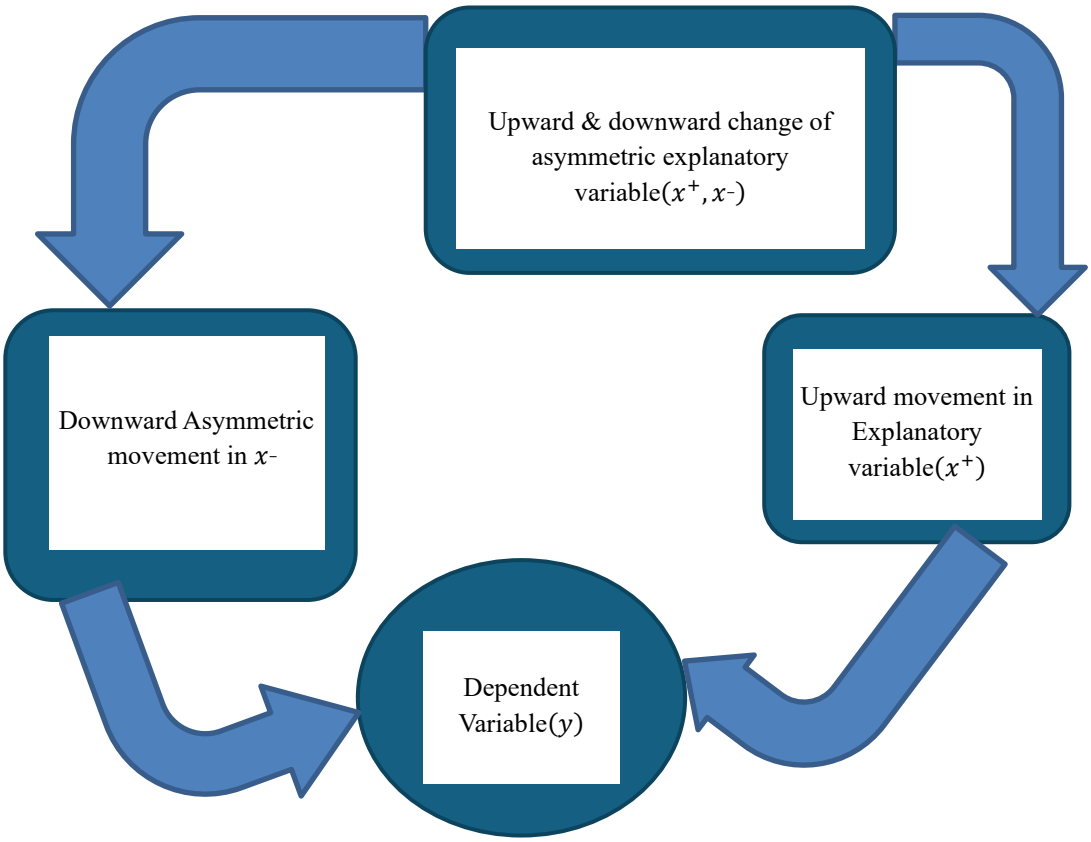
economic growth (Kura, 2024) and contributes to ongoing internal conflicts in three major regions(Oromia, Amhara and Tigray). These conflicts disrupt economic activities thereby weakening the supply chain of food production, limited access to finance and an unpredictable business climate as a result of deterring both domestic and foreign investment. Besides, negative shocks from the COVID-19 and the Russia-Ukraine war amplify the macroeconomic challenges. Moreover, the economy remains heavily reliant on rain-fed agriculture, making it highly vulnerable to climate change that impacts millions of lives by droughts and floods.

Inflation in Ethiopia remains high, due to excessive money supply growth (AEO, 2024). A high rate of inflation that erodes purchasing power, increases the cost of living and discourages savings, investment and business activities. In the meantime, the National Bank of Ethiopia (NBE) as of August 2024 has continued currency depreciation against US dollars. The NBE has considered this depreciation as one of the components of the reform that encourages growth in export, owing to fiscal consolidation. However, deepening the structural change of the economy, the most viable option for ensuring the pursuit for industrialization requires the development and transformation of the agricultural sector. Though the agriculture sector remains a sector of the economy, contributing 32 percent of GDP and over 70 percent of both employment and exports generation, Ethiopia is still at an early stage of industrialization relative to its regional peers. Consequently, large public investments in infrastructure has decelerated by about 7.8 percent over recent years underscoring the limitation of the public sector-led growth model (African Development Bank, 2022).

It is not surprising that in today's technologically thriving, Ethiopia has one of the lowest income per-capita with a profoundly agriculture-based economy. The economy has been characterized as a subsistence agricultural sector, low-quality product of infant manufacturing industry and unsatisfactory delivery services to the public by the service sector that retard growth and development except, the Ethiopian Airlines. There are also structural bottlenecks that make the private sector uncompetitive, limited access to finance, and high government debt distress leads to complex restructuring negotiations, Furthermore, restraining fiscal space for essential public investments, exacerbated by weak export performance, poses a risk to sustained growth. Yet, the Ethiopian agricultural sector where a large number of the population engages for livelihood has been lagging behind and lost its position by the service as a leading sector recently.

The preceding paragraphs of an introduction call for additional studies. It is not only to examine more conclusive evidence on the effect of the sectoral structural change on economic growth, but also a deeper understanding of the nature of economic growth from the nonlinear asymmetric analysis aspect. In this framework, what is actually being realized is a structural problem of the economy that needs to be addressed by looking into the potentiality and challenges. Hence, the effect analysis of the linkage between the economy and its determinants is an important long-term view, but not an accidental phenomenon. Following an illustrated conceptual framework in (Figure 1) underpinning for the analyses of ascertaining asymmetric upward & downward change in main explanatory variables. The main objective of this study is, therefore, to make a unique contribution to economic analysis by introducing a new approach, nonlinear autoregressive distributed lags-error correction mechanism (NARDL-ECM) model alongside standardized datasets. The research study transforms the datasets into logarithm, then standardizes the selected variables and ultimately, splits out the basic explanatory variables into a negative and positive category. To the extent that there has been no published research work prior to this study to analyze the problem of dynamic economic structure. Later on, the study checks the robustness of asymmetric growth estimation with the help of canonical cointegrating regression method proposed by Park(1992) and dynamic inter-temporal Granger causality of Engle & Granger (1987) for the validity and credibility of the findings.

The paper presents the related empirical literature, the type and description of data and specification of appropriate model in the methodology part, the empirical results and discussions in part four. Finally, the research offers concluding remarks and recommendations in the subsequent section.



Source: Author's own: ↑ in x^+ causes ↑y & ↑ in x- causes ↓ y

Figure 1 Conceptual Framework

2. Related Empirical Literature

This study attempts to review the current related empirical studies. For example, a recent study by Kura(2024) used the ARDL method to investigate the institutional reform initiatives and the economic growth in Ethiopia over the period 1996-2020. The study pronounced that political instability resulted in adversely influencing economic growth by diminishing investment, human capital and exports. The economies similar to Ethiopia such as Pakistan, the studied in Hussaina, et al. (2019) the nonlinear ARDL technique asymmetric impact of exchange rate on GDP growth were proved to be positive significant from the evidence of short-run, long-run estimation while ARDL symmetric effect had little effect. In addition, Amin, Anwar & Liu (2020) used NARDL over the sample study period 1990–2019 to investigate

the long-run and short-run impacts of FDI on Romania's economic growth, comparatively stronger than the Ethiopian economy. The study results by Khan, Sisi & Siqun (2018) indicated that both an increase and a decrease in FDI had a positive and significant impact on GDP whereas environmental regulations and carbon emissions were statistically significant negative linear relationship with GDP, using ARDL both in the short and long-run but NARDL does not exist for the period of 1991–2015 in China.

In fact, as a contribution to the asymmetric research literature worldwide by Shin, Yu & Greenwood-Nimmo (2014), a cointegrating nonlinear ARDL model in short- and long-run nonlinearities were introduced via positive and negative partial sum decompositions of the explanatory variables. In deriving so, they illustrated the traverse between the short- and the long-run asymmetric dynamic multipliers graphically. Since then, some researchers have used the NADRL model for economic analyses. Fousekis, Katrakilidis & Trachanas (2016) investigated the vertical price transmission in the US beef sector by employing the Nonlinear ARDL model which can allow prices to be tied by asymmetric relationships both in the long- as well as in the short-run. In their empirical analysis, they showed the long-run elasticities of price transmission were more important from the wholesale to retail level than from the farm to the wholesale level.

One of the most striking findings of the article in very recent years was a research work by Mcmillan, Rodrik & Verduzco-Gallo (2014) indicated that in many Latin American and SSA countries, patterns of structural changes were served to reduce rather than increase economic growth since 1990, while in Asia the patterns were pro-economic growth. According to the authors, first labor productivity growth could be driven by the growth in productivity of specific economic sectors through greater capital accumulation, technological change, better allocation between productive plants, and etc. The second one was the structural change that occurs when labor moves from low productivity to high productivity, a sector that increases the overall labor productivity in the economy.

Numerous studied were also conducted on developed economies using NARDL, an extension of ARDL method such as Jareño, Escribano & Koczar (2020) to show the reaction to positive and negative changes in market returns of German, British, American and the Chinese stock markets, evidencing strong short-run asymmetry. The research work by Habibi (2019) also employed the NARDL model, indicating there was a positive short-run nonlinear effect of exchange rate on production into

the long-run of the economy in the United States. On top of these, NARDL asymmetric effects of cyclical output on South Africa's unemployment was applied in study by Mazorodze & Siddiq (2018) to see the difference in economic contraction and expansion. The response of the labour market was asymmetric in the long-run ensuring that it lost more workers during contraction than it employed during recoveries. Explicitly the study by Ali et al.(2018) explored the dynamics between economic growth and overseas investment in China, using asymmetric ARDL technique. The authors suggested that ignoring the intrinsic asymmetries may conceal the true information about the equilibrium relationship among the variables and thus lead to misleading results. The findings also revealed that economic growth in China responded positively but differently to an increase and decrease in its overseas investment. Finally the study concluded that the empirical evidence obtained through asymmetric models seems to be superior to symmetric ones and thus led to more efficient policymaking to achieve sustainable economic development.

Using NARDL, Katrakilidis & Trachanas (2012) provided the evidence suggesting that ignoring the intrinsic nonlinearities may lead to misleading inference and the results were found to be significantly negative changes of the explanatory variables in both the long- and short-run time horizons. Bahmani-Oskooee & Baek (2016) used the linear and nonlinear ARDL to investigate the phenomenon between Korea and its 14 trading partners to check whether the exchange rate changes have short-run and long-run asymmetric effects on the bilateral trade balances. They concluded that separating depreciation from appreciation was the main feature of the nonlinear model that relies upon nonlinear adjustment of the exchange rate. The study of Karamelikli(2016) in applying NARDL showed that the dynamic housing sector has an important size in economic activities of Turkey in the sense that a decreasing rents would cause an increase in household savings because of lightening their basic expenditures in the long-run. On top of the described analyses above, this study realized that the study by Ibrahim (2015) employing NARDL, concluded that the absence of significant influence of oil price reduction on the food price both in the long-run and short-run, the role of market power in shaping the behaviour of Malaysia's food price would likely to be significant.

In summary, from the above related empirical literature, this research study observes most of the empirical available evidence clearly suggesting that the asymmetric effects analysis is more magnified than symmetric linearity even though the debate remains on-going which necessitates for further studies on the matter. In addition,

recent researchers have identified significant differences within the modern manufacturing activities of the same industry or sector, there is a productivity gap and this gap tends to be much larger in developing countries than in advanced economies. The productivity gap may be indicative of allocative inefficiencies that reduce overall productivity in a given economy, the developing nations which may be an important engine of economic growth. This is because, when work and other resources move from less productive activities to more productive activities, the economy grows even if there is no productivity growth in the sectors.

3. Methodology of the Study

Methodology of the study consists of source of data, variables description, model specification and justification. Researchers are much interested in sustainable levels of economic growth since internal and external factors are the main cause and responsible for unstable economic progress (see Barro, 1991; Baker, 1998 and Caballero, 2007). Specifically in developing countries, the main sources of unstable GDP are exogenous shocks such as financial markets, terms of trade; domestically intrinsic instability and self-inflicted policy faults (Kharroubi, 2006; Raddatz, 2007). In addition, weak shock absorption capacity of technologies (see Lucas, 1988; Barro,1991) by the economies in developing nations is another factor. Regarding the data for the analysis, a crucial stimulus to work on growth whether the per capita income is a matter of new datasets creation with information (Maddison, 1982; Heston &Summers, 1991 and Romer, 1994). The evidence about growth has been "long taken for granted that poses a challenge for growth theorists. There has been argued that many people use the existing data to replicate physical activities and technological advancements that come from things that people do" (Romer, 1994:12-13).

The descriptions and definitions of sectoral value added are determined by the International Standard Industrial Classification Revision 3 or 4. The United Nations system of national accounts calls for value added to be valued at either basic prices which exclude net taxes on products, sales and value added taxes but include net taxes on products paid by producers. Both valuations exclude transport charges that are invoiced separately by the producers. The definitions of value added according to the United Nations system of national accounts are as follows. Value added is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources. Thus value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs.

This study used the Ethiopian macroeconomic annual data, obtained from World Bank Development Indicators spanning over the period 1992 to 2024. The selected variables included the growth rate of real GDP per-capita as a proxy for economic growth(y_t). The explanatory variables such as the calculated growth rate of total factor productivity (x_{1t}), the sectors value added of agriculture including forestry and fishing (x_{2t}), of industry comprising construction (x_{3t}) and of the services sector (x_{4t}). On top of these, the study utilized foreign direct investment (x_{5t}), economic openness (x_{6t}) and macroeconomic instability index (x_{7t}) overtime as regressors to examine whether they were considered as driving forces of economic growth. The dependent variable (y_t) and the first five regressors were expressed at constant 2015 U.S dollars and the growth rates were calculated. The calculations were made using the concepts of economic theory with the help of algebraically and derivatives of calculus (as can be seen in Appendix I).

The real GDP at constant 2015 US$ in millions, capital stock in millions of US$, labor force in millions of people were transformed into logarithms form and used in the calculation of total factor productivity (TFP). Exports and imports of goods and services on the current balance of payment in millions of US$, were also used to have a calculation for openness of the economic index. Finally, the macroeconomic instability index was constructed based on the Early Warning System (EWS) as a composition of the level of corruption perceptions index score out of 100, inflation rate, unemployment rate, general government debt in percentage of GDP, income inequality index in Gini coefficient and official exchange rate (see Appendix I). EWS is the most important method for evaluating the reliability of time series, regulating the business cycle and their turning points and understanding the crisis of prediction and gives detailed guidelines for the occurrence of that crisis(Berg & Pattillo,1999 and Berg, Borensztein & Pattillo,2005).

EWS is a system which has behavioral control on economic variables over the time and passes the variables through threshold limit, considering the occurrence of crisis. Therefore, the study on the basis of determining the predicting variables and following the methodology presented by Kaminsky, Lizondo & Reinhart (1998), it is possible to construct the macroeconomic instability index for Ethiopia. Warning variables were selected according to the theoretical and empirical literature. The value of the index is in between zero and one, with one indicating high macroeconomic instability and zero means stability. The data for the macroeconomic instability index were obtained from different sources such inflation rate and general government debt from International Monetary Fund (IMF) ,corruption perceptions

index from Transparency International, income inequality index measured in Gini index between 0 and 1, of 0 represents perfect equality, while an index of 100% implies perfect inequality that the extent to which the distribution of income among individuals within an economy deviates from a perfectly equal distribution. While others were from World Bank Development Indicators. The macroeconomic instability index of Ethiopia over the sample period shows that dramatically increases on average from 2009 onward but there rate of increament slightly decreases since 2022 due to increasing in inflation rate, corruption and unemployment rate among others.

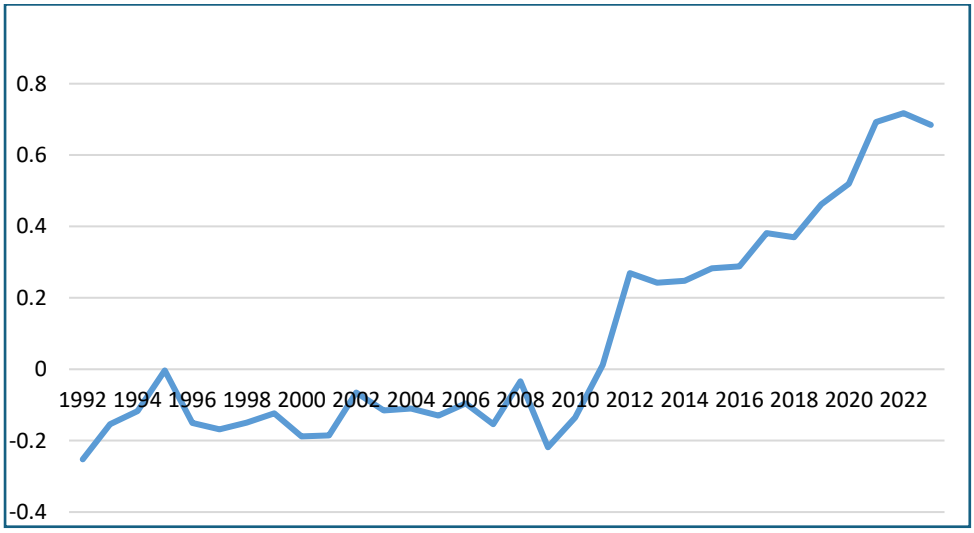


Figure 2. Ethiopian Macroeconomic Instability from 1992-2024
Source: Author calculation based on the datasets

Specifying the model after carefully examining of the related empirical findings for the entire analysis, the study attempts to set an appropriate method, nonlinear autoregressive distributed lags-error correction mechanism (NARDL-ECM) or simply NARDL model framework. In very recent years, the NARDL model cointegration has become popular in time series dataset analysis. The neoclassical model developed and applied first by Solow (1956) and then step forward in the process of constructing a formal model of growth by Romer(1994) and Romer (1996) are the benchmarks for this study. Once source of the variables are described and each variables are calculated and defined, now the Ethiopian economy can be modeled as

$$Y_t = \prod_{j=1}^{n} e^{\emptyset \mu_j x_j \varepsilon_t} \qquad (\mathbf{1})$$

where n is the total number of non-negative quantities of the factor of production, $\emptyset$ and μ are intercept and elasticity parameters of output with respect to input factors j.

The log transformation of production function of data generating process in equation (1) be defined as a vector of variables, $z_t = \left(y_t, x_{jt}'\right)'$and decomposition of each explanatory variable into a partial sum of positive and negative changes in general form of NARDL is modelled to capture the effect of asymmetric forms as NARDL$\left(p, q_1, \cdots, q_{k,}\, q_1', \cdots, q_{k'}\right)$:

$$y_t = \alpha + \sum_{i=1}^{p} \Psi_i\, y_{t-i} + \sum_{k=1}^{K} \beta_{k,0}^{+}\, x_{k,t-i}^{+} + \sum_{k'=1}^{K'} \beta_{k',0}^{-}\, x_{k,t-i}^{-} + \sum_{k=1}^{K} \sum_{j=0}^{q_k} \beta_{j,k}^{+}\, x_{j,t-j}^{+} + \sum_{k'=1}^{K'} \sum_{j=0}^{q_{k'}} \beta_{j,k'}^{-}\, x_{j,t-j}^{-} + \varepsilon, \ , \varepsilon_t \sim iidN(0, \sigma^2) \qquad (\mathbf{2})$$

Subtracting y_{t-1} and x_{t-1} in equation (2) from their respective terms, we will get the dynamics short-term error correction mechanism(ECM) as:

$$\Delta y_t = y_t - \Psi_1 y_{t-1} = \alpha + \sum_{i=2}^{p} \Psi_i\, \Delta y_{t-i+1} + \sum_{k=1}^{K} \beta_{k,0}^{+}\, \Delta x_{k,t}^{+} + \sum_{k'=1}^{K'} \beta_{k',0}^{-}\, \Delta x_{\bar{k},t}^{-} + \sum_{k=1}^{K} \sum_{j=0}^{q_k} \beta_{j,k}^{+}\, \Delta x_{k,t-j}^{+} + \sum_{k'=1}^{K'} \sum_{j=0}^{q_{k'}} \beta_{j,k'}^{-}\, \Delta x_{\bar{k},t-j}^{-} + \varepsilon, \ \varepsilon_t \sim iidN(0, \sigma^2) \qquad (\mathbf{3})$$

The coefficients of the variables on the first difference in equation (3) from the terms 2-5 represent the short-run causality which show an asymmetric degree of the same impact relationship of a positive and negative changes in each explanatory variable on the dependent variable. However, this assumption may not hold up in reality all the time. If the magnitude of the impact is not the same on both sides of the change, the impact of the explanatory variables on the dependent variable is asymmetric. This provokes research in the field of asymmetry.

The following equation(4) indicates the ECM representation after isolating long-run effects from short run by expressing lagged terms in terms of the long-run coefficients:

$$\Delta y_t = \sum_{i=2}^{p} \Psi_i \, \Delta y_{t-i+1} + \sum_{k=1}^{K} \beta^{+}_{k,0} \, \Delta x^{+}_{k,t} + \sum_{k'=1}^{K'} \beta^{-}{}_{k',0} \, \Delta x^{-}_{k,t} + \sum_{k=1}^{K} \sum_{j=0}^{q_k} \beta^{+}_{j,k} \, \Delta x^{+}_{k,t-j} + \sum_{k'=1}^{K'} \sum_{j=0}^{q_{k'}} \beta^{-}_{j,k'} \, \Delta x^{-}_{k',t-j} + (\Psi_1 - 1) \left\{ y_{t-1} - \left(\sum_{i=2}^{p} \theta_k \; x^{+}{}_{k,t-1} + \sum_{i=2}^{p} \theta_{k'} \; x^{-}{}_{k',t-1} \right) - \frac{\alpha}{1 - \sum_{i=1}^{p} \Psi_i} \right\} + \varepsilon_t \, , \varepsilon_t \sim iidN(0, \sigma^2) \qquad (\mathbf{4})$$

where on the right side of equation(4), the 2nd and 3rd terms denote the short term effects, the 1st, 4th, and 5th terms is lagged adjusted terms, and the 6th is the error correction term denoted by $y_{t-1} - \left(\sum_{i=2}^{p} \theta_k \; x^{+}{}_{k,t-1} + \sum_{i=2}^{p} \theta_{k'} \; x^{-}{}_{k',t-1} \right)$, Δ is difference & $\lambda = \Psi_1 - 1$ represents the speed of adjustment parameter attached to the error correction term which measures how fast returns to equilibrium by the variables. α is drift; $\Psi, \beta^{+}, \beta^{-}, \; \& \; \lambda$ are parameters to be estimated.

Noteworthy, replacing the last term in the set of (4) by the error correction term (ECT_{t-1}), ultimately we will have dynamic short-term error correction mechanism (ECM) in NARDL model as

$$\Delta y_t = \sum_{i=2}^{p} \Psi_i \, \Delta y_{t-i+1} + \sum_{k=1}^{K} \beta^{+}_{k,0} \, \Delta x^{+}_{k,t} + \sum_{k'=1}^{K'} \beta^{-}_{k',0} \, \Delta x^{-}_{k,t} + \sum_{k=1}^{K} \sum_{j=0}^{q_k} \beta^{+}_{j,k} \, \Delta x^{+}_{k,t-j} + \sum_{k'=1}^{K'} \sum_{j=0}^{q_{k'}} \beta^{-}_{j,k'} \, \Delta x^{-}_{k',t-j} + \lambda \mathrm{ECT}_{t-1} + \varepsilon_t \, , \varepsilon_t \sim iidN(0, \sigma^2) \qquad (\mathbf{5})$$

In the analysis of long-run behaviour in the short-run dynamics with time series data and macroeconomic panel data using NARDL models, we have to calculate the component of long-run coefficients of the model (see Blackburne and Frank, 2007). We can also derive the long-run coefficients in the NARDL model of multiple independent variables to solve the relationship in long-run equilibrium,

assuming: $y_t = y_{t-1} = y$; $x_{1,t} = x_{1,\,t-1} = x_1$; $x_{2,t} = x_{2,\,t-1} = x_2$; $x_{n,t} = x_{n,\,t-1} = x_n$; & $\varepsilon_t = 0$.

Take (2) and transfer the second term, the lagged dependent variable to its left side and consider the long-run and solving for y, we get the long-run coefficients of the NARDL model as shown below.

NARDL$\left(p, q_1, \cdots, q_{k,}\, q_1', \cdots, q_{k'}\right)$:

$$y = \frac{\alpha}{\left(1 - \sum_{i=1}^{p} \Psi_i\right)} + \frac{\sum_{k=1}^{K} \beta_{k,0}^{+}\, \Delta x_{k,t}^{+}}{\left(1 - \sum_{i=1}^{p} \Psi_i\right)} + \frac{\sum_{k'=1}^{K'} \beta_{k',0}^{-}\, \Delta x_{\bar{k},t}^{-}}{\left(1 - \sum_{i=1}^{p} \Psi_i\right)} + \frac{\sum_{k=1}^{K} \sum_{j=0}^{q_k} \beta_{k,j}^{+}\, x_k^{+}}{\left(1 - \sum_{i=1}^{p} \Psi_i\right)} + \frac{\sum_{k'=1}^{K'} \left(\sum_{j=0}^{q_{k'}} \beta_{j,k'}^{-}\right) x_k^{-}}{\left(1 - \sum_{i=1}^{p} \Psi_i\right)} \qquad (6)$$

The above (6) is therefore, the long run component of ARDL .

where $\alpha/\left(1 - \sum_{i=1}^{p} \Psi_i\right)$ denotes long-term intercept and the terms from 2nd through 3rd on the right side of equation (6) represents long-term slopes for x_k, and x_k^- in each and , ϵ_t is the error term which independently and identically distributed over zero mean and constant variable, respectively. For a valid long-run relationship, the NARDL model must stable in the stability condition where

$$1 - \sum_{i=1}^{p} \Psi_i > 0 \Rightarrow 1 > \sum_{i=1}^{p} \Psi_i$$

The decomposed explanatory variable, x_t into $x_0 + x_t^+ + x_t^-$ which shows there is a short-run cumulative dynamic multiplier effect of m_h^+ of the decomposed positive (x_t^+) increases a regressor that increases the dependent variable. On the other sided, a short-run cumulative dynamic multiplier effects of m_h^- of the decomposed negative (x_t^-) increases the regrssor that decreases the dependent variable and these can be evaluated, respectively as follows:

$$x_t^+ = \sum_{j=1}^{t} \Delta x_j^+ = \sum_{j=1}^{t} max\left(\Delta x_j^+, 0\right) \;\&\; x_t^- = \sum_{j=1}^{t} \Delta x_j^- = \sum_{j=1}^{t} min\left(\Delta x_j^-, 0\right)$$

$$m_h^+ = \sum_{j=0}^{h} \frac{\partial \Delta y_{t-j}}{\partial \Delta x_t^+} \;\&\; m_h^- = \sum_{j=0}^{h} \frac{\partial \Delta y_{t-j}}{\partial \Delta x_t^-}, h = 0,1,2, \ldots n,$$

$$\text{as } h \to \infty, m_h^+ \to -\frac{\beta^+}{\Psi_0} \;\&\; h \to \infty, m_h^- \to -\frac{\beta^-}{\Psi_0} \qquad (7)$$

where $\beta^{+}\ and\ \beta^{-}$ are the long-run parameters associated to the decomposed regressors into partial sum of the processes of positive and negative changes in x_t. Thus the long-run impact of NARDL asymmetric coefficients can be obtained by dividing the negative and positive coefficients of each explanatory variable by the negative coefficient of one period lag of the dependent variable separately as specified in equation (7).

4. Results and Discussions

Under this section, the study presents the analyses of descriptive statistics, per- and post- diagnostic tests and estimation parameters of the econometric model. The descriptive statistical estimated results presented in (Table 1), are essential as a milestone for econometric analysis. Here, before splitting the data into a negative and positive series of datasets for asymmetric analysis, the descriptive statistics results show that the median and minimum values of five out of eight variables are not far away from their respective mean values. These entail the standard deviations are close to zero indicating the data points are close to the mean, considerably the error distribution in the variables is quite insignificant. However the values of $x_{2,t}$, $x_{3,t}$ and $x_{4,t}$variables are not the case.

A fundamental task in statistical analyses is to characterize the location and variability of datasets based on skewness and kurtosis. Skewness is a measure of symmetry in a dataset and thus, as can be seen in (Table 1), y_t, $x_{1,t}$, $x_{2,t}$and $x_{6,t}$ are negatively skewed while others are positively skewed which indicate the datasets are neither symmetric nor asymmetric. The skewness results in absolute terms for the variables, except, y_t are less than a unit, indicating the skewed distribution is relatively low in peaks. With regard to kurtosis, a measure of whether the data are heavy-tailed or light-tailed relative to a normal distribution which points out that a dataset with high kurtosis results tends to have presence of outliers compared to the low kurtosis results. Here, the results of kurtosis and skewness are insignificant and not different from zero, there would be no rejection of the null hypothesis of normality. The results of Jarque-Bera show that all the variables of the model have zero mean and finite covariance, which confirms the selected datasets are normally distributed. Finally, the number of observations for each variable is 30, which is substantially considered for the time series analysis.

Table 1: Descriptive analysis of the data for unstandardized variables

	y_t	$x_{1,t}$	$x_{2,t}$	$x_{3,t}$	$x_{4,t}$	$x_{5,t}$	$x_{6,t}$	$x_{7,t}$
Mean	0.0436	0.0026	4.9480	10.151	9.2101	0.2030	0.2817	0.1009
Median	0.0541	0.0175	5.3523	9.1477	8.9292	0.1961	0.2996	-0.0493
Maximum	0.0973	0.0911	15.667	21.593	15.475	2.6049	0.4202	0.7174
Minimum	-0.0667	-0.0953	-11.076	3.6120	4.3029	-1.2448	0.1374	-0.2186
Std. Dev.	0.0402	0.0556	5.8539	5.1752	3.2052	0.8576	0.0962	0.2993
Skewness	-1.1053	-0.2405	-0.8812	0.8755	0.3117	0.6599	-0.1879	0.7778
Kurtosis	3.7884	1.7513	4.7061	2.7231	2.1931	3.7449	1.6209	2.2461
Jarque-Bera	6.8857	2.2380	7.5208	3.8298	1.2696	2.8715	2.5538	3.7356
Prob.	0.0320	0.3266	0.0233	0.1402	0.5221	0.2380	0.2789	0.1545

Number of observations for each variable is 30.

Source: Author's Estimation based data

The most important consideration in times-series data estimation is to establish an appropriate dynamic model with the most suitable lag structure. One of the possible sources of the problem in the functional form of the model is due to the lack of lagged structure resulting in an autocorrelation.. In this case, one way of overcoming an autocorrelation is to add a lagged variable in the system. Thus the study determines an appropriate optimal lag length through vector auto-regressive (VAR) process as one of the preliminary per-estimation tests. Following the selection of lag length after splitting out each series of the dataset into a negative and positive effects of the main driving factors for NARDL-ECM model analysis, the study determines the Akaike information criterion (AIC). It choses AIC out of standard selection criteria due to the fact that the lowest error value indicates the best appropriate method. Therefore, we confirm that one optimal lag length to be implemented for the entire analysis as can be seen from the results reported in (Table 2, under Appendix II).

other pre-diagnostic tests which include unit roots, structural breaks and endogeneity problems are mandatory criteria for the time series data estimation analysis. Hence, the study attempts to conduct a unit root test for both the dependent and explanatory variables as Hansen (1992) suggests that the augmented Ducky-Fuller (ADF) unit root test statistics follow the Phillips & Ouliaris (1990) distributions adjusted for a constant and trend, with dimension parameter n−2. Meaning, the cointegrating residual includes deterministic terms such as constant and trend in which the unit root tests should account for (Hansen, 1992). In autoregressive distributed lags error correction mechanism (ARDL-ECM) model and its extended, non-linear asymmetric NARDL-ECM, it is not necessary to perform the pre-test for the unit roots to verify

whether the variables are of order 0 or 1, but not I(2) or higher. The unit roots test results as reported in (Table 3, under Appendix II) shows each undertaken variables has a unit root at 5% level of significance but after first difference becomes stationary even at 1% level of significance exhibits at most integrated order of one, ,except x_{6t}. Cointegration naturally arises in economics and finance, most often associated with economic theories that imply long-run equilibrium relationships between variables in time series datasets. Because the economic forces act in response to deviations from the equilibrium, it may take a long time to restore that equilibrium. As a result, the cointegration modeled using long spans of low frequency time series data measured quarterly or annually are used to explain the long-run behavior of the variables (see Phillips & Ouliaris, 1990 and Hansen, 1992). One of the main advantages of NARDL approach is the ability to examine the existence of cointegration without verifying an integrated order of 0 or 1 in the variables and yields greater efficiency with small sample sizes. The presence of unit roots or a non-stationarity data process becomes stationary after first difference that affirms cointegration exists and NARDL includes the ECM for the short-run estimation coefficients to be considered as short-run estimation. Thus, the results reported in (Table 3) reveal that all the variables have integrated order of one at first difference, except ($x_{6,t}$).

In the bounds test, the study checks the cointegration/ long-term relationships among the variables using F-test. The nonlinear asymmetric ARDL bounds testing for cointegration procedure is based on the F- or Wald-statistics tests. Thus, Pesaran, Shin & Smith (2001) compute the two sets of critical values for a given significance level by assuming some variables are a set of I(0) and some others of I(1) or combination of the two. Even though the NARDL model separates the reaction of the dependent variable towards the negative and positive change in the explanatory variables, the bounds test procedures for asymmetric long-run cointegration is similar to the ARDL bounds test.

For examining the cointegration among the variables, the study uses the non-linear autoregressive distributed-error correction mechanism (NARDL-ECM) model, simply, NARD which is an extended version of ARDL approach. The computed F-statistic value, F=7.0104 exceeds the upper critical bounds values in the models(3.2500 and 3.8400); there would be a rejection of the null-hypothesis of no cointegration at 5% and 1% levels of significance (see Table 4). Thus, we conclude there is a level relationship among the variables in the non-linear asymmetric ARDL models. Note that on the one side, if the F-statistic falls between the upper and lower

bounds, then the test becomes inconclusive and if it is below the lower the critical bounds values, implies no cointegration.

Table 4: F-bounds test using asymmetric nonlinear ARDL (1, 0, 1, 1, 1, 1, 0, 1, 0, 1, 1, 1)

F-Value		**7.0104**
Asymptotic Test Significance.	Integrated order of I(0)	Integrated order of I(1)
5.00%	2.2100	3.2500
1.00%	2.6800	3.8400

Null Hypothesis: No levels relationship and * & ** Finite sample critical values are valid up to 7 error-correction variables denotes 1% and 5% levels of significance, respectively. Dependent Variable:$Dlny_t$ for the level.
Source: Author's estimation based on the data

Having implemented the bound test to establish cointegration among the variables as affirmed by Engle & Granger (1987) there is a concern of potential problem of endogeneity. Endogeneity exists when one or more regressors are correlated with the residual error term. It also refers to the relationship between the observed and unobserved variables. Observed heterogeneity usually consists of the covariates and unobserved heterogeneity consists of any unobserved difference like ability or effort. As a result, the estimation coefficients are biased and inconsistent in the presence of endogeneity, otherwise, it has to be removed from the series of the dataset. Thus the study conducts the test of an exogeneity and confirms that the data is free from the endogeneity problem (the test result is available with the author).

Checking non-stationarity, integrated order and cointegration are not sufficient for the estimation coefficients in the time-series data. In other words, the existence of cointegration does not necessarily imply that the estimated coefficients are stable as argued in Bahmani-Oskooee and Brooks (1999). Noteworthy, here the study also conducts the diagnostic tests for stability conditions resulting in structural breaks by employing the cumulative sum (CUSUM) and cumulative sum squares (CUSUMSQ) for the endogenous tests of the Brown et al. (1975) based on recursive regression residuals. The test statistics are updated recursively and plotted against the break points of the model, confirming statistically the two lines of CUSUM and CUSUM squares are contained within the critical bounds of the lines at 5% level of significance. It is implemented by means of graphical representation as shown in

(Figure 3 under Appendix II) which confirms the regression has stable condition and hence no structural breaks in the dataset.

Before estimation of the long-run and short-run parameters, the study conducts the post-estimation diagnostic tests including model specification, serial-correlation, heteroskedasticity etc. The Ramsey RESET model specification is statistically insignificant at any conventional level of significance, indicating the model specification is correct and well fit to the data. Also data used in this analysis are free from serial-correlation and heteroskedasticity (see Table 5 under Appendix II). Hence, the results in the NARDL model couldn't give any evidence for the existence of these problems since the datasets have been transformed into log form, then the variables are standardized and major explanatory factors are separately set by dividing into a negative and positive category.

The NARDL asymmetric estimation coefficients reported in (Table 6) depict that a positive change upward movement in total factor productivity(TFP) growth rate (denoted by $D(x_{1,t}^{+})$) has a positive effect on the short-run economic status ($D(y_t)$) in the short-run, while all others remain unchanged. This means, a 1 perecentage point increase in $D(x_{1,t}^{+})$ that raises D(y_t) by about 0.05 perecntage point immediately in the short-run, all others remain constant. Likewise, the agricultural value added has both negative,($D(x_{2,t}^{-})$ and positive, $D(x_{2,t}^{+})$ effects on the entire economy, in the short-run while all others remain unchanged. Specifically, a unit increase upward in the agricultural value added leads to an increased economic effect and also, a negative downward movement in the agricultural value added has a negative effect on the economy in the short-run, while all others remain constant. Similarly, a negative downward movement of the industrial sector value added, $D(x_{3,t}^{-})$ has a negative effect on the economy in the short-run, while all others remain constant. There is a positive statistically significant relationship between the growth rate of foreign direct investment, D(x_{5t}) and economic growth D(y_t) as well as degree of openness of the economy D(x_{6t}) and economic growth in Ethiopia whereas by reducing macroeconomic instability, D(x_{7t}), the government can also achieve a targeted economic growth in the short-run, while other factors held constant.

Finally, cointegration among the variables further supported by the results from the error correction model as the error correction term is negatively statistical significant. Since theoretically this term lies between -1 and 0, which measures the speed of adjustment from short-run to long-run equilibrium. Thus the coefficient of –0.7503 shows that at a rate of 75 percent of the disequilibrium is corrected in each period for

the variables return back to the normal long-run equilibrium condition once the economy is being shocked by internal or external factors that will take nearly one year and three months(1/0.7503=1.3328). The negative error correction term indicates that one period lagged of the dependent variable is below the equilibrium, implies the change in the dependent variable increases to ensure the convergence towards long-term equilibrium to be stable and restore balance.

Table 6: Short-run coefficient estimation with NARDL (1,0,1,1,1,1,0,1,0,1,1,1) model

Variable	Coefficient	t-Statistic	Prob.
COINTEQ*	-0.7503	-15.728	0.0000**
$D(x_{1,t}^{+})$	0.0509	2.0971	0.0496*
$D(x_{2,t}^{-})$	0.0867	36.853	0.0000**
$D(x_{2,t}^{+})$	0.0650	27.929	0.0000**
$D(x_{3,t}^{-})$	0.0412	3.4738	0.0025*
$D(x_{4,t}^{-})$	0.0206	1.2509	0.2262
$D(x_{5t})$	0.1022	3.7756	0.0013*
$D(x_{6t})$	0.2607	2.5623	0.0191*
$D(x_{7t})$	-0.5731	-8.2278	0.0000**

** and * denotes the level of significance at 1% and 5%;. Dependent variable:$D(y_t)$; and D is the difference; Method: NARDL;Dependent lags: 1 (Automatic);Automatic-lag linear regressors (1 max. lags): X1_NEG X1_POS X2_NEG X2_POS X3_NEG X3_POS X4_NEG X4_POS X5 X6 X7; Deterministics: Unrestricted constant and restricted trend (Case 4); Model selection method: Akaike info criterion (AIC); Number of models evaluated: 2048 Selected model: ARDL(1,0,1,1,1,1,0,1,0,1,1,1); HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 4.0000.)

In order to split out the data on major factors into a negative and positive, (we run the model via NARDL model via labeled by entering "asyvars" on EViews and followed by explanatory variables then go to "add in" to make a platform of the NARDL estimation) and conducting diagnostics tests are the most important consideration.

The plotted asymmetric cumulative dynamic multiplier graph based on equation (7) presented in (Figure 4, under Appendix III) shows the effect of a unit change in the growth rate of agricultural value added (positive or negative) on changes in economic growth. The multipliers indicate the new long-run equilibrium of the adjustment pattern of economic growth follows a positive or negative unitary shock in the

agricultural value-added growth rate. From this graph, we can clearly see how economic growth responds positively to the positive shock and negatively to a negative shock in agriculture. In response, economic growth to either negative or positive shock is more pronounced in the long-run than in the short-run where virtually operating on the same level over the horizon. The upper continuous and the lower dash black lines show how the economic growth adjusts itself all over the horizon due to positive and negative changes in the value added of agricultural. While the red dash line is an asymmetric plot which reflects the difference between the dynamic multipliers of the positive and negative change in the agricultural sector, but not in either of two value added sectors (noted that the graphs for industrial and service sectors valued added are available with the author). Since the zero line falls out of the upper and lower lines interval that is statistically significant, there is an asymmetry effect of the agricultural sector on economic growth in the long-run with more negative response of the economic growth when the negative shocks happen to the economy.

The NARD model long-run coefficients estimation results are reported in (Table7). While other factors kept constant, as the growth rate of agricultural sector value added and its one year lagged downward movement increases, there is a decrease in economic growth in the long-run. Likewise, an increase in upward movement in the growth rate of agricultural sector value added leads to an increase in economic growth in the long-run, other factors remain unchanged. Specifically, an upward movement in the growth rate of agricultural sector value added by one percentage point that causes the economic growth per annum increases by about 0.005 percentage in the long-run, keeping other factors unchanged.

Similarly, the growth rate of an upward movement in the industrial sector and service sector's value added are to increase Ethiopian economic growth in the long-run, ceteris paribus. Lastly, one period lagged in openness of the economy and the current and one year lagged in macroeconomic instability, each has a negative impact on Ethiopian economic growth per year in the long-run over the period of sample study, while other factors are constant. Justifications for the negative impact of openness on economic growth might be every high tariff tax imposed on imported items by the government and low quality of exported items to advanced countries from Ethiopia. As evidence from the previous research by Edwards (1993) on the work openness, trade liberalization, and growth in developing countries, Harrison, (1996) on the openness and growth in the study of Keho (2017) on the impact of trade openness on economic growth had also reported such a negative relationship.

From this model relatively speaking, what we can easily understand is that agricultural sector value added has more effect on economic growth than any other determinants because by standardizing we put all regressors on an equal footing. On the other hand, the standardized regression coefficients are the beta coefficient since they are unit-free numbers even if the t-, and F-test statistics are the same as regression coefficients of unstandardized variables. However, for different factors having different units of measurement in the case of non-standardized variables, there would be misleading conclusions unlike standardized models. Since all variables are measured in the same units of measurements, the interpretation we infer would be free from misleading so that we can compare the impacts of each determinant on the dependent variable in the cases of standardized regression results on the variables. Finally, the Durbin-Watson statistic values in both short-run and long-run coefficient estimation exceed the adjusted coefficients of determination when adjusted degree of freedom, which ensure the estimation regressions are non-spurious.

Finally, the study checks for the robustness of NARDL-ECM model results estimation using canonical cointegrating regression method and pairwise Granger causality test. The canonical cointegrating regression method is used to test a cointegrating vector in a model with the integrated process of I (1). However, it concentrates on data transformation unlike FMOLS which focuses on transformation of both data and parameters Park (1992). In order to justify robust estimation of the model, we triangulate the same dataset with canonical cointegrating regression (CCR) method (the results are supplemented to that of NARDL which are presented in (Table 8,under Appendix II). Hence, the study comes up with more robust consistency results of CCR with NARDL methods. It also generates a robust dynamic inter-temporal Granger causality test and the results are reported in(Table 9, under Appendix II). These show that there are statistically significant bi-directional Granger Causality between economic growth and the growth rate of upward movement in agriculture sector value added. Moreover, economic growth causes the growth rate of an upward movement of total factor productivity ($x_{1,t}^{+}$) and a downward movement of agricultural sector value added($x_{2,t}^{-}$). In addition, the growth rate downward ($x_{4,t}^{-}$) and upward ($x_{4,t}^{+}$) movements in the service sector value added and openness of the economy cause statistically significant economic growth to grow up (as can be seen on the 3^{st}, 4^{nd}, 5^{th} , 6^{th} , , 8^{th} and 11^{th} of the row in Table 9.

Table 7: Long-run Coefficient Estimation with NARDL (1,0,1,1,1,1,0,1,0,1,1,1)

Variable	Coefficient	t-Statistic	Prob.*
y_{t-1}	-0.7503	-2.3486	0.0512*
$x^{-}_{1,t}$	-0.1478	-0.7006	0.5062
$x^{+}_{1,t}$	0.0508	0.6613	0.5296
$x^{+}_{1,t-1}$	-0.0643	-0.6086	0.5620
$x^{-}_{2,t}$	0.0066	5.2557	0.0012***
$x^{-}_{2,t-1}$	0.0043	2.9217	0.0223**
$x^{+}_{2,t}$	0.0050	7.0502	0.0002***
$x^{+}_{2,t-1}$	0.0031	1.8072	0.1137
$x^{-}_{3,t}$	0.0012	1.3432	0.2211
$x^{-}_{3,t-1}$	0.0023	1.5570	0.1634
$x^{+}_{3,t}$	0.0052	3.2070	0.0149**
$x^{-}_{4,t}$	0.0006	0.2410	0.8165
$x^{-}_{4,t-1}$	0.0026	1.0517	0.3279
$x^{+}_{4,t}$	0.0085	1.9024	0.0988*
x_{5t}	0.0022	1.2267	0.2596
$x_{5,t-1}$	-0.0047	-1.4085	0.2018
x_{6t}	0.0607	0.6315	0.5478
$x_{6,t-1}$	-0.1377	-1.9522	0.0919*
x_{7t}	-0.0731	-2.0147	0.0838*
$x_{7,t-1}$	-0.0889	-3.2747	0.0136**
Constant	0.1845	0.6570	0.5322
@Trend	0.0016	0.1940	0.8517

***,** and * denotes the level of significance at 1%, 5% and 10% respectively. Dependent variable:y_t; ; Method: ARDL; Dependent lags: 1 (Automatic); Automatic-lag linear regressors (1 max. lags): X1_NEG X1_POS X2_NEG X2_POS X3_NEG X3_POS X4_NEG X4_POS X5 X6 X7; Deterministics: Unrestricted constant and restricted trend (Case 4); Model selection method: Akaike info criterion (AIC); Number of models evaluated: 2048; Selected model: ARDL(1,0,1,1,1,1,0,1,0,1,1,1); HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 4.0000) and *Note: p-values and any subsequent test results do not account for model selection.

R-squared	0.995713	Akaike info criterion	-7.573580
Adjusted R-squared	0.982852	Schwarz criterion	-6.536321
F-statistic	77.42221	Hannan-Quinn criterion	-7.248723
Prob(F-statistic)	0.000002	Durbin-Watson stat	2.430359

6. Conclusion and Recommendations

Economic growth in Ethiopia in recent years has been driven by an expansion in the services sector, followed by the agricultural sectors. While achieving remarkable economic growth, sustaining this momentum under macroeconomic instability requires increased agricultural productivity, economic diversification and strategic investments in basic infrastructure and human capital. These can stimulate growth in the manufacturing and service sectors through value-added activities in the process of industrialization such as food processing, agro-industries and agri-businesses as milestones for sustainable economic growth. Since a large proportion of the population in rural areas depends on agriculture, improving agricultural productivity is an essential for poverty reduction. Despite diversification efforts, agriculture plays a critical role by improving productivity so as to reduce poverty in rural areas, an integral to the success of other sectors' growth and to be considered as the backbone of the Ethiopia economy in terms of contributing significantly to employment, GDP and export earnings.

Ethiopia has huge developmental opportunities with a large number of dynamic young population and uncultivated land which are potentially to increase production and productivity of the agricultural sector that ensures food security. Despite the importance of the agricultural sector, challenges persist, which include hardship in agricultural activities and lack of modern infrastructure, land degradation and climate change in which the sector is highly vulnerable to climate-related shocks, negatively impacting food security and gradual declining agricultural productivity.

The decline in production and productivity of agriculture sector in nationwide in general, the food supply to urban residents affected by high cost of transport for long distance and inefficient supply chains in particular, for many decades has been driven upward the food prices. This leads to high rate of inflation, thereby worsen millions of lives. Rising food prices due to disruption of supply chain, climate-related shocks, domestic conflicts, and the outbreak of COVID-19 pandemic deadly disease and emerging trends of geopolitical tensions besides the Russia-Ukraine war, all contribute to defining the macroeconomic policy challenges. Even foreign exchange shortages, income inequality and corruption are another dimensions of the challenges. Nevertheless, the growth has been accompanied by these challenges, an attempt made by the government to make the economy to be sustained through implementation of just the financial sector reform, ignoring the agriculture and industry may possibly be thought-provoking. Since without realization of maintaining the disruption of supply chains from the agriculture sector as

preconditions for macroeconomic stability, trying to implement economic reform entails aggravating inflation rate continuously, which leads to raising the cost of living.

In this sense, thus, the empirical findings of the study reveal that there is a statistically significant dynamic inter-temporal bi-directional Granger causality between economic growth and up-ward movement growth rate in agriculture sector value added. Furthermore, the downward and upward movements in the service sector value added and openness of the economy also cause statistically significant economic growth to grow up. In the end, based on the findings the study recommends the following remarks:

Efforts to improve modern farming techniques and develop agro-processing industries aim at boosting the sector's contribution to economic growth since the agriculture sector offers great potential for creating jobs and increasing value-added exports.

Expansion of cultivating land to the low-land areas, promoting sustainable agricultural practices and climate resilient crops can further ensure the sector's contribution to growth in the face of climate challenges.

With improved access to technology and better agricultural policies, Ethiopia has significant potential for growth. These can help maximize the country's potential for driving long-term sustainable development. Therefore, the government has to focus on modernizing agriculture, improving infrastructure, and diversifying exports.

Further studies are required to investigate the effects on the economy and well-being by taking some other factors such as macroeconomic policy and trade with neighbouring countries is the way forward by this study.

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Appendixes

Appendix I. Important notes and calculation

Total factor productivity (TFP) can contribute as endogenous technology to economic growth only when sufficient absorptive capability of advanced technologies exist. This can be obtained through a residual approach as stated in (Solow, 1956), the most commonly used measure for technological change due new creation of resources (Romer,2012) that relates input–output production function in the Cobb-Douglas form:

$$Y_t = A_t K_t^{\alpha} L_t^{\beta}, \qquad \alpha + \beta = 1, \alpha \geq 0 \,\&\, \beta \geq 0.$$

By transformation the logarithm, total factor productivity (TFP) over time becomes

$$lnTFP_t \equiv lnA_t = ln\left(\frac{Y_t}{K_t^{\alpha} L_t^{\beta}}\right) = lnY_t - (\alpha lnK_t + \beta_t lnL_t)$$

Again from the Cobb-Douglas production function, we can derive the marginal product of capital and marginal product of labor by taking first partial derivatives Y_t with respect to K_t and to L_t using standard calculus respectively as follows

$$MPK_t = \frac{\partial Y_t}{\partial K_t} = \alpha A_t K_t^{\alpha-1} L_t^{\beta} = \frac{\alpha A_t K_t^{\alpha} L_t^{\beta}}{K_t} = \frac{\alpha Y_t}{K_t} \Rightarrow \alpha = \frac{MPK_t \times K_t}{Y_t} \,\&$$

$$MPL_t = \frac{\partial Y_t}{\partial L_t} = \beta A_t K_t^{\alpha} L_t^{\beta-1} = \frac{\beta A_t K_t^{\alpha} L_t^{\beta}}{L_t} = \frac{\beta Y_t}{L_t} = (1-\alpha)\frac{Y_t \times L_t}{Y_t}$$

$$\Rightarrow 1 - \alpha = \frac{MPL_t \times L_t}{Y_t}$$

Here, α and $1-$ are the share of capital and labor respectively.

Economic growth rate as dependent variable and growth rates of factor driving force including TFP, value added in agriculture, industry and service sectors and of foreign direct investment, respectively as $ln\left(\frac{y_t}{y_{t-1}}\right)$ and $ln\left(\frac{x_{j,t}}{xj_{t-1}}\right)$ where j =1,2,⋯,5 as well as openness of economy and macroeconomic instability indexes were calculated :

$$\boldsymbol{x_{6,t}} = \frac{Import_t + \ EXport_t}{GDP_t} \ \ \& \, x_{7,t} = MII_t = \sum_{j=1}^{6} \mathrm{sd_j}\left(\frac{W_{j,t} - minW_{j,t}}{maxW_{j,t} - minW_{j,t}}\right)$$

where $W_{1,t}, \cdots, W_{6,t}$ stands for corruption perceptions index score out of 100, inflation rate in %, unemployment rate in % , general government debt in % of GDP, income inequality index in % and official exchange rate in % were used for the

construction of macroeconomic instability index (MII_t) respectively overtime and sd_j is standard deviation normalization, $\sum_{j=1}^{6} sd_j = 1$.

Appendix II.

Table 1: Selection of optimal lag length criteria

Lag	AIC	BSIC	HQIC
0	12.608	13.174	12.785
1	-2.8114*	4.5436*	-0.5078*

* indicates lag order selected by the criterion; VAR Lag Order Selection Criteria for endogenous variables: Y X1_NEG X1_POS X2_NEG X2_POS X3_NEG X3_POS X4_NEG X4_POS X5 X6 X7;Exogenous variables: C for Sample: 1992- 2023.
Source: Author's estimation based on the data

Table 2. Unit roots test with Augmented Dickey-Fuller (ADF) method

Variable at level	t-Statistic	Prob.	Variable at 1st Difference l	t-Statistic	Prob.
y_t	-4.1342	0.0146*	$D(y_t)$	-4.1822	0.0006**
$x_{1,t}^{-}$	-3.4964	0.0579	$D(x_{1,t}^{-})$	-6.3403	0.0001**
$x_{1,t}^{+}$	-2.3807	0.3814	$D(x_{1,t}^{+})$	-6.5330	0.0000**
$x_{2,t}^{-}$	-1.7302	0.7073	$D(x_{2,t}^{-})$	-5.6049	0.0006**
$x_{2,t}^{+}$	-1.8890	0.6343	$D(x_{2,t}^{+})$	-6.5887	0.0000**
$x_{3,t}^{-}$	-0.8292	0.9509	$D(x_{3,t}^{-})$	-5.6145	0.0005**
$x_{3,t}^{+}$	-2.6448	0.2652	$D(x_{3,t}^{+})$	-4.3474	0.0095**
$x_{4,t}^{-}$	-3.6388	0.0438*	$D(x_{4,t}^{-})$	-5.4468	0.0008**
$x_{4,t}^{+}$	-1.5552	0.7858	$D(x_{4,t}^{+})$	-6.6669	0.0000**
x_{5t}	-6.4048	0.0001**	$D(x_{5t})$	-8.6334	0.0000**
x_{6t}	-2.7553	0.2244	$D(x_{6t})$	-1.9778	0.5857
x_{7t}	-1.5183	0.8013	$D(x_{7t})$	-5.4061	0.0008**

* and ** denotes level of significant at the 5% and 1% respectively; Lag length based on AIC with constant and trend and Probability based on MacKinnon (1996) one-sided p-values.

Table 3: NARDL (1,0,1,1,1,1,0,1,0,1,1,1) model validation

Type of Residual Diagnostics	Short-run model and Long-run model	
	F-statistic	Prob(F)
Jarque-Bera Normslity	0.7681	0.6811
Breusch-Godfrey LM Test for Serial Correlation	4.0692	0.6859
Breusch-Pagan-Godfrey for Heteroskedasticity	1.0902	0.4872
Ramsey RESET Test for model Misspecification	0.3928	0.5539

Source: Author's estmation based on data

Table 4: Robust Long-run Estimation using Canonical Cointegrating Regression Method

Variable	Coefficient	t-Statistic	Prob.
$x_{1,t}^{-}$	0.0754	1.1556	0.2648
$x_{1,t}^{+}$	-0.0007	-0.0208	0.9836
$x_{2,t}^{-}$	0.0055	13.160	0.0000***
$x_{2,t}^{+}$	0.0047	23.749	0.0000***
$x_{3,t}^{-}$	0.0024	6.3448	0.0000***
$x_{3,t}^{+}$	0.0024	4.4552	0.0004***
$x_{4,t}^{-}$	0.0003	0.3162	0.7559
$x_{4,t}^{+}$	0.0027	2.6113	0.0189**
$x_{5,t}$	-0.0007	-0.4668	0.6469
$x_{6,t}$	0.0044	0.1476	0.8845
$x_{7,t}$	-0.0701	-3.0390	0.0078**
constant	0.0899	1.3620	0.1921
@Trend	0.0022	1.5296	0.1456

***,** and * denotes the level of significance at 1%, 5% and 10% respectively.Dependent Variable: Y; Method: Canonical Cointegrating Regression (CCR); Sample (adjusted): 1995 2023;Included observations: 29 after adjustments; Cointegrating equation deterministics: C @Trend, Long-run covariance estimate (Prewhitening with lags = 1 from AIC, maxlags = 1, Bartlett kernel, Newey-West automatic bandwidth =3.8445, NW automatic lag length = 1)

R-squared 0.965627

Adjusted R-squared 0.939847

Source: Author's estimation based on the data

Table 5: Pairwise Granger Causality for NARDL long-run model estimation

Null hypothesis	F-Statistic	Prob.
$x_{1,t}^{-} \neq y_t$	0.99808	0.3834
$y_t \neq x_{1,t}^{-}$	0.71882	0.4975
$x_{1,t}^{+} \neq y_t$	1.20154	0.3182
$y_t \neq x_{1,t}^{+}$	6.02873	0.0076*
$x_{2,t}^{-} \neq y_t$	2.43750	0.1096
$y_t \neq x_{2,t}^{-}$	3.99791	0.0324*
$x_{2,t}^{+} \neq y_t$	3.92845	0.0341*
$y_t \neq x_{2,t}^{+}$	6.82985	0.0047**
$x_{3,t}^{-} \neq y_t$	0.01710	0.9831
$y_t \neq x_{3,t}^{-}$	0.41708	0.6639
$x_{3,t}^{+} \neq y_t$	0.47212	0.6296
$y_t \neq x_{3,t}^{+}$	0.57961	0.5681
$x_{4,t}^{-} \neq y_t$	2.96995	0.0712*
$y_t \neq x_{4,t}^{-}$	0.23668	0.7911
$x_{4,t}^{+} \neq y_t$	2.90978	0.0747*
$y_t \neq x_{4,t}^{+}$	1.90175	0.1721
$x_{5t} \neq y_t$	1.13247	0.3396
$y_t \neq x_{5t}$	0.05736	0.9444
$x_{6t} \neq y_t$	5.22562	0.0131**
$y_t \neq x_{6t}$	0.37233	0.6930
$x_{7t} \neq y_t$	0.04019	0.9607
$y_t \neq x_{7t}$	1.59636	0.2234

** and * denotes the level of significance at 1%, and 5% respectively. Null hypothesis: X1_NEG does not Granger Cause Y and for the remaining represented by ≠ denotes does not Granger Cause, lags 1 for the sample: 1992 -2023

Source: Author's estimation based on data

Appendix III. Figures

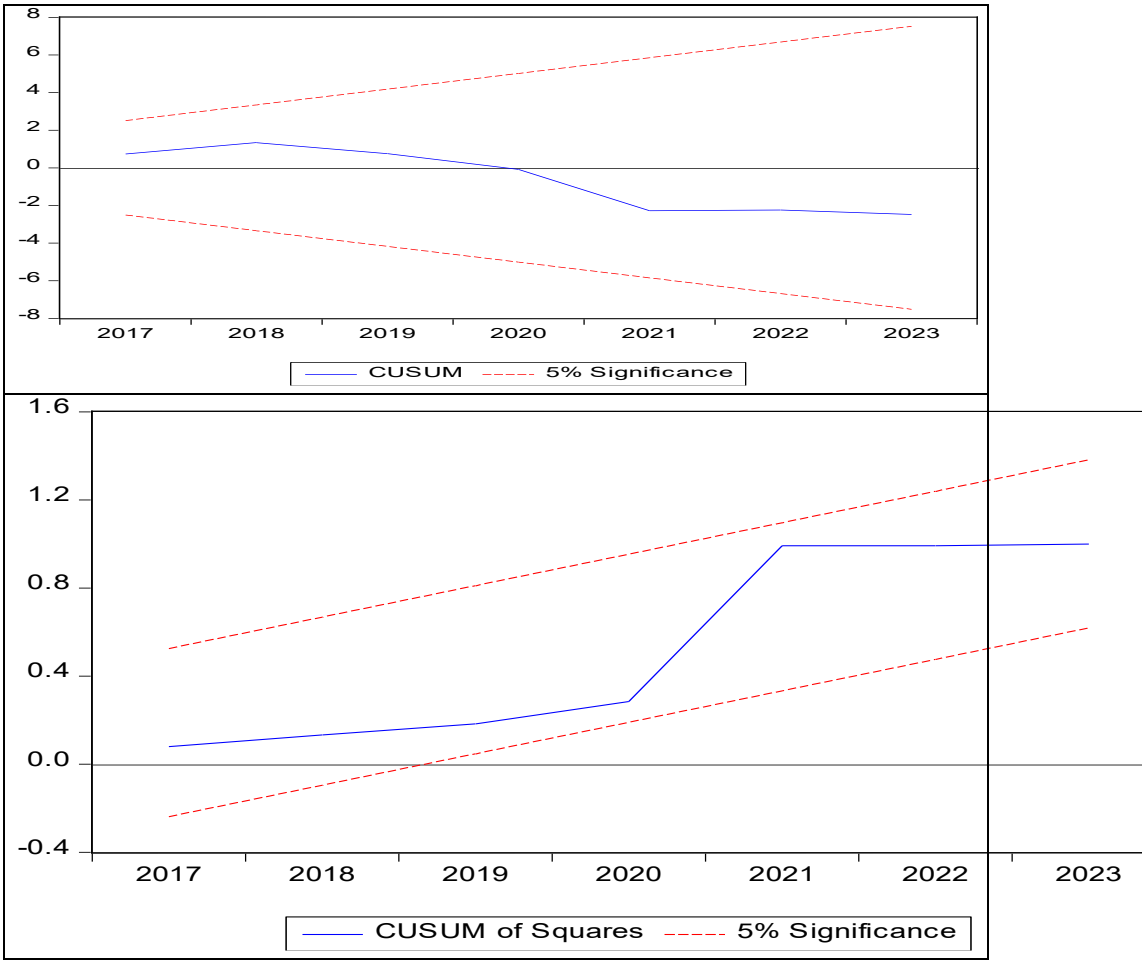


Figure 1: CUSUM and CUSUMSQ diagnostics tests for structural breaks and stability

Source: Author's calculation based on data

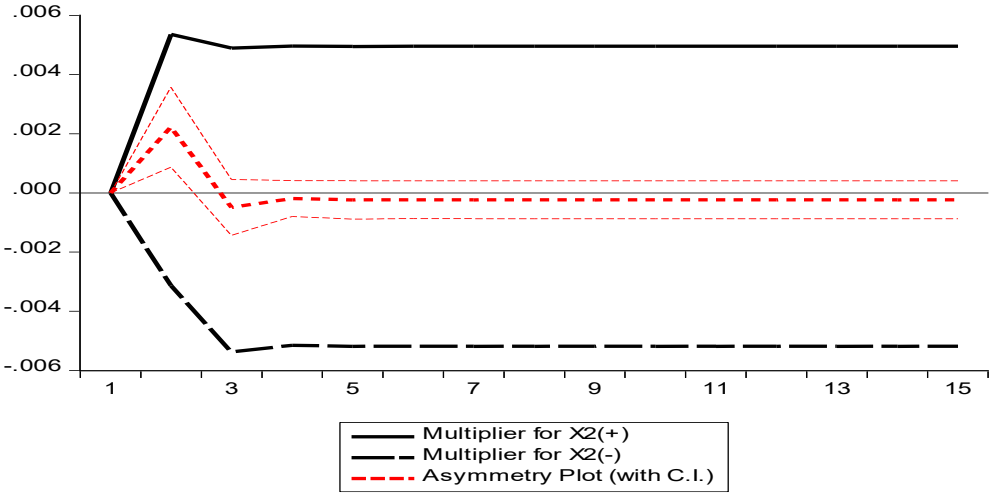


Figure 2. The long-run NARDL dynamic multiplier graphs of the three sector

Source: Author's estimation based on data

Adoption of Small-Scale Irrigation and Its Welfare Impact in North Wollo Zone, Amhara National Regional State, Ethiopia

Zinabu Tesfaw Wube[1]*, Alemu Molla Zegeyea, and Muluken Gebeyehu Arega[1]

Abstract

Irrigation improves the availability and accessibility of food by improving farm productivity, enabling portfolio diversification, and encouraging the adoption of agricultural innovations. The objective of this study is to investigate adoption decision and intensity of small-scale irrigation and to estimate the welfare impact in North Wollo zone, Ethiopia. A cross-sectional research design was employed to collect data from 385 systematically sampled households through face-to-face interviews, using a validated and pre-tested questionnaire. This study employs the Heckman two stage model for the analysis of adoption decision and its intensity of adoption. For welfare impact analysis, this study employs Endogenous Switching Regression model to address potential biases from non-random placement of irrigation schemes and the self-selection of farmers to adopt irrigation on their plots. The descriptive results indicate that river diversion is the dominant irrigation technology across all districts, and gender is associated with differences in irrigation technology adoption. In addition, irrigation governance problems and weak land tenure security undermines irrigation expansion and utilization. The first stage model result reveals that adoption decisions are positively influenced by sex of household head, education level of household head, extension service, credit, off/non-farm income, training participation, irrigation governance and infrastructure, participation of households in irrigation maintenance, and access to climate information. on the other hand, the intensity of irrigation adoption is positively affected by labor availability, education level of household head, training participation, off/non-farm income, irrigation governance and participation of households in irrigation maintenance. Conversely, adoption of irrigation and its intensity is negatively influenced by distance of the plot to irrigation water source and district market. The results of treatment effect show that adoption of irrigation is associated with households' greater calorie intake, household income, consumption expenditure and Asset accumulation. The results provide insight into the further efforts needed to encourage greater access of irrigation water for crop production. Hence, the local government and development partners should continue to improve the socio-economic constraints, irrigation technologies and infrastructure challenges to promote farmers' access to irrigation water.

Keywords: Irrigation; Adoption; welfare Impact; Heckman Sample selection; Endogenous switching regression; North wollo zone; Ethiopia

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1. Introduction

Agriculture continues to serve as the backbone of African economies (African Center for Economic Transformation, 2017). However, climate change significantly impacts agricultural productivity (Okolie et al., 2022) and all dimensions of food security and nutrition (World Food Program, 2014). Therefore, adoption of appropriate climate change adaptation strategies is getting more attention (Schneider & Asch, 2020) because climate change adaptation is necessary to maintain future food security (Chen et al., 2017). As a result, climate-smart agricultural practices are one of the most recent strategies to reduce the negative impact of climate change (Tadesse & Ahmed, 2023).Therefore, it is a crucial strategy to investigate the adoption and intensity of appropriate climate-smart agricultural practices. The adoption of climate-smart agricultural practices can increase farmers' ability to cope with climate change (Teklu et al., 2023) and it is the most effective way to minimize the adverse effects of climate change on agriculture (Belay et al., 2023). This demonstrates the significant effect of climate-smart agricultural practices adoption to mitigate the impact of climate change (Abera et al., 2019) and increases agricultural productivity (Acevedo et al., 2020).

Irrigation development is crucial to stimulate food system transformation. Consistent with this, small-scale irrigation is a catalyst for agricultural intensification (Nakawuka et al., 2018); access to irrigation induces greater use of complementary agricultural inputs (Song et al., 2018), and enhances joint adoption of multiple agricultural technologies, which had greater impacts on crop yields, household incomes, and poverty (Khonje et al., 2018). The reliability of irrigation water positively and significantly affects farm-level productivity (Gebru et al., 2025), and irrigation also increase smallholder's productivity by extending production into the dry season and making them resilient to climate shocks (Adamson et al., 2017; Bryan Elizabeth et al., 2019)

Irrigation coverage in sub-Saharan Africa remains low, despite the returns to investments being potentially high (World Bank, 2007). In Ethiopian agricultural policy, irrigation development is a cornerstone of food security and poverty reduction. This policy has led to intensive efforts to expand irrigation development in the country for the next 10 years. Despite the major attention given to irrigation development, this sector has not sufficiently improved in Ethiopia. Ethiopia has a huge irrigation potential of 4.14 million hectares. However, the actual irrigated area and the number of beneficiaries are insignificant, which is estimated to be 587,000

ha and about 4.2 million farmers, respectively (Planning and Development Commission, 2020). In the Amhara National Regional State, the actual irrigated land is 260,000 ha (11.8%) of the total irrigation potential of 2.2 million ha (Amhara region Agriculture Bureau, 2023). In North Wollo Zone, the actual irrigated land is 15,343.97 ha (16.3%) of the total irrigation potential of 94,138 ha (North Wollo Zone Agriculture Office, 2023).

The low level of irrigation development is due to the fact that irrigation development requires huge investment, irrigation system management and a lack of other support services, including extension services, input services, and market linkage (Planning and Development Commission, 2020). Despite the investment and efforts made in irrigation development, many irrigation schemes in Ethiopia are performing below design expectations, leaving large areas and many beneficiaries without irrigation (Berhe et al., 2022). As a result, the poor performance and operational management of existing irrigation schemes require equal attention (Gebul, 2021). In the study area, adoption of irrigation is considered as one of climate smart agricultural practices. Hence, domestic climate-resilient agricultural productivity must be increased, which requires substantial investment in improving irrigation infrastructure (International Monetary Fund, 2022).

Although a growing body of empirical literature examines the adoption of small-scale irrigation in Ethiopia, most studies demonstrated that there is gap in the methodology employed. For instance, Geddafa et al. (2021) and Daru et al. (2023) applied double hurdle model without testing alternative models for sample selection bias and does not include important variables including access to climate information, the physical system of irrigation infrastructure, governance and collective management of irrigation infrastructure. In addition, Ngango and Hong (2021) employed an impact evaluation model (propensity score matching model) which considers only the adoption decision but not the intensity of adoption and does not consider governance and infrastructure issues of irrigation. Similarly, Asfaw Eshetu and Mekonen (2024); Mume et al. (2023); (Zemarku et al., 2022) and Assefa et al. (2022) used binary logistic regression to analyze the determinants of small scale irrigation adoption. The researchers do not take into account possible sample selection bias due to non-random placement of irrigation schemes, ignore the intensity of adoption and important variables including irrigation governance and infrastructure and access to climate information. Furthermore, Gebregziabher et al. (2014) conducted a study on economic analysis of factors influencing adoption of

water pumps using a probit model. The authors did not consider the intensity of adoption and possible sample selection bias from observed and unobserved factors.

Overall, despite increasing scholarly attention to irrigation adoption, two major gaps remain evident in the existing empirical literature. First, empirical studies have largely focused only on binary adoption models which ignore the intensity of adoption. Second, those empirical evidences did not consider possible sample selection bias from non-random placement of irrigation schemes. Hence, the analysis leads to biased estimates of parameters. Generally, there is methodological limitation to fully capture the adoption and intensity of irrigation by considering sample selection bias. Second, important variables such as institutional arrangements, climate information, irrigation governance and infrastructure are not included in the econometric model.

This research directly addresses these research gaps and contributes to the existing knowledge in three distinct ways. First, methodologically, we employ a structurally consistent Heckman two-stage sample selection model that treats adoption and intensity as an interconnected, two-stage decision, effectively controlling for sample selection bias. Second, conceptually, we expand the conventional demographic and socioeconomic variables by incorporating access to climate information, irrigation governance and infrastructure to capture the physical, social and organizational system of irrigation development. Third, policy-wise, by establishing the average marginal effect for adopters, this study provides actionable, localized empirical parameter estimation. Hence, the objectives of the research are i) to investigate factors influencing the adoption decision and the intensity of small-scale irrigation, and ii) to analyze the impact of small-scale irrigation on household welfare in the North Wollo Zone.

2. Theoretical Framework of Agricultural Technology Adoption

Technology adoption is defined as a mental process an individual pass from first hearing about an innovation to final utilization of it (Feder et al., 1985). Adoption may vary from farmer to farmer and will change over time depending on social, personal, economic and institutional factors. This study is based on individual adoption which is the adoption that takes place at the stage of farmers. Although there are a number of adoption theories and models developed by different scholars such as Theory of Diffusion of Innovation; Technology Acceptance Model; Decomposed Theory of Planned Behavior; Expectancy Livelihood Model; The Basic Model of

Human Behavior with Technologies; this study adopted the Random Utility Theory due to its practical application to the farmers situation.

Random utility theory is based on the hypothesis that every individual is a rational decision-maker, maximizing utility relative to his or her choices. In this study, assuming that farm households are risk-neutral, their decision to adopt small-scale irrigation depends on the value of the expected utility from adoption and not-adoption, which is expressed by indicators such as total income and food consumption. The random utility model is specified as:

$$U_i = \beta Y_i + \alpha A_j + \varepsilon_i \quad \textbf{(1)}$$

where U_i is the expected utility for household i; Yi is the vector of observed explanatory variables; A_j is adoption decision in small-scale irrigation (A_j = 1, if farmers adopted small-scale irrigation and A_j = 0, otherwise); α is the effect of small-scale irrigation on the expected utility (income, and food consumption); and εi is an error term that captures unobserved factors affecting the adoption decision. The utility U_i derived from adoption of small-scale irrigation is not observable but only the choice of adoption or not-adoption can be observed which is represented by a latent variable $U*_i$. Accordingly, farm households would adopt small-scale irrigation only when the expected benefit from adoption $U*_{1i}$ exceeds the expected benefit from not adoption ($U*_{0i}$).

Many scientists have introduced various adoption theories and models to describe the technology adoption in a variety of fields. These theories have been evolved over time considering different factors. Therefore, a separate model with all factors being considered can be developed to suit the agricultural technology adoption model, which includes technological factors, personal factors, social factors and economic factors (Dissanayake et al., 2022). Based on the theoretical framework, the following conceptual framework was developed for this study.

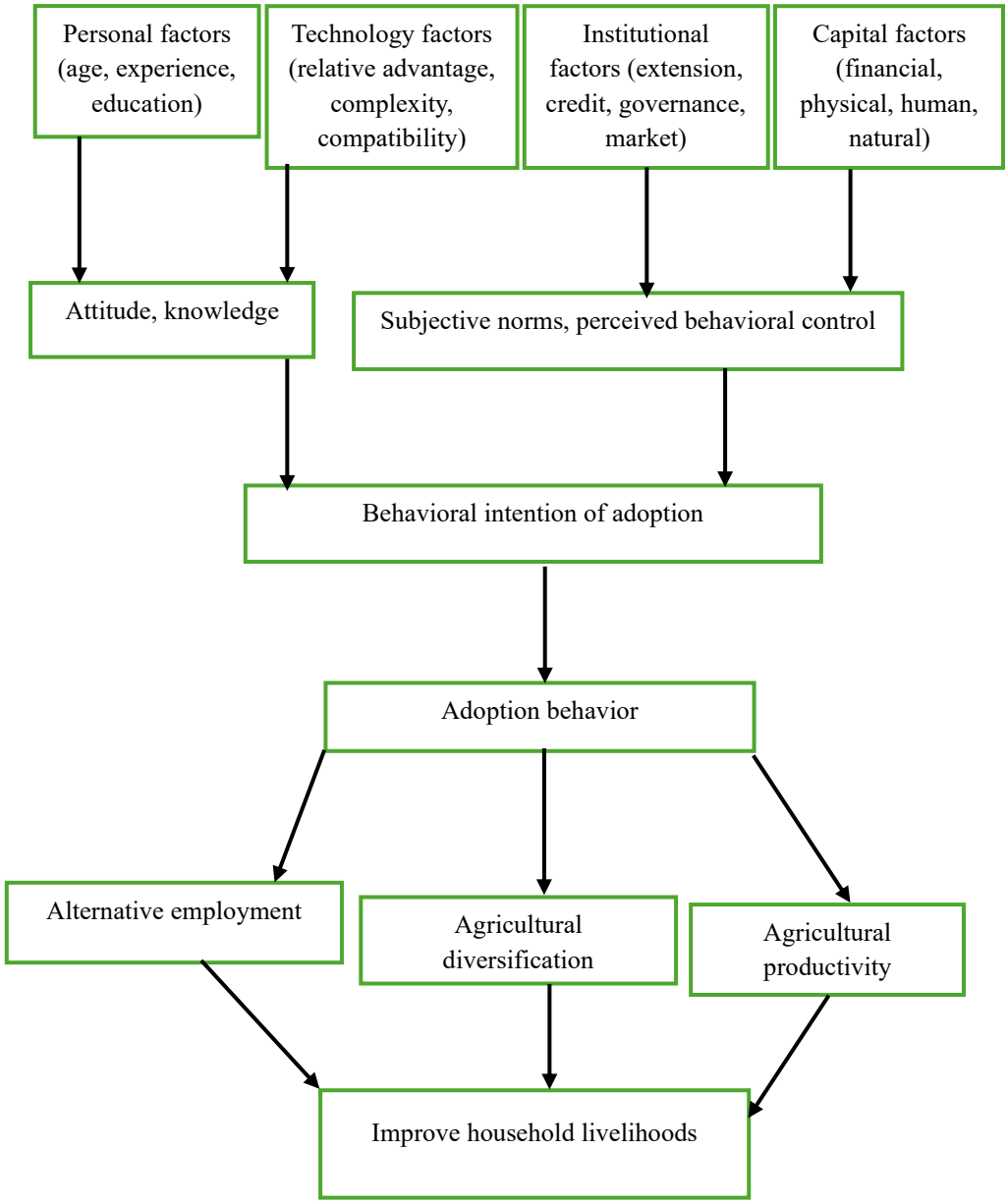


Figure 1: Conceptual framework of the study

Sources: Adopted from Dissanayake et al. (2022) and modified

3. Analytical Framework of Agricultural Technology Adoption

Agricultural technology adoption involves two steps: the decision to adopt and how much to use, which are assumed to occur jointly or separately (Cragg, 1971; Feder et al., 1985). Agricultural technology adoption is not random. A common form of sample selection is called incidental truncation (Wooldrige, 2016). As a result, sample selection problems occur in a wide range of applications in econometrics. Hence, compared to other econometric models , Heckman sample selection model is more efficient to estimate the parameters of irrigation adoption decision and its intensity simultaneously. It provides a principled econometric framework for correcting sample selection bias when outcomes are observed only for a non-random subset of units. By incorporating the Inverse Mills Ratio as a correction term, the model recovers unbiased coefficient estimates even in the presence of endogenous selection (Heckman, 1979). The model combines a Probit model with a linear outcome equation, jointly estimating both to recover unbiased coefficients.

If the farmer is actually irrigating at the time of the survey, then we observe the irrigated land. But for farmers out of irrigation, we cannot observe irrigated land. Therefore, the truncation of irrigated land is incidental because it depends on another variable, which is, irrigation adoption. Importantly, we would generally observe all other information about a farmer, such as age, education, experience, gender, marital status, and family size.

The usual approach to incidental truncation is to add an explicit selection equation to the population model of interest:

$$y = x_i\beta_i + \mu_i, E(\mu_i|x = 0) \quad \textbf{(2)}$$

$$s = 1\,[z_i\gamma_i + v_{\,i} \geq 0] \quad \textbf{(3)}$$

where s=1 if we observe y, and zero otherwise. We assume that elements of x and z are always observed. The error term v in the sample selection equation is assumed to be independent of z (and therefore x (a strict subset of z)). We also assume that v has a standard normal distribution. We can easily see that correlation between u and v generally causes a sample selection problem. Therefore, we can estimate γ by Probit model of si on z_i, using the entire sample. In a second step, we can estimate β using Truncated regression model.

The basic assumption is that x_i should be a strict subset of z_i. This has two implications. First, any element that appears as an explanatory variable in the outcome equation should also be an explanatory variable in the selection equation. A second major implication is that we have at least one element of z_i that is not also in x_i. This means that we need a variable that affects selection but does not have a partial effect on y. The results are usually less than convincing unless we have an exclusion restriction in the outcome equation. The reason for this is that while the inverse Mills ratio is a nonlinear function of z_i, it is often well approximated by a linear function. If $z_i = x_i$, the estimated inverse mills ratio can be highly correlated with the elements of x_i . As we know, such multicollinearity can lead to very high standard errors for the estimated βj. Intuitively, if we do not have a variable that affects selection but not the outcome equation, it is extremely difficult, to distinguish sample selection from a miss specified functional form (Wooldrige, 2016).

4. Empirical Models used for Impact Evaluation

A range of econometric models have been used to address the issue of sample selection bias and estimate the treatment effects of small-scale irrigation adoption and program intervention using cross sectional data. These include Propensity Score Matching (PSM), inverse-probability-weighted regression-adjustment (IPWRA) estimator, augmented inverse-probability-weighted (AIPW) estimator and Endogenous switching regression (ESR) (Di Falco et al., 2011; Dillon, 2011a; Foudi & Erdlenbruch, 2012; Ma & Abdulai, 2019; Shiferaw et al., 2014). Among these econometric models PSM, IPWRA and AIPW can only help to mitigate the selection bias originating from observed heterogeneity not that induced by unobserved heterogeneity (El-Shater et al., 2016; Khonje et al., 2018; Ma et al., 2019). Although the two-stage least square (2SLS) regression model has also been used to address the endogeneity problem (Ma et al., 2019; Thapa et al., 2018), this model is not applicable because it requires two continuous dependent variables. In our analysis, the dependent variable (i.e., adoption of small-scale irrigation) in the first stage of the estimation is a dummy variable.

By contrast, as suggested by previous studies (Adamchik & Bedi, 2000; Lokshin & Sajaia, 2004), compared to other impact evaluation econometric models the Endogenous Switching Regression model has obvious advantages such as selection bias arising from both observed and unobserved factors are addressed, provides more information by enabling the estimation of one selection equation (i.e. adoption to irrigation equation) and two outcome equations (i.e. one for irrigators and another

for non-irrigators) and it calculates the average treatment effects (ATT) of adoption to small scale irrigation on daily calorie intake, household income, consumption expenditure and asset holding. The validity of the ESR model in adoption and impact assessment has been confirmed in studies such as (Di Falco et al., 2011; Huang et al., 2015). Therefore, this study applies the Endogenous switching regression model.

5. Methodology of the Study

5.1. Description of the study area

The study was conduct in selected districts of North Wollo zone, Amhara National Regional State, Ethiopia. As illustrated in Figure 2, Amhara National Regional State is extracted from the map of Ethiopia. Then, from the map of Amhara region, North Wollo Zone is extracted. Finally, sample districts are extracted from the map of North Wollo Zone. North Wollo zone comprises 15 districts (11 rural and 4 urban administrations) with 277 kebeles. It exhibits substantial yet underutilized small-scale irrigation potential. This potential is characterized by a network of perennial and seasonal river catchments (such as the Golina, Hormat, and Alawiha sub-basins), high shallow-groundwater tables in the lowland of Kobo-Girana valley, and localized pockets of low-slope irrigable land. Given the zone's exposure to severe rainfall variability, these hydrological resources offer a critical pathway for scaling up socio-economic resilience through modern river diversions and groundwater extraction systems. Mixed farming is the main livelihood of farm households. However, the agricultural sector is rain-fed and subsistence. As a result, there is a high incidence of drought and food insecurity. The total cultivated agricultural land is 246,278.2 ha and the total number of farmers is 527,342, of which 439,582 are males and 87,760 are females. From the total cultivated land, 15,364 ha is under irrigation. The total beneficiaries of small-scale irrigation are 94, 923 of which 85,238 are male while 9685 are female.

Major crops grown under small-scale irrigation include cereals, vegetables and root crops, spices, pulses and fruits. For the first-round irrigation, the total production is 1,905,414.52 qt. Regarding input utilization 21481.78 qt fertilizer, 244145.34 qt compost, and 1405.06 qt improved seed were utilized. Irrigation methods in the North Wollo Zone include river diversion, motor pump, groundwater, and night water storage (North Wollo Zone Agriculture Office, 2023).

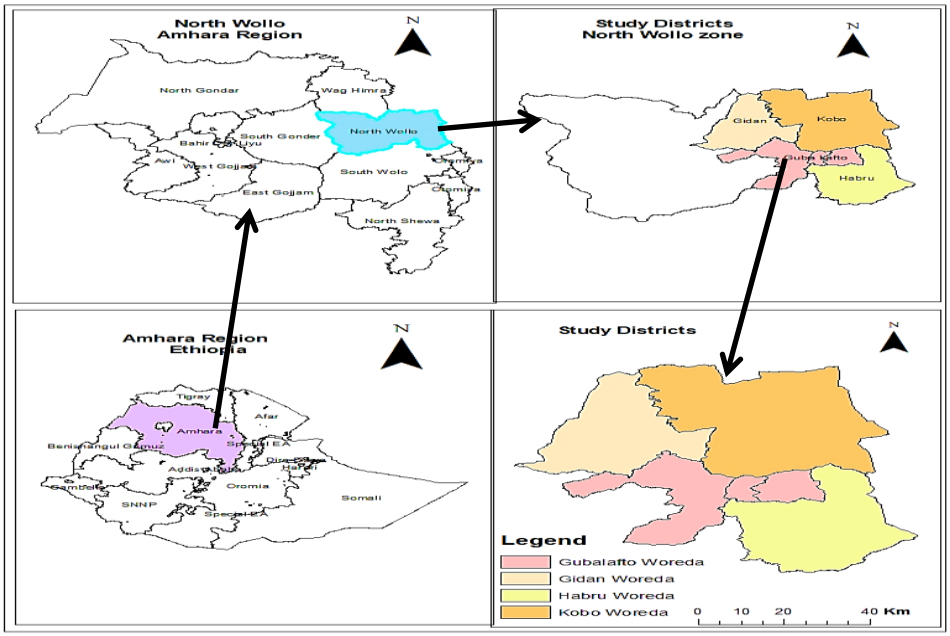


Figure 1: Location map of the study area

5.2. Data type, sources and collection methods

The study was used both primary and secondary data sources. In addition, both qualitative and quantitative data types were collected. The survey was conducted by enumerators using a semi-structured questionnaire. Qualitative data were collected by using focus group discussions (FGD) and key informant interviews (KII).

5.3. Ethical considerations

Ethical approval for this study was obtained from Institutional Review Board of Woldia University. Before data collection, the board evaluate and approve ethical issues regarding confidentiality and anonymity of data, no harm to participants, informed consent, and voluntary participation and right to withdraw. Moreover, during data collection, the researchers explain the purpose of the study to all participants, and informed consent was obtained from each respondent before the household survey, focus group discussions, and key informant interviews. Participants were assured that their responses would remain confidential and would be used solely for academic purposes, and that they could withdraw from the study at any time without any negative consequences. No personally identifiable information was collected or disclosed in the reporting of results.

5.4. Sampling technique and sample size

A multi-stage sampling technique was employed for sample selection. In the first stage, we purposively select 4 districts such as Raya Kobo, Gubalafito, Habru and Gidan based on their irrigation potential. In the second stage, four kebeles within Raya Kobo and three kebeles within each district were randomly chosen. In the third stage, sample household heads in each kebele were randomly selected based on probability proportion to size. The total sample size is determined by using (Cochran, 1977).

$$n_o = \frac{z^2 pq}{e^2} = \frac{(1.96)^2(0.5)(0.5)}{(0.05)^2} = 385 \quad \textbf{(4)}$$

Table 1: Distribution of sample size across selected districts

Sample districts	Total number of household heads	Non-adopters	Adopters	Total sample
Raya kobo	96,209	84	70	154
Gubalafito	43,329	38	32	70
Habiru	65,085	56	48	104
Gidan	35,368	33	24	57
Total sample size		211	174	385

Source: North Wollo Zone fruit, vegetable and irrigation water utilization department (2022)

5.5. Methods of data analysis

Descriptive statistics such as means, frequency tables, and graphs were used to summarize household characteristics. The Chi-square test and t-test were used to assess associations between categorical variables and mean differences in continuous variables, respectively. To strength the descriptive analysis, the Heckman sample selection econometric model was used to identify the determinants of small-scale irrigation adoption and its intensity simultaneously. In addition, endogenous switching regression model was used to evaluate the welfare impact of irrigation adoption.

5.5.1. Specification of the Heckman two stage model

The Heckman sample selection model comprises two separate equations, namely the selection and outcome equations (Heckman, 1979). In the first stage, the probability

of being an adopter is estimated using Probit model and in the second stage, truncated regression is estimated, including the inverse Mills ratio, which is obtained from the first selection equation. The inverse Mills ratio contains information about unobserved factors that determine the selection decision and helps to control the zero-censored data in the outcome equation. A statistically significant inverse Mills ratio result in the selection equation reflects the presence of selection bias that suggests the need for considering two separate models for the selection and outcome decisions.

In the Heckman selection model, the Inverse Mills Ratio (IMR) commonly denoted by the Greek letter λ (lambda) is used to correct for sample selection bias. It represents the probability density function divided by the cumulative distribution function of a standard normal distribution (Wooldrige, 2016). Accordingly, the likelihood of households' small-scale irrigation adoption was estimated using Probit model, which has given us an estimate of 'λ', inverse Mills ratio, or hazard function (Birhanu et al., 2017). Mathematically, it is formulated as

$$\lambda(\acute{z}_\iota\gamma) = \frac{\varphi(\acute{z}_\iota\gamma)}{\Phi(\acute{z}_\iota\gamma)} \quad \textbf{(5)}$$

where;
$\acute{z}_\iota\gamma$ is the linear combination of the selection equation variables and their estimated coefficients
$\varphi(\acute{z}_\iota\gamma)$ is the standard normal probability density function
$\Phi(\acute{z}_\iota\gamma)$ is the standard normal cumulative distribution function

Then, in the second stage , factors associated with the intensity of small-scale irrigation adoption were estimated using truncated regression for different explanatory variables Xi and λ. The conditional expected value of the intensity of irrigation adoption is given by:

$$E(Y_{1i}|Y_{2i} = 1) = \beta\acute{x}_\iota + \rho\delta\lambda(\acute{z}_\iota\gamma) \quad \textbf{(6)}$$

Where Y1 denotes the intensity of small-scale irrigation adoption and Y2 denotes small-scale irrigation adoption, $\lambda(\acute{z}_\iota\gamma) = \frac{\varphi(\acute{z}_\iota\gamma)}{\Phi(\acute{z}_\iota\gamma)}$, is the inverse mills ratio.
Given the above equation, the intensity of small-scale irrigation adoption was modeled as a joint process involving the decision to continue small-scale irrigation

adoption and the intensity of adoption. Let Y1 denote the intensity of small-scale irrigation adoption and Y2 denote small-scale irrigation adoption, which is a dummy variable that takes the value 1 if the household heads are adopting small scale irrigation and 0 otherwise. In Equation 6, x and z are vectors of explanatory variables for the intensity of adoption and adoption equations, respectively. Then we can write:

$$Y_{1i} = \beta \acute{x}_\iota + \sigma \mu_i \quad \textbf{(7)}$$

Y_{1i} is: intensity of small-scale irrigation adoption, which is observed only when $Y_{2i} = 1$

x_i: is a vector of explanatory variables

σ is a scale factor

$$Y_{2i} = \begin{cases} 1 \; if \; \acute{z}_\iota \gamma + \varepsilon_i \geq 0 \\ 0 \; if \; \acute{z}_\iota \gamma) + \varepsilon_i < 0 \end{cases} \quad \textbf{(8)}$$

Y_{2i} is the likelihood of small-scale irrigation adoption

z_i is the explanatory variables

The joint distribution of (μ_i, ε_i) is assumed to be bivariate normal with zero means, variances equal to 1 and correlation 'ρ'.

5.5.2. Identification strategy (exclusion restriction)

Following Wooldrige (2016) and Heckman (1979), to ensure proper identification of the sample selection model, at least one exclusion restriction variable is required that significantly influences the adoption of small-scale irrigation but has no direct effect on intensity of irrigation. In this study, the variable access to climate information was used as an exclusion restriction variable in the Heckman two stage sample selection model. This variable is included in the first-stage probit model (small scale irrigation adoption equation) but excluded from the second-stage outcome equation (intensity of small-scale irrigation equation). The theoretical rationale is that accessing real and timely information regarding climate shocks, particularly drought through community meetings, extension services, mobile phone and mass media, encourage the farmers to adopt small scale irrigation as a climate adaptation strategy.

Access to climate information does not provide a farmer with additional land or increase water discharge to expand their irrigated plots. Its influence lies primarily in shaping the initial decision to adopt irrigation rather than directly determining the scale of continuous operation. Thus, the effect of climate information is indirect, operating through the adoption choice rather than exerting a measurable impact on the intensity of irrigation use. Empirical studies in Ethiopia (Yona et al., 2025) and

(Ahmed et al., 2025b) confirm that integration of climate information is important to enhance the adaptation of climate change and adoption of climate smart agricultural practices requires timely weather information to respond and minimize the effect of climatic shocks respectively.

5.5.3. Specification of the endogenous switching regression model

The Endogenous Switching Regression model involves two stages. The first stage models factors affecting farmers' adoption to small scale irrigation. For the purpose of the analytical setting, we assume that farmers are risk-neutral and making decisions whether or not to adopt small-scale irrigation in order to maximize the expected profit. Let the expected profit obtained by farmer i from adopting small-scale irrigation be UiA and that derived from not adopting be UiN, and in this case, a rational farmer will choose to adopt small-scale irrigation only if the expected profit difference between adoption and non-adoption is positive, i.e., Ui* = UiA - UiN > 0. However, Ui* cannot be directly observed because it is subjective, and it can though be formulated by a latent variable function as follows:

$$U_i^* = \alpha Z_i + \mu_i \; with \; U_i = \begin{cases} 1 \; if U_i^* > 0 \\ 0 \; otherwise \end{cases} \qquad \textbf{(9)}$$

where U_i^* is a binary variable which equals 1 if farmer i adopts small-scale irrigation and 0 otherwise. z_i is a vector of household, farm-level and socio-economic characteristics that may affect the adoption decision of small-scale irrigation. α is a vector of parameters to be estimated. μ_i is an error term which is assumed to be normally and independently distributed with zero mean and variance σ2 (Eq 9) can be estimated by Probit model.

In the second stage of the Endogenous Switching Regression model, the outcome equations for adopters and non-adopters, based on the regimes of small-scale irrigation adoption, are given by

$$\text{Regime 1 (adopters): } Y_{iA} = \beta_{iA} X_i + \varepsilon_{iA} \; if \; \mathrm{U}_i = 1 \qquad \textbf{(10a)}$$

$$\text{Regime 2 (non-Adopters): } Y_{iN} = \beta_{iN} X_i + \varepsilon_{iN} \; if \; \mathrm{U}_i = 0 \qquad \textbf{(10b)}$$

where Y_{iA} and Y_{iN} are the outcome variables (calorie intake, household income, consumption expenditure and Asset accumulation) of farmer i with and without adoption to small-scale irrigation. X_i is a vector of exogenous variables that may

affect the outcome variables. β_{iA} and β_{iN} are parameters to be estimated. ε_{iA} and ε_{iN} are the random disturbance terms.

In Eqs (10a) and (10b), X_i captures the selection bias arising from observed factors. However, if there exists selection bias caused by unobserved factors, the impacts of small-scale irrigation adoption on outcome variables may still be biased. In the Endogenous Switching Regression framework, the inverse Mill's ratios (IMRs) are calculated after estimating Eq. (6) and automatically included in Eq (10a) and (10b) to capture the unobserved selection bias (Adamchik & Bedi, 2000; Huang et al., 2015; Lokshin & Sajaia, 2004). After the inclusion of inverse mill's ratio, Eqs (10a) and (10b) can be rewritten as follows:

$$Y_{iA} = X_i\gamma_{iA} + \sigma_{\mu A}\lambda_{iA} + \omega_{iA} \; if \; \mathrm{U}_i = 1 \qquad \textbf{(11a)}$$

$$Y_{iN} = X_i\gamma_{iN} + \sigma_{\mu N}\lambda_{iN} + \omega_{iN} \; if \; \mathrm{U}_i = 0 \qquad \textbf{(11b)}$$

where Y_{iA}, Y_{iN} and X_i are defined previously; γ_{iA} and γ_{iN} are parameters to be estimated; $\lambda_{iA} = \frac{\phi Z_{i\alpha}}{\Phi Z_{i\alpha}}$ and $\lambda_{iN} = \frac{\phi Z_{i\alpha}}{1-\Phi Z_{i\alpha}}$ are the Inverse Mill's Ratio obtained after estimating (Eq. 9); $\sigma_{\mu A} = cov(\mu_i, \varepsilon_{iA})$, $\sigma_{\mu N} = cov(\mu_i, \varepsilon_{iN})$, ω_{iA} *and* ω_{iN} are the random disturbance terms. Following (Lokshin & Sajaia, 2004), the full information maximum likelihood (FIML) estimator is utilized to estimate (Eq. 6) and (Eq. 11a) and (Eq. 11b) jointly. Besides estimating the coefficients of the variables, the FIML estimator also calculates the correlation coefficients ($\rho_{\mu A}$ and $\rho_{\mu N}$) between the error terms in selection (Eq. 9) and the outcome (Eq. 10a) and (Eq. 10b). The statistical significance of the ($\rho_{\mu A}$ and/or $\rho_{\mu N}$) would suggest the presence of selection bias arising from unobserved factors (Lokshin & Sajaia, 2004; Ma & Abdulai, 2016).

5.5.4. Exclusion variables in the Endogenous Switching Regression model

To correctly identify the Endogenous Switching Regression model, Z_i in (Eq. 9) should include the same variables as X_i in (Eq. 10a) and (Eq. 10b) and with the inclusion of at least one suitable instrumental variable (IV) as a regressor. The IV should theoretically and statistically only affect adoption to small scale irrigation but not the outcome variables. For this purpose, a variable representing the average distance from the farm plot to the nearest irrigation water sources (e.g., reservoir, rivers, pond or motor-pumped well) is used as an instrument variable. Logically, the

distance between plot and water sources meets the criteria for an appropriate instrument: it affects the endogenous variable, adoption to irrigation but not the outcomes except through its impact on irrigation adoption. To test the validity and effectiveness of the instrument variable, we conducted a falsification test (Pizer, 2016).

5.5.5. Estimating the treatment effects of irrigation adoption

The expected outcome for adopters with small-scale irrigation adoption (observed):

$$E[Y_{iA}|\mathrm{U}=1] = X_i\gamma_{iA} + \sigma_{\mu A}\lambda_{iA} \quad (12)$$

The expected outcome for small-scale irrigation adopters if they were not adopters (the counterfactual):

$$E[Y_{iN}|\mathrm{U}=1] = X_i\gamma_{iN} + \sigma_{\mu N}\lambda_{iA} \quad \textbf{(13)}$$

(Eq. 9) represents the expected outcomes in an observed context, while (Eq. 10) represents the expected outcomes in a counterfactual context. Then, the ATT can be calculated as the difference between (Eq. 12) and (Eq. 13):

$$ATT = E[Y_{iA}|\mathrm{U}=1] - E[Y_{iN}|\mathrm{U}=1] = X_i(\gamma_{iA}-\gamma_{iN}) + \lambda_{iA}(\sigma_{\mu A}-\sigma_{\mu N}) \quad \textbf{(14)}$$

Table 2: Treatment effect, predictions from Endogenous switching regression model

Sub-samples	Regimes and counterfactuals		Treatment effects
	Adopt	Not to adopt	
Irrigator households	$E(Y_{1i}\|I_i=1$ (a)	$E(Y_{2i}\|I_i=1$ (b)	ATT (a-b)
Non-irrigator households	$E(Y_{1i}\|I_i=0$ (c)	$E(Y_{2i}\|I_i=0$ (d)	ATU (c-d)
Heterogeneity effects	BH1 (a-c)	BH2 (b-d)	TH=ATT-ATU

5.5.6. Variable definition and measurement

Small-scale irrigation is defined as farmer-managed, low-cost, and localized systems that provide water to crops on a relatively small area of land. It includes water harvesting, wells, pumps, and gravity. Adoption of small-scale irrigation refers to the utilization of irrigation water by individual farm households for crop production. It takes a value of 1 if the household utilize small scale irrigation and 0 otherwise.

Intensity of small-scale irrigation adoption refers to the amount of cultivated land under irrigation measured in hectare during the survey year.

Outcome variables

A. Calorie intake: refers to the total kilocalories consumed by all members of a household over the last seven days preceding the survey period. Calorie intake is commonly used to measure food security status at the household level. In impact evaluations, it is typically calculated using household food consumption data converted into kilocalories (kcal). The procedures are as follows

Step 1: Data collection approach: using a 7-day recall, we have to collect the type of food consumed, quantity consumed, units and sources preceding the survey period.

Step 2: Convert food quantities to standard units: we have to convert local quantities by using local conversion factors and other quantities into kilograms and grams

Step 3: Convert quantities into calories: By using the Ethiopian food composition table, we have to convert quantities into calories.

$$Calories\ from\ food\ item = quantity\ consumed * calorie\ per\ gram$$

For all food items consumed by the households, total calories can be computed by

$$Total\ household\ calories = \sum(food\ quantity * calorie\ conversion\ factors)$$

Step 4: Convert to daily household calorie intake using the following formula

$$Daily\ household\ calories = \frac{total\ weekly\ calories}{7\ days}$$

Step 5: Adjust for household size: because households differ in size and composition

$$Calorie\ per\ adult\ equivalent = \frac{daily\ household\ calories}{total\ adult\ equivalent}$$

Step 6: Compare with food security threshold: in Ethiopia, the commonly used threshold is 2200 kcal per adult equivalent per day. Hence, the household is food secure if the calorie per adult equivalent is greater than or equal to 2200 kcal per adult equivalent per day.

B. Household Income: It is the annual income of all members of the household from both farm and non-farm sources. Household income is an important measure of household economic welfare. It is measured in monetary value.

C. Consumption Expenditure: It is the total amount of money spent by households for food, non-food items and services within the production year. It is measured in monetary value.

D. Asset accumulation: It refers to the process by which farm households increase their stock of productive assets (farm assets) and household assets over time, thereby strengthening their economic capacity, resilience, and long-term welfare. In agricultural and development economics, Asset accumulation is considered a dynamic indicator of welfare, reflecting a household's ability to generate income, manage risk, smooth consumption, and invest in future productivity. In household surveys, Asset accumulation is commonly measured using:

$$Total\ asset\ value = \sum (quantity\ of\ each\ asset * current\ market\ price)$$

Based on a review of theoretical framework and empirical literature, demographic, socio-economic and institutional factors are identified for the determinants of adoption and intensity of small-scale irrigation ((Adela & Aurbacher, 2018) (Birhanu et al., 2017). The rational to use perception-based measures such as irrigation governance, irrigation maintenance and irrigation infrastructure was guided by two considerations. First, these constructs are inherently qualitative and context-dependent, making perception a practical proxy for capturing community level realities. Second, binary coding facilitated their incorporation into regression models while preserving analytical clarity. To reduce subjectivity, we relied on standardized questionnaires and triangulated responses with focus group discussions and field observations. The definition and expected hypothesis of independent variables on the dependent variables are summarized in Table 3.

Table 3: Variable definition, measurement and expected hypothesis

Dependent Variables	Description and type of measure	
Adoption of small-scale irrigation	Refers to the utilization of irrigation water by individual farm households for crop production. It is a dummy variable which takes 1 if household heads have adopting small scale irrigation and 0 otherwise.	
Intensity of small-scale irrigation adoption	It is the amount of cultivated land under irrigation during the survey year. It is a continuous variable measured in hectare.	
Independent Variables	**Description and type of measure**	**Expected hypothesis on adoption**
Age of household head	Refers to the number of years lived by a household head which serves as a proxy for experience, decision-making maturity, and risk preferences. It is a continuous variable measured as age in years	+/-
Sex of household head	It refers to the natural biological differences between males and females. This is a dummy variable that is measured as 1 if the household head was male and 0, otherwise.	+
Education level of household head	It refers to the highest grade or formal qualification attained by the household head during the survey period, usually measured in terms of years of schooling.	+
Labor	It is defined as the human effort, both physical and intellectual, mobilized in the production process, serving as a critical input that determines productivity, technology adoption, and sustainability in agricultural systems. It includes household members who are eligible and willing to work and hired labor for agricultural production. It is a continuous variable measured in man-equivalent.	+
Livestock	It is defined as domesticated animals reared by households for food, draft power, income generation, and cultural purposes, commonly measured in Tropical Livestock Units to capture household asset endowment	+
Extension service	It is defined as the institutional mechanism through which agricultural knowledge, innovations, and advisory support are delivered to farmers, enabling them to adopt improved practices and enhance productivity. It is measured as the frequency of contact or visits made by agricultural extension workers to farm households during the survey year.	+
Land size	It is defined as the aggregate area of farmland under crop production by a household during a survey year, encompassing both irrigated and rainfed plots. It is a continuous variable measured in hectares.	+/-

Irrigation distance	It refers to the physical length between a farmer's plot and the nearest accessible water source (river, canal, pond, or groundwater point) used for irrigation. It is measured in kilometer.	–
Distance of plot to district market	It is defined as the physical separation between a household's farmland and the nearest district market center, where agricultural products are sold or purchased. It is measured in kilo meter.	–
Off/non-farm income (log)	The portion of farm households' income that is generated from outside of the farm itself and non-farm business. It includes wages, business and remittances. It is a continuous variable measured in Ethiopian Birr.	+/-
Credit amount (log)	It is the total amount of money borrowed by households from formal and informal sources for agricultural production. It is a continuous variable measured in Ethiopian Birr.	+
Training participation	It is defined as a structured process of transferring agricultural knowledge and skills to farmers by governmental and non-governmental organizations, enabling them to adopt improved agricultural practices and enhance productivity through capacity building. It is a dummy variable, coded 1 if the household head participated in agricultural training and 0 otherwise.	+
Irrigation governance	It is defined as the set of institutional mechanisms, rules, and collective practices that regulate the management and distribution of irrigation water, ensuring efficiency, equity, and sustainability in agricultural production. It takes a value of 1 if a farmer perceives there is good irrigation governance, 0 otherwise.	+
Irrigation infrastructure	It refers to physical facilities, structures and technologies that enable the diversion, conveyance, distribution and application of water for agricultural purpose. It takes a value of 1 if a farmer perceives there is good irrigation infrastructure, 0 otherwise.	+
Participation of households in irrigation maintenance	It refers to the active involvement of farming households in the repair, maintenance and management of irrigation infrastructure and water distribution systems. It takes the value of 1 if the households participate in irrigation infrastructure maintenance and 0 otherwise.	+
Access to climate information	It refers to the collection and interpretation of weather and climate data that is credible, relevant and usable. Smallholder farmers obtain climate information through various sources such as, community meetings, extension services, and mass- media. It takes a value of if farm households have access to climate information, 0 otherwise.	+

6. Results and Discussion

6.1. Descriptive and inferential analysis of explanatory variables

The descriptive result of Table 4 indicated that there is significant mean differences of adopters and non-adopters of small-scale irrigation with respect to total family size, man equivalent, educational attainment, dependency ratio, distance to irrigation water sources, production, off/non- farm income, extension contacts, distance to district market, distance to main road, credit amount, production cost. In addition, the average family size, man equivalent, educational attainment, extension contacts, credit amount, income from crop production, non/off farm income, and production cost of adopters are higher than non-adopters of small-scale irrigation. On the other hand, dependency ratio, distance to irrigation water sources, distance to district market and main road of adopters is lower than that of non-adopters. Moreover, the share of irrigated land in total cultivated land is 28% for the whole sample and 62% for adopters of small-scale irrigation. The descriptive result indicated that the extent of irrigation adoption in North Wollo is low compared with the irrigation potential.

Table 4: Mean differences between adopters and non-adopters of small-scale irrigation

Variables	Combined mean	Adopters	Non-adopters	Mean difference
Age	48.70	48.39	48.96	-0.57
Total family size	5.09	5.25	4.95	0.3*
Adult equivalent	4.04	4.07	4.02	0.05
Man equivalent	3.45	3.82	3.15	0.67***
Educational attainment	4.51	6.22	3.11	3.11***
Dependency ratio	1.42	1.37	1.46	-0.09**
Total cultivated land	0.91	0.94	0.89	0.05
Distance to irrigation water source	4.54	2.72	7.26	-4.54***
Total livestock in TLU	4.62	4.60	4.64	0.045
Total extension contacts	4.66	6.78	2.91	3.87***
Distance to district market	87.57	60.26	110.09	-49.84***
Distance to main road	39.06	36.61	41.10	-4.48***
Total amount of credit	7960.39	10923.85	5516.59	5407.26***
Income from livestock	24145.8	24993.2	23447	1546.20
Income from crop production	69612.85	102286	42669.08	59616.97***
Non/off-farm income	17650.23	27368.55	9636.08	17732.48***
Production cost	16473.14	24636.3	9741.43	14894.86***
Irrigation ratio	28%	62%		

Source: Own survey data, 2022; *** p<0.01, ** p<0.05, * p<0.1

As indicated in Table 5, the Chi-square test result showed a significant relationship between sex, marital status, training, education status, membership in an irrigation cooperative, access to agricultural credit, access to reliable input and output market, access to weather information, irrigation governance, irrigation infrastructure, and adoption of small-scale irrigation at different levels of significance.

Table 5: Characteristics of dummy variables between adopters and non-adopters

Variables	Category	Number of adopters	Number of non-adopters	$\chi 2$ -test
Sex (male=1)	Female	21	53	10.459***
	Male	153	158	
Marital status (married=1)	Married	143	150	6.45**
	Single	31	61	
Educational status (literate=1)	Illiterate	55	85	5.62*
	literate	119	157	
Irrigation Training (yes=1)	Yes	156	0	318.04***
	No	18	211	
Membership in an irrigation cooperative (yes=1)	Yes	132	0	243.58***
	No	42	211	
Credit access for agriculture (yes=1)	Yes	55	85	3.1*
	No	119	126	
Off/non-farm income participation (yes=1)	Yes	130	134	5.56**
	No	44	77	
Access to reliable input and output market (yes=1)	Yes	44	90	12.68***
	No	130	121	
Access to climate information (yes=1)	Yes	123	66	59.26***
	No	51	145	
Good irrigation governance (yes=1)	Yes	120	62	59.94***
	No	54	149	
Good irrigation infrastructure (yes=1)	Yes	153	158	10.46***
	No	21	53	
Participation in irrigation maintenance (yes=1)	Yes	116	47	76.96***
	No	58	164	

Source: Own survey data, 2022; *** $p<0.01$, ** $p<0.05$, * $p<0.1$

6.2. Sources of irrigation water

The result in Figure 2 indicated that river diversion is the main source of irrigation water in the study area. Water pump is the second-highest source of irrigation. However, based on focus group discussion, there is no district market or maintenance for this irrigation technology. The Chi-square test showed a significant relationship between sources of irrigation water and access to irrigation at 1% level of significance.

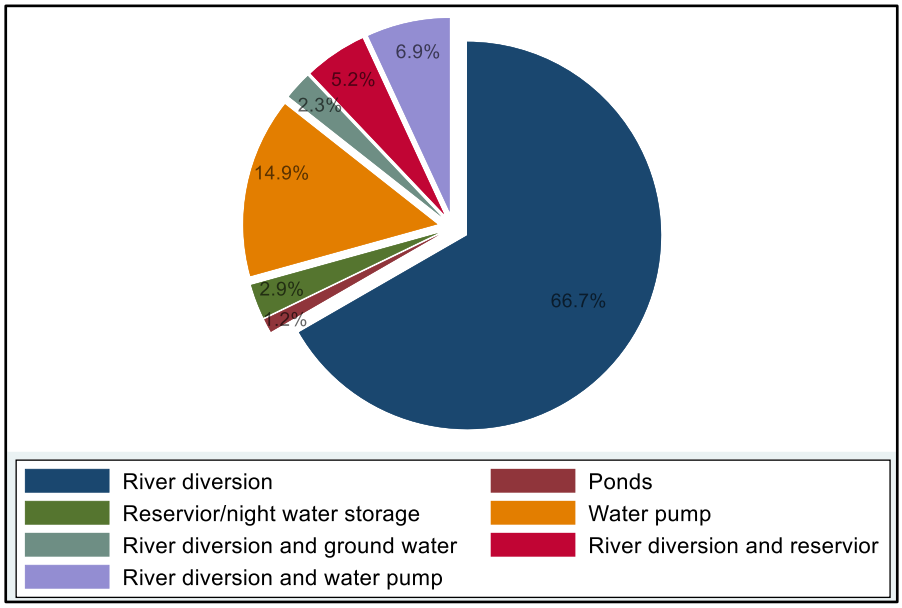


Figure 2: Sources of irrigation water in the study area

6.3. Comparison of irrigation sources by district

The descriptive result of Table 6 shows the distribution of irrigation sources across the four study districts. River diversion is the predominant source, used by 67% of households, while water pumps and combined irrigation systems are concentrated in Raya Kobo and Habru districts. The distribution of irrigation sources varies across districts. For instance, Raya Kobo has the most diverse sources, while Gubalafito and Gidan rely mostly on river diversion. The Pearson chi-square test indicates a significant association between district and irrigation source ($\chi^2 = 46.76$, $p = 0.0002$), suggesting that the type of irrigation used varies systematically across districts. The result implies that development interventions can target districts with less diversity of irrigation adoption.

Table 6: Tabulation of Irrigation Source by District

Source of irrigation water	District				
	Gidan	Gubalafito	Habru	Raya kobo	Total
River diversion	19	25	34	38	116
Ponds	2	0	0	0	2
Reservoir/night water storage	1	0	0	4	5
Water pump	2	6	7	11	26
River diversion and groundwater	0	0	0	4	4
River diversion and night water storage	0	0	0	9	9
River diversion and water pump	0	1	7	4	12
Total	24	32	48	70	174
Pearson Chi2 = 46.76 Prob = 0.0002					

6.4. Descriptive analysis of outcome variables

The descriptive result in Table 7 shows the summary statistics of the outcome variables. The result of the t-test confirms that there is a significant mean difference between adopter and non-adopter households at 1% level of significance for all outcome variables. The income of households that have adopted small-scale irrigation is significantly higher than that of households that have not adopted small-scale irrigation. This means that households that have adopted small-scale irrigation are more likely to increase their household income. The total consumption expenditure of households that have adopted small-scale irrigation is significantly higher than that of households that have not adopted small-scale irrigation. This means that households that adopt irrigated agriculture are more likely to increase their total consumption expenditure. In addition, daily calorie intake per adult equivalent and asset accumulation are significantly higher among small-scale irrigation adopters than non-adopters.

Table 7: Summary statistics of the outcome variables

+	Combined mean	Adopters	Non-adopters	Mean difference
Household income	111408.9	154647.8	75752.15	78895.6***
Consumption expenditure	57057.43	60404.32	54297.43	6106.90***
Calorie intake	2325.16	2629.98	2073.78	556.20***
Asset accumulation	310857.60	391276.40	244540.60	146735.9***

Source: Own survey data, 2022; *** p<0.01, ** p<0.05, * p<0.1

6.5. Econometric results

6.5.1. Model specification and diagnostic reports

As illustrated in Table 8 a model diagnostic test was conducted to evaluate the appropriateness of using Heckman two stage sample selection model instead of other alternative econometric models. The log likelihood ratio of the model was highly significant at a 1% level, which shows rejection of all the model regression estimates are jointly zero. This reveals that the hypothesized variables jointly explain small-scale irrigation adoption and its intensity. To test multicollinearity among independent variables, variance inflation factors (VIF) test was conducted and the result confirmed that data was free from multicollinearity problem (Appendix Table 1). The Likelihood Ratio (LR) test of independent equations evaluates the structural independence between irrigation adoption and intensity of adoption. The test yields a chi-squared statistic of 9.21 with a p-value of 0.0024. Therefore, we reject the null hypothesis of joint independence at 1% significance level. This confirms that unobserved factors simultaneously influence both the decision to adopt small-scale irrigation and the subsequent intensity of adoption.

Consistent with the LR test, the inverse mills ratio (lambda) from the selection equation has negative value (-0.075) and it is significantly different from zero at 1% significant level, which confirms the presence of selection bias in the sample (Table 8). This indicates that the error terms of the selection model, irrigation adoption and the outcome model, intensity of irrigation, are negatively correlated suggesting unobserved factors that make success of irrigation adoption are more likely to be associated with lower intensity in irrigation adoption. Substantively, this implies that resource-constrained, highly vulnerable, or risk-averse households who are more eager to select into irrigation as a climate-risk mitigation strategy face binding labor or capital limitations that restrict their capacity to expand their actual irrigated plots. Overall, the model diagnostic results statistically justify the application of the Heckman sample selection model over standard linear models to control for sample selection bias.

6.5.2. Determinants of small-scale irrigation technology adoption

This section presents the results of Heckman first stage model (Probit) for identifying factors associated with small scale irrigation technology adoption (Table 8). Since the Probit model is non-linear, we can interpret the sign and statistical significance of the independent variables. To interpret the coefficients, marginal effects should be estimated after running the model using margins command. The marginal effect

(dy/dx) reported in Table 8 provide insights into the change in probability of irrigation adoption to a unit change in the continuous independent variables and a change in the probability of irrigation adoption for discrete change of dummy variable from 0 to 1. The result in Table 8 illustrated that small scale irrigation adoption is positively and significantly affected by sex of the household head, education level, extension service, training, off/non-farm income, credit, irrigation governance, irrigation infrastructure, participation of households in irrigation maintenance, and access to climate information. The sign of independent variables aligns with the expected hypothesis. Nevertheless, it was observed that irrigation distance and distance of plot to district market were negatively associated with the small-scale irrigation adoption.

As shown in Table 8, there was a positive and significant relationship between sex of household head and small-scale irrigation adoption at 5% significance level. The result revealed that being male household head associated with 10.6% more likelihood to adopt small scale irrigation than female counter parts. While both male and female smallholders encounter obstacles when adopting small-scale irrigation, female farmers face a disproportionately higher number of overlapping structural constraints. These disparities are heavily rooted in unequal resource endowments and insecure property rights. In most rural contexts, women experience lower access to credit, smaller land allocations, and less secure tenure, which severely undermines their willingness to invest in irrigation and restricts their capacity to independently control its economic benefits. Furthermore, these resource constraints are compounded by severe input market imperfections, leaving female-led households persistently disadvantaged in securing reliable water, labor, and competitive output markets.

These socio-economic inequalities are reinforced by institutional exclusion within collective water governance and extension networks. Water User Associations dictate irrigation water allocation matrices and control access to distribution canals. However, women's membership and leadership in these vital local bodies are systematically restricted because eligibility is often contingent on formal land ownership or recognized household headship. Additionally, the timing and location of meetings frequently conflict with women's domestic care work, while deeply entrenched traditional social norms continue to define public resource negotiation as an exclusively male domain. This institutional isolation is mirrored in information dissemination channels; female farmers are routinely excluded from extension

contact, farmer field days, and agronomic training modules, creating severe information asymmetries.

Finally, these challenges are exacerbated by lack of gender responsive technological designs. Household irrigation equipment such as motorized or manual pumps is rarely designed with or for women, meaning their specific ergonomic preferences, physical labor constraints, and operational time allocations are completely omitted from design and dissemination strategies. Cumulatively, these interconnected financial, institutional, and technological frictions function as powerful entry barriers that suppress women's participation in small-scale irrigation. This results consistent with finding of Kumasi et al. (2019) who showed that relative to male headed farmers, female was less capable of coping with climate shocks due to lack of irrigation access and Ahmed et al. (2025a) household head being male affects the adoption of climate smart agriculture positively.

The results indicated that irrigation adoption was positively and significantly influenced by the education level of the household head at the 5% significance level. The value of marginal effect showed that the probability of adopting irrigation increased by 0.9% as family head education increased by one year of schooling. The result illustrates that more educated farmers have more likelihood to adopt irrigation compared to less educated farmers. This result suggests that the adoption of small-scale irrigation depends on the level of education of farm households. The result is in line with the findings of (Asfaw Eshetu & Mekonen, 2024; Birhanu et al., 2017; Daru et al., 2023; Sisay, 2024), which emphasize the importance of education in promoting the adoption of small-scale irrigation.

As expected, the model result revealed that extension contact was positive and significant at 1% significance level. The positive effect indicates that the likelihood of irrigation adoption increases as farmers contact with extension agents increase. The marginal effect revealed that as the frequency of extension contact increased by one unit, the likelihood of adopting irrigation has increased by 4.5%, assuming all other variables constant. This result is consistent with the findings of Bojago and Abrham (2023) which emphasize households having agricultural extension services have more likely benefit from the use of small scale irrigation. Moreover, (Abdurezak et al., 2026) found that extension contact positively influence the adoption of climate smart agricultural practices.

Distance of irrigation water source and irrigation adoption showed a negative and significant relation at 1% significance level (Table 8). This means that there is an

inverse relationship between distance to irrigation water source and the likelihood of irrigation adoption, as 1 kilo meter increase in distance to irrigation water source leads to a 1.1% decrease in the likelihood of irrigation adoption. The explanations are longer distance between a cultivated plot, and the water source exponentially increases the capital and energy required to transport water, increased seepage and evaporation losses along traditional canals. Furthermore, plots located farther from the primary source face increased vulnerability to water scarcity, as upstream users often appropriate the majority of the flow. This indicates that plots that are far from the irrigation source are less likely to have access to irrigation water, probably due to traditional irrigation canals, poor management and maintenance of irrigation infrastructure. This result is consistent with the findings of (Agide et al., 2016; Muleta & Milkias, 2021; Sisay, 2024) which argued that access to reliable water supply and distance of land from the irrigation source affect households' participation decision in small scale irrigation. In addition, (Abdurezak et al., 2026) argued that market and plot distance negatively affect smallholder farmers' adoption of climate smart agricultural practices.

The result showed that the adoption of small-scale irrigation negatively and significantly affected by distance of plot to district market at 1% significant level. The marginal effect showed that as distance of plot to district market increase by 1 kilo meter, then the likelihood of irrigation adoption decreased by 0.1% (Table 7). A possible explanation for this result could be that plots further away from the district market have greater difficulty in accessing inputs and selling their produce in time due to higher transaction costs. The result is supported by Dawid et al. (2021) and Sisay (2024) which argues that distance to district market negatively influence irrigation adoption.

Off/non-farm income and credit has a significant positive impact on the likelihood of irrigation adoption at 5% significance level (Table 8). The average marginal effect revealed that a 1% increase in household off/non-farm income led to 2.1% increase in the likelihood of irrigation adoption. Similarly, a 1% increase in credit service led to 0.6% increase in the likelihood of irrigation adoption. This result implied that the important role of increased institutional support in promoting irrigation adoption. The result confirmed that delivering agricultural credit can enhance the adoption of small-scale irrigation by alleviating the liquidity problems. Previous findings of Muleta and Milkias (2021) and Ngango and Hong (2021) reported that access to credit services affected household participation decision in small scale irrigation. In addition, these findings aligns with Tesfaye et al. (2021) research which shown that

smallholders are constrained by inadequate access to financing options to adopt more efficient and labour-saving water lifting technology.

The adoption of small-scale irrigation was positively and significantly affected by training participation at 5% significance level. The average marginal effect results illustrated that the likelihood of irrigation adoption increased by 20.3% as farmers participated in agricultural training. When the farmers trained about climate smart agriculture, natural resource management, crop and livestock production, they can adopt innovative agricultural technologies. The result also revealed that adoption of small-scale irrigation positively and significantly affected by the quality of governance, infrastructure, and participation of households in the infrastructure maintenance at 1% significance level.

The marginal effect results revealed that compared to households without good irrigation governance, households having good irrigation governance have 9.6% more likely to adopt small-scale irrigation. Similarly, compared to farm households which has irrigation infrastructure problem, households having good irrigation infrastructure have10.6% more likely to adopt irrigation. Furthermore, compared to non-participant households, the likelihood of irrigation adoption increases by 6.7% for households participating in irrigation maintenance and management. This result is supported by focus group discussant which argues that management of irrigation system faces multidimensional challenges including poor operation and maintenance practices, low level of community participation in planning and design, and weak public private coordination. In addition, water users association face financial constraints due to low membership fees, limited leadership capacity, inadequate access to credit, low administrative capacity, limited technical knowledge, and unclear water fee systems.

Consistent with previous studies (Adela & Aurbacher, 2018), possible explanations are irrigation water scarcity is caused by poor irrigation governance and mismanagement. Moreover, the result is consistent with the findings of Adela et al. (2019) which argues that scheme governance, perceived water scarcity, and access to information have significant effects on the adoption of irrigation and Awulachew and Ayana (2011) who also suggest that the proper management of irrigation systems should be given equal attention as the development of new systems. The result is supported by Agide et al. (2016) which argues irrigation schemes in Ethiopia, regardless of their typology, have low water delivery performance. As a result, if farmers are participated in the different activities of irrigation infrastructure maintenance and management, then there is a high propensity of farmers in adopting

small scale irrigation activities. The findings are in line with previous studies of Enyew (2024) which argues that investments in improved irrigation infrastructure foster sustainable agricultural and food systems and Yohannes et al. (2017) poor scheme level water management practices are among the major causes for aggravating water scarcity.

Table 8: First stage estimates of the Heckman two stage model (Probit model)

Variables	Coefficient	Std. Err	Average marginal effect	
			dy/dx	Std. Err
Age of household head	-0.013	0.016	-0.001	0.001
Sex of household head	1.169**	0.5	0.106	0.044
Education level of household head	0.104**	0.05	0.009	0.004
Labor	0.107	0.134	0.010	0.012
Livestock	-0.125	0.096	-0.011	0.009
Extension services	0.493***	0.097	0.045	0.007
Land size	0.574	0.402	0.052	0.036
Irrigation distance	-0.127***	0.04	-0.011	0.003
Distance of plot to district market	-0.012***	0.004	-0.001	0.000
Off/non-farm income (log)	0.235**	0.118	0.021	0.011
Credit amount (log)	0.069**	0.031	0.006	0.003
Training participation	2.245**	1.129	0.203	0.101
Irrigation governance	1.064***	0.273	0.096	0.023
Irrigation infrastructure	1.177***	0.339	0.106	0.028
Participation of households in irrigation maintenance	0.745***	0.286	0.067	0.025
Climate information	0.923***	0.268	0.083	0.023
Constant	-3.387***	1.249		
Model diagnostic reports				
Number of observations= 385; Selected = 174; Nonselected = 211				
Log likelihood = 107.1361 Wald chi2(15) = 256.75 ; Prob > chi2 = 0.0000				
LR test of independent equations (rho = 0): chi2(1) = 9.21 Prob > chi2 = 0.0024				
Lambda (Inverse mills ratio): Coefficient: -0.075*** ; standard error: 0.025				
Rho (ρ): -0.75041				
sigma (σ): 0.099				

Source: Model result; *** significant at 1%, ** significant at 5%, * significant at 10%

Access to climate information which is the exclusion variable in the Heckman two stage model positively and significantly affected the adoption of small-scale irrigation at 1% significance level. The marginal effect demonstrated that the likelihood of adopting irrigation increased by 8.3% as farmers access climate information. Having real and timely climate information encourage the farmers to adopt small scale irrigation. this result is supported by Ahmed et al. (2025b) which indicated that the likelihood of adopting climate smart agricultural practices increased by 12.7% as farmers access to climate information. In addition, Teklu et al. (2023) asserted that access to information communication, and social networks have an impact on the adoption of climate smart innovations.

6.5.3. Determinants of adoption intensity of small-scale irrigation

The second-stage Heckman selection model results provide deep insights into the determinants of intensity of irrigation adoption (Table 9). The diagnostic parameter reveals that the inverse Mills ratio, estimated from the first-stage selection model, is included as an explanatory variable in this model to control for the effects of possible selection bias for parameter estimation. As shown in Table 9, the coefficient of the inverse Mills ratio is negative and statistically significant at the 1% significance level. This confirms strong evidence that the unobserved factors that determine irrigation adoption in the first stage also affect the intensity of adoption in the second stage. The results indicate that unobserved factors that increase the likelihood of small-scale irrigation adoption are associated with lower adoption intensity. This suggests that resource-constrained households may have a higher unobserved drive to adopt irrigation, yet their resource limitations restrict them to irrigating smaller cultivated areas.

The second stage average marginal effects reveal that among households that have adopted small-scale irrigation, an additional year of formal schooling increases the intensity of irrigation adoption by 0.014 hectares, ceteris paribus. Higher human capital enhances the cognitive and analytical capabilities of the farm manager, allowing them to process technical water schedules, manage input to output efficiently, and aggressively scale up their irrigated farm size. For adopters, an increase in available human labor by one man equivalent expands the cultivated land area under irrigation by 0.032 hectares, ceteris paribus. This finding confirms that small-scale irrigation is an exceptionally labor-intensive work, relying heavily on manual tasks like irrigation management, land preparation, and agronomic practices. Given widespread rural labor market imperfections, a larger household labor endowment acts as a crucial asset that permits the physical expansion of irrigated land.

Because off-farm income is specified in its natural logarithm, a 10% increase in non/off farm income increases the intensity of irrigation adoption by approximately 0.0024 hectares. In environments constrained by incomplete formal credit markets, non/off farm income serves as an indispensable source of internal liquidity. This alternative cash flow allows households to self-finance the high upfront and recurring operational investments required to sustain a larger irrigated land, such as purchasing agricultural inputs.

Participation in agricultural training exerts the largest positive impact on the intensity of irrigation adoption. Among irrigation adopters, household heads who participated in agricultural training cultivate an average of 0.241 more hectares under irrigation compared to those who did not participate. Training programs bridge critical information gaps regarding agronomic practices, high-yielding crop varieties, diseases and pest management. This institutional capacity building reduces perceived production risks, giving smallholders the confidence to scale up their irrigated land. The presence of good irrigation governance structures yields a substantial positive impact, increasing irrigated land intensity by 0.085 hectares for participating adopters relative to those operating without good governance. Strong local institutions such as irrigation cooperative, and water users association ensure predictable water rotation schedules, minimize resource conflicts, and enforce penalties on rule-breakers. This structural stability provides a secure environment that incentivizes smallholders to make large land and asset commitments to the irrigation scheme.

The second-stage average marginal effects indicate that household participation in irrigation infrastructure maintenance has a positive and statistically significant influence on the intensity of small-scale irrigation adoption. Specifically, among irrigation adopters, households that actively contribute to maintenance activities cultivate an average of 0.023 more hectares under irrigation than those who do not participate in infrastructure upkeep. This finding highlights that the operational sustainability and intensive utilization of smallholder irrigation schemes depend heavily on local collective action. Active engagement in canal cleaning and system repairs secures more reliable water delivery schedules and fosters social capital, thereby enabling smallholders to confidently expand and sustain larger areas under irrigated cultivation. The result is in line with the finding of Alam et al. (2012) which argues that household participation in irrigation maintenance is considered as a key factor to the long-term sustainability of irrigation schemes.

Conversely, each additional kilometer of physical distance between the agricultural plot and the primary irrigation water source significantly reduces the intensity of irrigation adoption by 0.027 hectares among irrigation adopters. This negative coefficient captures spatial friction and conveyance costs. Plots located further down the line suffer severe water losses due to evaporation and seepage in earthen canals, demand higher financial outlays for piping and fuel, and require intensive monitoring labor, forcing "tail-end" farmers to shrink their irrigated operational areas. This could be because, as the distance from the water source increases, the cost of accessing and transporting water for irrigation can increase significantly, and farms further away may have less reliable access to water, especially in times of drought or water scarcity. The result shows that plots closer to the upstream of irrigation water sources have high chances of receiving reliable irrigation water than plots located downstream to the irrigation water sources. The result agrees with Tesfay (2021) and Geddafa et al. (2021) whose result revealed that households located within the irrigation command area positively and significantly affect irrigation participation.

Table 9: Heckman second stage model for determinants of small-scale irrigation intensity

Variables	Coefficient	Std. Err	Average marginal effects	
			dy/dx	Std. Err
Age of household head	0.001	0.001	0.001	0.001
Sex of household head	0.006	0.03	0.050	0.035
Education level of household head	0.01***	0.002	0.014	0.003
Labor	0.027***	0.006	0.032	0.007
Livestock	-0.003	0.004	-0.008	0.005
Extension services	0.005	0.005	0.014	0.005
Land size	-0.024	0.017	-0.001	0.023
Irrigation distance	-0.021***	0.003	-0.027	0.003
Distance of plot to district market	-0.001**	0.0004	-0.001	0.000
Off/non-farm income (log)	0.036***	0.007	0.024	0.007
Credit amount (log)	0.002	0.002	0.000	0.002
Training participation	0.371***	0.075	0.241	0.071
Irrigation governance	0.042**	0.018	0.085	0.018
Irrigation infrastructure	0.011	0.024	0.056	0.026
Participation of households in irrigation maintenance	0.053***	0.017	0.023	0.018
Constant	0.386***	0.07		
Lambda (Inverse mills ratio)	-0.075***	0.025		
Rho (ρ)	-0.75041			
sigma (σ)	0.099			

Source: Model result;***, **, and * significant at 1%, 5%, and 10% significance level respectively

Similar with this result, a one-kilometer increase in the distance from the agricultural plot to the district market decreases the area under irrigation by 0.001 hectares for adopters. Although small per kilometer, its cumulative impact over long distances is critical. Remote farmers face steep transportation costs and heightened post-harvest spoilage risks for highly perishable irrigated cash crops. This geographic isolation and weak market integration reduce profit margins and disincentivize farmers to increase their irrigated land. The result implies that greater market distance discourages expansion due to higher transaction and transportation costs. The result is supported by Mango et al. (2018) which argues that distance travelled to the nearest market negatively influence the adoption of small-scale irrigation farming decisions.

6.5.4. Results of the endogenous switching regression model

6.5.4.1. Treatment effect of irrigation on calorie intake and consumption expenditure

The ATT result in Table 10 shows that adoption of small-scale irrigation leads to an increase in daily calorie intake per adult equivalent by about 568.32 kcal compared to the counterfactual. The transitional heterogeneity effect indicates that the effect of irrigation adoption on calorie intake is higher for current non-adopters than current adopters by about 55 kcal in the counterfactual case that the former became adopters. In addition, the base heterogeneity confirms that if current non-adopters were to become adopters of small-scale irrigation, their average daily calorie intake would have been higher than that of current irrigators by about 67.4 kcal. On the other hand, if current adopters were to become non-adopters, they would have lower average daily calorie intake compared to current non-adopters by about 12.1 kcal. This finding reinforces the earlier work of (Bacha et al., 2011; Tesfaye et al., 2008), which confirms that access to irrigation significantly contributed to household food security. Similar to previous studies, for instance, Jambo et al. (2021) argue that participation in small-scale irrigation increased the daily calorie intake of farm households by 643.76 kcal over non-user households.

The ATT result in Table 10 shows that adoption of small-scale irrigation leads to an increase in total consumption expenditure by about 6,210.63 birr compared to the counterfactual case that those households were non-adopters. The transitional heterogeneity result shows that the welfare gain from small-scale irrigation adoption is larger for current adopters than for non-adopters. Even if non-adopters adopted irrigation, their increase in total consumption expenditure would be about 24,612 birr lower than that of current adopters, suggesting that if non-adopters adopt irrigation,

they may initially allocate a large share of income to irrigation investments, which can temporarily reduce household consumption expenditure.

Table 10: Average treatment effects of daily calorie and consumption expenditure, predictions from the endogenous switching regression model

Outcome variables	Sub-samples	Regimes and counterfactuals		Treatment effects
		Adopters	Non- adopters	
Daily calorie	Adopters	2630.06	2061.73	ATT=568.32***
		(14.5)	(9.7)	(10.5)
	Non-adopters	2697.45	2073.82	ATU= 623.63***
		(10.72)	(5.22)	(8.92)
Heterogeneity effects		BH1 = -67.39***	BH2 = -12.09***	TH= -55.03***
		(17.69)	(10.54)	(13.7)
Total consumption expenditure	Adopters	60,493.22	54,282.59	ATT= 6,210.63***
		(733.9)	(644.4)	(622.5)
	Non-adopters	35,886.27	54,287.59	ATU= -18,401.33***
		(915.2)	(551.8)	(634)
Heterogeneity effects		BH1 = 24,606.95***	BH2 = -5.01	TH= 24,611.96***
		(1208.2)	(843.6)	(898.4)

Source: Analysis of survey data, 2022, *** p<0.01, standard errors are in parenthesis

6.5.4.2. Treatment effect of irrigation adoption on household income and Asset accumulation

The ATT result in Table 11 shows that adoption of small-scale irrigation leads to an increase in household income by about 58,625.8 birr compared to the counterfactual case that those households were non-adopters. The transitional heterogeneity result indicates that impact of irrigation adoption on household income is higher for current adopters than for current non-adopters by about 34,171.8 birr (Table 11).

In addition, the ATT result indicates that adoption of small-scale irrigation leads to an increase in Asset accumulation of households by about 66,211 birr compared to the counterfactual case that those households were non-adopters. The transitional heterogeneity result shows that the impact of irrigation adoption on Asset accumulation is higher for current adopters than for current non-adopters by about 19,865.3 birr. The result is in line with the findings of (Dawid Mume et al., 2023) and (Bojago & Abrham, 2023) who show that access to irrigation significantly improves farm households' livelihoods. In addition, related works by Gizaw et al.

(2025) show that irrigation access has a positive impact on rural livelihood indicators and Gebrehiwot et al. (2017) confirm that irrigation use increases asset formation by 186% compared to non-irrigators.

This result is consistent with findings by Tesfay (2021), who argued area planted with the use of irrigation enables increased and stable income, and asset accumulation positively. Moreover, (Dillon, 2011b) argues that households with irrigation access save between 4.5 and 6.4 more tropical livestock units and are 20% more likely to engage in informal food sharing with non-irrigators and Maru et al. (2023) confirmed that irrigation participation can enhance the capital asset of farm households.

Table 1111: Average treatment effects of household income and Asset accumulation, predictions from the endogenous switching regression model

Outcome variables	Sub-samples	Regimes and counterfactuals		Treatment effects
		Adopters	Non- adopters	
Household income	Adopters	154,638.3 (5223.5)	96,012.6 (2652.2)	ATT=58,625.8*** (4864.1)
	Non-adopters	100,286.9 (5604.3)	75,833.0 (2017.4)	ATU=24,454.0*** (5084.7)
Heterogeneity effects		BH1 = 54,351.4*** (7784.1)	BH2 = 20,179.6*** (3276.8)	TH=34,171.79*** (7132.1)
Asset accumulation	Adopters	391,278.5 (6215.327)	325,067.5 (3741.312)	ATT=66,210.98*** (6607.314)
	Non-adopters	290,948 (4682.548)	244,602.3 (2762.206)	ATU=46,345.69** (5,549.851)
Heterogeneity effects		BH1 = 100,330.5*** (7644.572)	BH2 = 80,465.25*** (4559.926)	TH=19,865.29** (8564.388)

Source: Analysis of own survey data, 2022, *** p<0.01, standard errors are in parenthesis

7. Conclusion and Policy Implications

This study was conducted to investigate the determinants of small-scale irrigation adoption and its intensity in the North Wollo Zone, Ethiopia. The study used 385 farm households selected using multistage sampling techniques. This study employs the Heckman two stage model to analyze the adoption decision and its intensity, accounting for the self-selection bias. The model results shown that sex and education level of household head, extension service, training participation, off/non-

farm income and credit service, irrigation governance and infrastructure, participation of households in irrigation maintenance, and access to climate information positively affect the adoption of small-scale irrigation. However, plot distance to irrigation water source and district market negatively affect irrigation adoption. Result of the empirical analysis shown that the intensity of small-scale irrigation adoption is positively influenced by education level of the household head, labor, training participation, off/non-farm income, irrigation governance, and household participation in irrigation maintenance. Conversely, it is negatively affected by distance of the plot to irrigation water sources and district market. The result revealed that sustainable irrigation requires more than infrastructure, it requires strong partnership between public, private and producer farmers to adopt a variety of small-scale irrigation and transform traditional canal into modern line irrigation.

Local agricultural office should strengthen kebele level farmer field schools specializing explicitly in small scale irrigation. These practical field centers must provide hands on training for pest and diseases management, irrigation water utilization, infrastructure maintenance and water pump repairs. This localized approach bridges technical information gaps and provides smallholders with the practical skills needed to confidently scale up their irrigated land. While household labor size affects the intensity of irrigation adoption, structural gender barriers often prevent women from irrigation adoption. Policy initiatives must mandate that at least 25% of water users association committee must be reserved for female farmers. Furthermore, institutional support (training, credit and extension services) must be addressed directly to both male and female household heads, ensuring women receive equal technical access to resources and irrigation management methods. In addition, to scale up the adoption and intensity of small-scale irrigation, different institutions must collaborate with local agricultural extension office to deliver bundled irrigation packages.

Given that irrigation governance is one of the driver of irrigation adoption and intensity, regional and local bureaus of agriculture should empower water users association by raising managerial skills, delivering updated training, supported by sound policies for water use with appropriate oversight by local authorities. Rather than relying on curative irrigation infrastructure maintenance, local agricultural offices must assist water users association in establishing preventive maintenance fund. Under this system, member households contribute quarterly service fees or pre-scheduled physical labor hours for irrigation infrastructure maintenance.

To sustain intensive irrigation investments, smallholders require updated climate information. The ministry of agriculture, meteorological institute and local agricultural offices in partnership with mass media, should scale up and commercialize local weather advisory services such as weather, climate and early warning services. Providing these insights protects smallholders from sudden water stress events, securing their investments in high-value irrigated crops.

In addition, the finding reveals that adoption of small-scale irrigation has positively and significantly increased household welfare indicators such as calorie intake, household income, consumption expenditure and Asset accumulation by about 27.6%, 61.1%, 11.44% and 20.4%, respectively. The positive impact of small-scale irrigation adoption on household welfare indicators highlights the need to increase investment in small-scale irrigation which is a policy intervention that will require public-private partnership. The findings suggest that the government should continue to improve and expand irrigation infrastructure, access of irrigation technologies to promote smallholder farmers adoption. The study also underlines the important role of empowering water user associations in terms of knowledge and skill to enhance the management of irrigation infrastructure and irrigation technology adoption. Even if small-scale irrigation is owned by farmers, the government still has a significant role to play in increasing the adoption rates and promoting the sustainability of irrigation development in North Wollo Zone.

Limitation of the study

While this study provides robust empirical insights into the socio-economic and institutional determinants of small-scale irrigation, important methodological limitations must be acknowledged. First, the use of cross-sectional data restricts our ability to capture dynamic effects of different factors on irrigation adoption and its intensity over time. Second, several production and institutional variables are based on self-reported survey data, which are inherently subject to recall bias. In addition, the study utilized a purposive selection districts due to their irrigation potential. While this targeted sampling strategy maximizes the internal validity of our findings, it restricts the direct statistical generalizability of the results to regions characterized by different agro-ecological or institutional landscapes. These limitations should be considered when interpreting the results. Finally, the measurement of institutional variables such as irrigation governance, and irrigation infrastructure quality as binary dummy variables. While binary indicators are practical and reduce respondent fatigue in field surveys, they inevitably introduce an element of subjectivity and may fail to capture the full spectrum of institutional performance.

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Exploring Child Marriage Risks in the Context of the Polycrisis: Similarities and Differences Across Ethiopia

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Introduction[2]

In recent years, the intersection of global and national polycrises—characterised by escalating poverty, severe climate shocks, and protracted armed conflict—has profoundly disrupted the development pathways of young people across the Global South. In Ethiopia, these compounding crises interact dynamically with pre-existing structural vulnerabilities linked to gender, rurality, pastoralist livelihoods, climate shocks and conflict episodes. While the detrimental effects of economic and environmental shocks on youth are well-documented, there remains a critical gap in understanding how a multi-layered polycrisis shapes gender-related vulnerabilities, especially risks of child marriage which can be a key coping mechanism for young people, their households and communities.

This paper explores the localised mechanisms through which cascading macro-level crises translate into micro-level violations of girls' fundamental rights. Drawing on unique mixed methods longitudinal data from the Gender and Adolescence: Global Evidence (GAGE) study, this paper investigates the shifting realities of young women aged 15–24 across rural and urban sites in the Afar, Amhara, and Oromia regional states, as well as Dire Dawa City Administration. It explores the extent to which the polycrisis intensify poverty and acted as a catalyst for child marriage by dismantling protective social structures, forcing families into negative coping mechanisms, and restricting girls' bodily autonomy. The paper pays particular attention to regional and urban-rural differences in re-shaping gender norms and practices related to child marriage. The paper concludes by reflecting on implications for tailored policy and programming responses in crisis-affected communities.

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[2] Note this paper draws heavily on findings from Gender and Adolescence: Global Evidence (GAGE) endline reports.

Background: Child Marriage in Crisis Contexts

Child marriage remains an entrenched global challenge, disproportionately affecting young women in regions suffering from systemic gender inequality (Girls Not Brides, 2023). While national trends in developing countries have shown a gradual decline over the past two decades, progress remains starkly uneven (Cappa, 2023). This fragile progress is increasingly jeopardised by the emergence of "polycrises"—overlapping macro-level shocks where economic, political, and environmental emergencies converge. Growing evidence from humanitarian settings indicates that fragile states exhibit nearly double the child marriage prevalence found globally (Freccero & Taylor, 2021). This disparity is driven by a complex architecture of economic desperation, the collapse of community institutions, and heightened insecurity.

During crises, safety nets are often disrupted or eroded. Protracted armed conflicts and climate-induced climate shocks—such as severe droughts or livestock loss—negatively impact household assets and income sources, and may force communities into harmful coping strategies (Presler-Marshall 2024a and 2024b). In patriarchal societies, families frequently view child marriage as an economic lifeline to reduce the number of dependent children or to acquire bride prices (Jones et al., 2020). Simultaneously, crises trigger the widespread closure of schools. Education acts as one of the most powerful systemic protectors against early union; when access to safe schooling is disrupted, girls face an immediate, heightened vulnerability to arranged marriages. Furthermore, localised conflicts dismantle civil registry frameworks and disrupt community-level adolescent and youth programming, stripping adolescent girls of institutional protections and formal legal avenues (UNICEF, 2023).

Methods and Sample

This paper draws on mixed-methods data collected in 2024 and 2025 in four locations in Ethiopia: rural South Gondar and the town of Debre Tabor in Amhara; the city of Dire Dawa; rural East Hararghe in Oromia; and Hari Rasu (Zone 5) in Afar. In all four locations, the endline (Round 5) follows up on a baseline survey (2017–2018) and Round 2 (2019–2020). South Gondar and East Hararghe were also included in Round 3 (2021–2022) and Round 4 (2022–2023); Dire Dawa and Afar were not.

In each location, the baseline sample combined randomly selected young adolescents (aged 10–12, and in urban sites also aged 15–17) with a smaller group purposefully

selected to include more of the most marginalised adolescents, particularly those with disabilities. At Round 2, further adolescents were purposefully added. In the three rural sites, most were aged 17–19 and formed an older cohort for comparison with urban peers. In all sites, the remainder were added to increase representation of particularly marginalised adolescents – including those with disabilities, those who were out of school and those who had married as children. Because many young adults in the rural sites were selected into the sample because they had already married, findings on marriage and childbearing for that cohort are not representative of their age group.

To keep the two cohorts distinct, we refer to the younger cohort as 'adolescents' (although most are now legally adults) and the older cohort as 'young adults'. Female adolescents are 'girls' and male adolescents 'boys'; female young adults are 'young women' and male young adults 'young men'. The sample as a whole is referred to as 'young people'. Girls and young women together are 'young females'; boys and young men together are 'young males'.

Table 1 summarises the endline sample in each location. Surveys were administered face to face by enumerators trained to communicate with marginalised populations – except in South Gondar, where conflict meant that surveys were conducted by phone (see below). With the exception of never-married adolescent boys, enumerators were typically the same sex as the respondent; all female respondents were interviewed by female enumerators. Where we present change over time, analysis is restricted to the panel sample – those who completed both the Round 2 and endline surveys. Statistical analysis was conducted using Stata 18.0.

Qualitative research included individual and group interviews with young people – most of whom were selected from the survey sample, deliberately oversampling the most disadvantaged – as well as interviews with caregivers, siblings and key informants (community leaders, service providers and officials). Interviews used interactive tools such as timelines, body mapping and vignettes (see Jones et al., 2025). They were transcribed and translated by native speakers and coded thematically in MAXQDA.

The research design and tools were approved by ethics committees at ODI Global, George Washington University and the Ethiopian Society of Sociologists, Social Workers and Anthropologists. Verbal consent was obtained from caregivers and married adolescents; verbal assent was obtained from unmarried adolescents under age 18. A referral protocol was tailored to each research site.

Table 1: Endline sample, by location

	South Gondar	Dire Dawa	East Hararghe	Afar
Survey mode	Phone	Face to face	Face to face	Face to face
Young people surveyed	2,610	751	2,166	732
Adolescents (mean age)	1,845 (18.9)	364 (18.3)	1,886 (18.1)	466 (18.0)
Young adults (mean age)	765 (22.9)	387 (22.6)	280 (21.8)	266 (21.4)
Young females / young males	1,381 / 1,229	382 / 369	1,279 / 887	433 / 299
Sub-sample married before age 18	258	57	843	246
Panel sample (Round 2 and endline)	1,824	630	1,868	655
Qualitative research participants	362	196	523	253

Note: South Gondar figures combine rural South Gondar and Debre Tabor. Qualitative participants include those interviewed individually and in groups.

South Gondar

Data were collected in 69 kebeles in 5 woredas of rural South Gondar and in 35 ketenas of urban Debre Tabor, in late 2024 and the first half of 2025. At baseline, the quantitative sample included 2,896 young adolescents – 2,754 randomly selected (aged 10–12 in rural sites, and aged 10–12 and 15–17 in Debre Tabor) and 142 aged 10–18 who were purposefully selected. At Round 2, 652 adolescents were purposefully added, bringing the total sample to 3,548. Most were aged 17–19 and formed the older rural cohort; the rest, aged 10–21, were particularly marginalised. At Round 3, an additional 807 adolescents aged 14–18 were recruited in Debre Tabor in anticipation of an impact evaluation there. To minimise attrition, a two-stage tracking strategy limited focus to a subset of those included in previous rounds (Hamory et al., 2025), for a total sample of 3,888 at Round 3 and 3,191 at Round 4. The endline surveyed 2,610 of these young people – 1,845 in the younger cohort (aged 18.9 years on average) and 765 in the older cohort (aged 22.9 years on average).

Qualitative research took place in 8 kebeles of Ebinat woreda and in Debre Tabor. It included individual interviews with 165 young people, as well as 118 caregivers, 25 siblings and 54 key informants.

Conflict in Amhara reshaped the South Gondar endline. Surveys were conducted by phone (and via Telegram or WhatsApp for those who had migrated abroad), the survey was shortened – including by removing some sensitive questions – and the usual two-stage tracking could not be used. Only 47% of the rural sample was reached, on a first-to-locate basis, compared with 97% of the urban sample. In rural areas, girls, younger adolescents and those who were married or had a disability when recruited were less likely to be reached. Qualitative interviews were also conducted by phone, which limited respondents' privacy. South Gondar findings are therefore not directly comparable with those from the other locations, and rural rates of child marriage and early pregnancy may be understated. Panel analysis correctly reflects change over time for those who were reached.

Dire Dawa

Data were collected in 20 menders (neighbourhoods) in 7 kebeles of Dire Dawa in 2024 and 2025 (see Figure 1). At baseline, the quantitative sample included 870 adolescents – 415 randomly selected individuals aged 10–12, 412 randomly selected individuals aged 15–17, and 43 aged 10–22 who were purposefully selected. At Round 2, 68 particularly marginalised adolescents aged 12–19 were purposefully added, bringing the total sample to 938. The endline focused again on the Round 2 sample and surveyed 751 of these young people – 364 in the younger cohort (aged 18.3 years on average) and 387 in the older cohort (aged 22.6 years on average).[3]

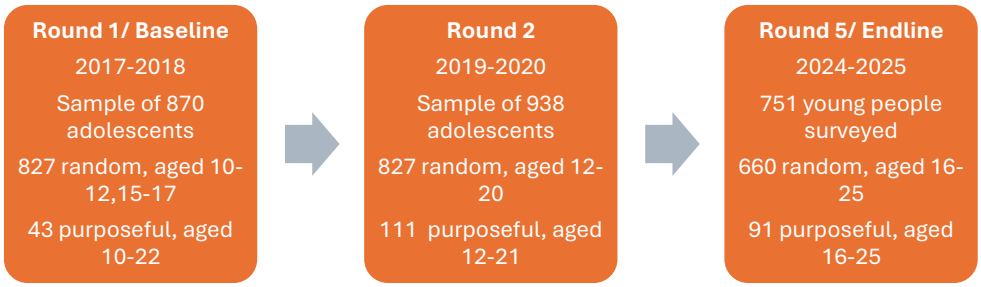


Figure 1: Timeline of GAGE research in Dire Dawa

Qualitative research included individual interviews with 45 young people and group interviews with 84, as well as 45 caregivers, 1 sibling and 8 key informants (City Administration officials).

[3] The endline sample is composed of a subset of individuals from the Round 2 sample, following commonly used methodology to lower bias due to survey attrition.

East Hararghe

Data were collected in 80 kebeles across 5 woredas of East Hararghe[4], Oromia, in 2024 and 2025 (see Figure 2). At baseline, the quantitative sample included 2,146 young adolescents – 2,059 randomly selected individuals aged 10–12 and 87 aged 9–15 who were purposefully selected. At Round 2, 474 adolescents were purposefully added, bringing the total sample to 2,620. Most were aged 17–19 and formed the older cohort; the rest, aged 13–16, were particularly marginalised. Round 3 attempted to interview nearly all of these adolescents, for a total sample of 2,365.[5] At Round 4, an additional 29 adolescents were purposefully added as part of the qualitative work, but only a subset of the prior sample (primarily the random sample and some of those purposefully added) was sought, for a total quantitative sample of 2,073. The endline focused again on the Round 3 sample and surveyed 2,166 of these young people – 1,886 in the younger cohort (aged 18.1 years on average) and 280 in the older cohort (aged 21.8 years on average).

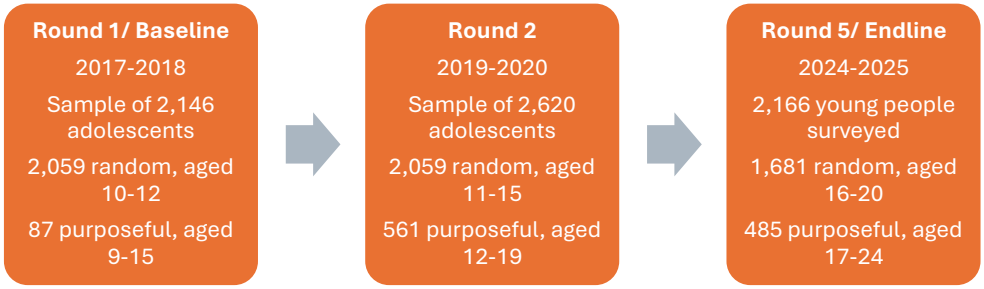


Figure 2: Timeline of GAGE research in East Hararghe

Qualitative research was conducted in 6 kebeles of Fedis woreda – intensively in 2 (one close to the district town and one remote) and with individual interviews with young people only in the other 4. It included individual interviews with 118 young people and group interviews with 199, as well as 107 caregivers, 15 siblings and 84 key informants.

[4] At endline, a small minority of young people had moved since Round 2. However, nearly all (98.4%) of these individuals were still living in East Hararghe at the time of data collection.

[5] Rounds 3, 4 and 5 utilised a two-stage tracking methodology to limit bias due to sample attrition. In particular, near the end of data collection in each round, a random subset of remaining unfound respondents were sample to be tracked 'intensively' while a small number of their counterparts were dropped from further tracking for the remainder of that round only. That is why the sample size for these rounds is slightly smaller than for Round 2.

Afar

Data were collected in 20 kebeles across 5 woredas in Hari Rasu (Zone 5), Afar, in 2024 and 2025 (see Figure 3). This research follows two[6] earlier rounds – at baseline (2017–2018) and Round 2 (2019–2020) (see Figure 4). At baseline, the quantitative sample included 540 young adolescents – 510 randomly selected individuals aged 10–12 and 30 aged 9–15 who were purposefully selected. At Round 2, 372 adolescents were purposefully added, bringing the total sample to 912. Most were aged 17–19 and formed the older cohort; the rest, aged 13–16, were added to increase representation of particularly marginalised adolescents, including those with disabilities, those who were out of school, or those who had married as children.

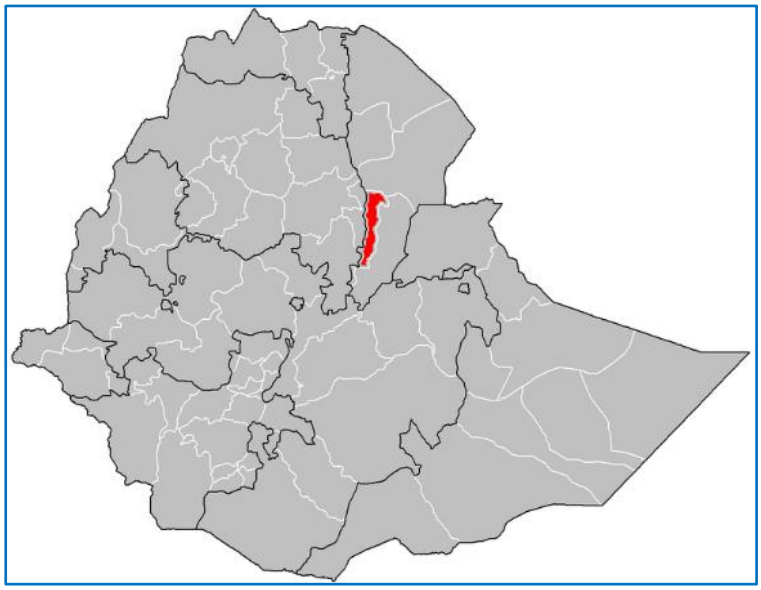


Figure 3: Hari Rasu (Zone 5), Afar

The endline surveyed 732 of these young people – 466 in the younger cohort (aged 18.0 years on average) and 266 in the older cohort (aged 21.4 years on average). Qualitative research was conducted in 2 kebeles of Semurobi woreda that were also part of the survey – one remote and one more central. It included individual interviews with 59 young people and group interviews with 78, as well as 62 caregivers, 17 siblings and 37 key informants.

[6] Rounds 3 and 4, which were undertaken in 2021-2022 and 2022-2023, did not include Afar.

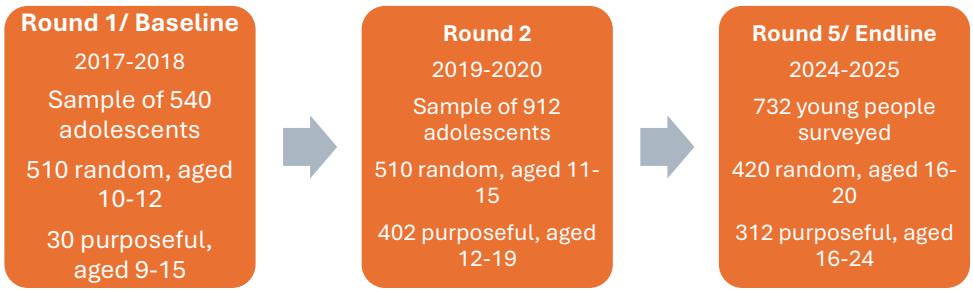


Figure 4: Timeline of GAGE quantitative research in Afar

Findings

Child marriage remains the norm for girls in East Hararghe and Afar, but is now uncommon among adolescent girls in South Gondar and Dire Dawa. Of adolescent girls – the largely randomly selected cohort – 54% in East Hararghe and 39% in Afar had married before age 18, compared with 10% in rural South Gondar, 6% in Dire Dawa and 2% in Debre Tabor. Because some adolescents were not yet 18 at endline, these rates will rise; rural South Gondar rates may also be understated because of survey attrition (see Methods). Knowledge of the marriage law follows the same pattern: 74% of young people in South Gondar and 60% in Dire Dawa knew that girls cannot legally marry before age 18, compared with 42% in East Hararghe and 23% in Afar. Who decides differs. Parents made most marriage decisions in South Gondar (73% of ever-married young people) and Afar (80% of ever-married young females). In East Hararghe, 76% of ever-married young people reported that they had decided themselves – although qualitative research shows that many of these 'choices' are shaped by harassment, abduction and peer pressure.

South Gondar

At endline, most young people were aware that child marriage is illegal, for girls and boys. Approximately three-quarters (74%) reported that girls cannot legally marry until at least age 18; 71% said the same of boys. For rural young people in the panel sample, knowledge about the marriage law had improved in the years between Round 2 and endline. The proportion who were aware that child marriage is illegal for girls climbed from 33% to 71%; the proportion aware that child marriage is illegal for boys climbed from 27% to 77%.

Rates of child marriage varied by gender, location and cohort. Young women (many of whom were selected into the sample because they had married as children) were the most likely to have married prior to age 18 – 70% of those in rural areas and 21% of those in Debre Tabor had done so (see Figure 5). With the caveat that rates will continue to rise, because some7 adolescent girls are not yet 18 years old, adolescent girls surveyed were unlikely to have married prior to age 18 (only 10% of those in rural areas and 2% of those in Debre Tabor had done so). Child marriage was uncommon for males: no adolescent boys and only 12% of young men in rural areas had married prior to age 18. No young males in Debre Tabor had married prior to age 18.

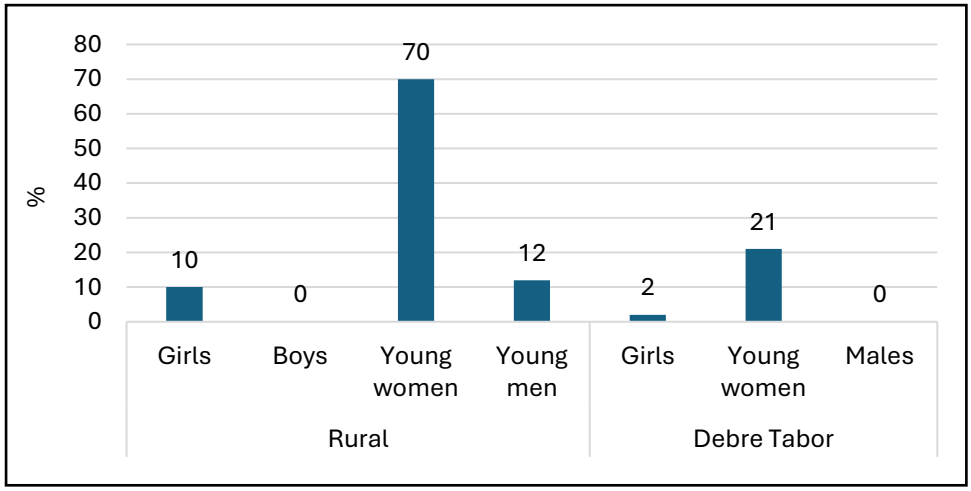


Figure 5: Proportion of young people married prior to age 18 (by gender, location and cohort)

Rates of marriage before age 15 also varied by location and cohort (see Figure 6). In rural areas, 18% of young women (many of whom were selected into the sample because they had married as children) and 6% of adolescent girls had married before age 15. Rates in Debre Tabor were 3% and 1% respectively.

[7] In rural South Gondar, 23% of adolescent girls were under age 18; in Debre Tabor the corresponding figure was 18%.

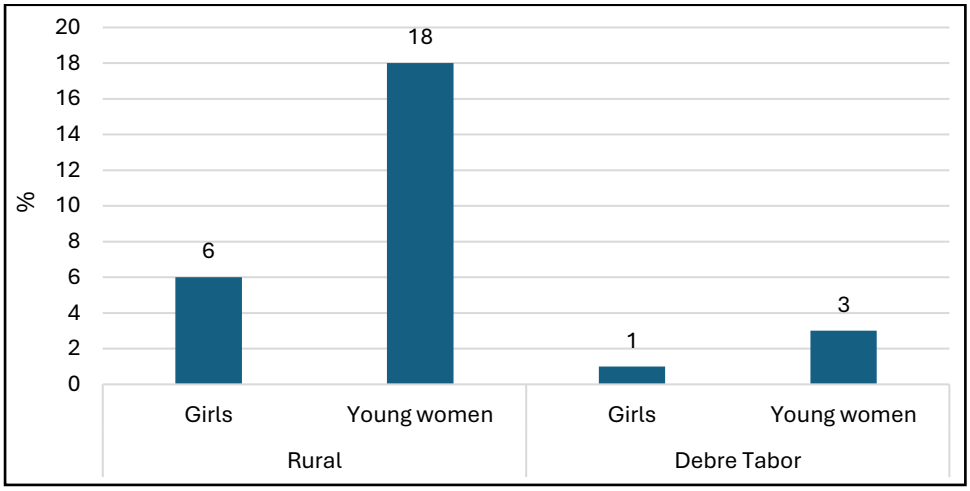


Figure 6: Proportion of young females married prior to age 15 (by location and cohort)

Of ever-married young people, only 26% reported that they themselves had made the decision to marry (see Figure 7). This was significantly more common in Debre Tabor than in rural areas (33% versus 23%). A large majority of young people (73%) reported that their parents or other relatives had made marriage decisions for them. This was significantly more common in rural areas than in Debre Tabor (79% versus 55%). Gender differences were not significant.

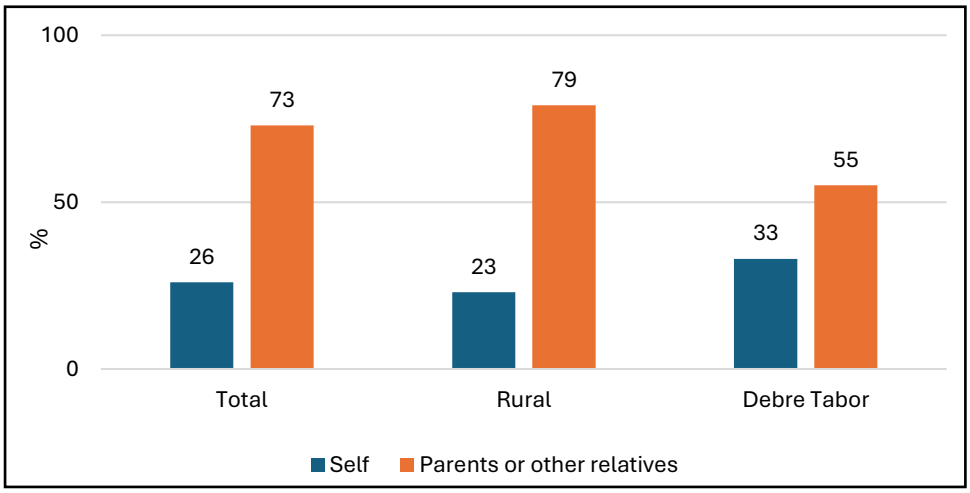


Figure 7: Proportion of marriage decisions made by self or family (by location)

Young brides were an average of 6.3 (see Figure 8). For young females, location differences were significant: young brides in rural areas, 74% of whom were married as children, were much less likely to report that they had been ready to marry than their peers in Debre Tabor: 36% versus 51%.years younger than their husband at the time of marriage. As a result, although both young females and young males primarily enter into arranged marriages, young grooms were far more likely to report that they had been ready to marry than were young brides (69% versus 40%)

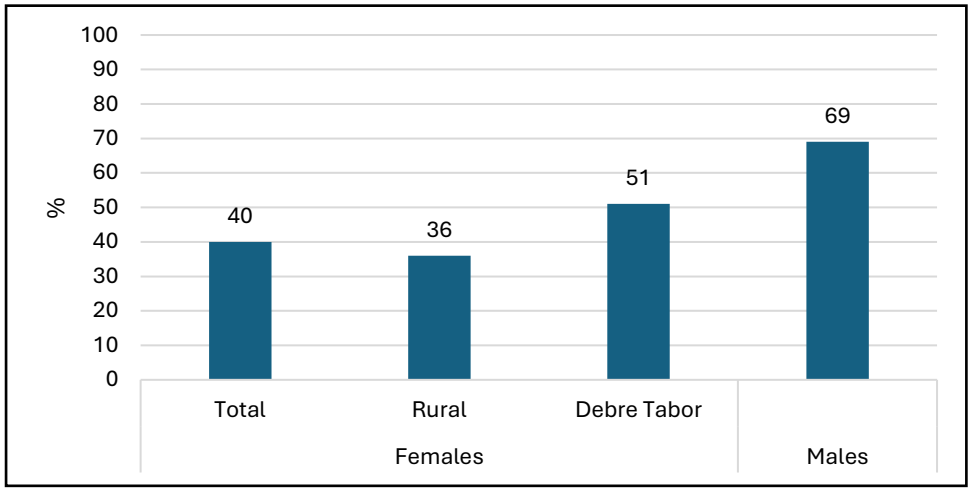


Figure 8: Proportion of married young people who were ready to marry at the time (by location and gender)

Child marriage in South Gondar is best understood by first explaining traditional practices. Namely, girls (and sometimes boys) were married by parental arrangement when they were very young – sometimes even toddlers. The thought was that girls would grow up dividing their time between their natal and marital homes, and that sexual relations were forbidden until girls experienced menarche. A mother from Community D explained, 'They arrange your marriage saying "she can grow together with her husband".' This tradition explains why marriage in middle adolescence is rarely understood as child marriage. A mother from Community G stated, 'A girl that is older than 15 is a grown one. It is bad to arrange their marriage under 15. Above 15 is a good age for marriage, she is grown at that age.'

Respondents agreed that it is now rare for girls to marry prior to age 15 – and increasingly uncommon for them to marry prior to age 18. This is in part, noted a mother from Community E, because 'The children themselves are refusing to get married.' With both classroom content and girls' clubs teaching young people that

child marriage is illegal, and schools serving as a venue for reporting that allows planned child marriages to be cancelled, girls (and some boys) often save themselves from child marriage. An 18-year-old young woman from Community E reported that she talked her parents out of marrying her: 'They arranged a marriage, but they never forced me to get married. They listened to me when I told them I didn't want to get married.' A 20-year-old young woman from Community C explained that a teacher had helped her remain single, 'When I joined grade 9, I understood about the law for early marriage, and I decided to refuse the marriage and to continue my education. When they intended to arrange my marriage, I told my teacher, who then advised my father against it.'

Decreased incidence of child marriage is also partly because parents – many of whom married very young themselves – now see value in letting their children complete their schooling and grow up before they take on adult roles. A father from Community E, who married at age 14 to a girl who was only 12, reported, 'My wife and I married at an early age and we were still kids… I was married by force… I do not allow my children to do that at all. I want them to continue and complete their education.' A mother from Community E agreed and added that whereas celebrating a child's marriage used to be a source of community status, now parents take pride in educating their children: 'Now no one considers marriage the way our parents did… The family wants to support the children's education… Because when they are educated they support us financially and change our life. Even if they cannot support us financially, it is a pride to have an educated child that achieves a position in life.'

That said, many girls are still married before the legal age of 18. These marriages are almost always arranged by parents – and many are forced. An 18-year-old young woman from Community E stated that parents arrange girls' marriage to prevent them from being raped: 'It is for fear of being exposed to unwanted pregnancy and being exposed to rape that parents arrange early marriage.' A 19-year-old young woman from Community D reported that parents' interest in girls' marriage spikes when girls are no longer able to continue their education: 'Parents force girls of 14 or 15 years old to get married… when they have no money to support girls' education.' An 18-year-old young woman from Community B, who married at age 15 when she left school, observed that force is hardly required for most girls, because they are socialised into compliance: 'They [the girl's parents] ordered me to do that and I did it unknowingly. I didn't know what was good and bad for me that time since I was too young.'

Respondents in many rural communities reported that the conflict has led to a resurgence of child marriage, because girls have lost the protective status of 'student' and because reporting and monitoring mechanisms have broken down. A father from Community F explained, 'The number of adolescents getting married at a young age has increased after the conflict because there is no other option for them. They wanted to continue their education, but the schools are closed right now, so they were forced to discontinue their education. The only option left for them was marriage.' A 19-year-old young woman from Community G agreed and elaborated: 'When there was justice there was supervision, now no law, no one is working. No one is supervising the community. Now, parents decide to marry off girls, it depends only on their interests. Before, they were encouraging girls to attend school and working to avoid child marriage. Now, there is no justice to stop child marriage.'

Dire Dawa

When asked to identify the minimum legal age at which girls may marry, 60% of young people reported at least age 18 (see Figure 9). A similar proportion (54%) reported that boys may not marry until at least age 18.

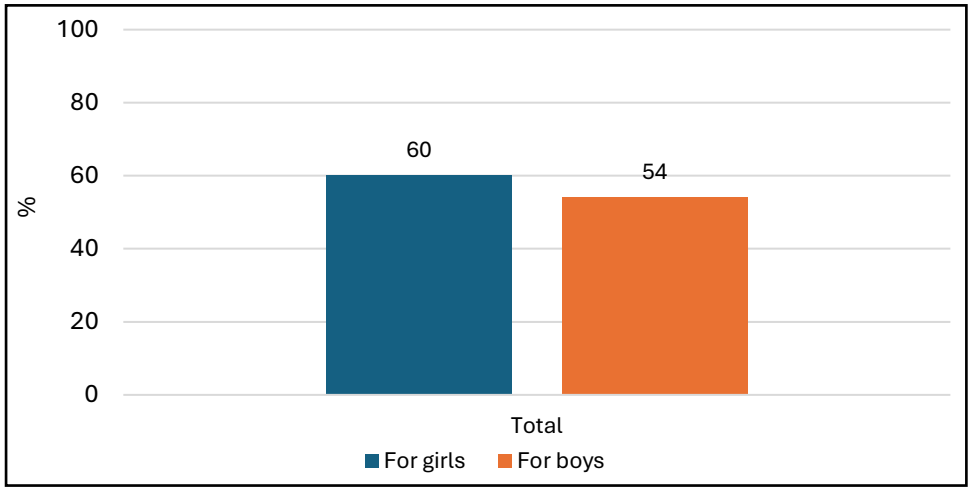


Figure 9: Proportion of young people able to identify at least age 18 as the legal minimum age for marriage for girls, at endline

Child marriage is uncommon among the young people in the Dire Dawa sample. With the caveat that many adolescents were not yet 18 years old at endline, only 1% of boys and 6% of girls in the GAGE sample had been married prior to age 18 (see

Figure 10). Of young adults, 21% of young women and 1% of young men had married prior to the age of 18.

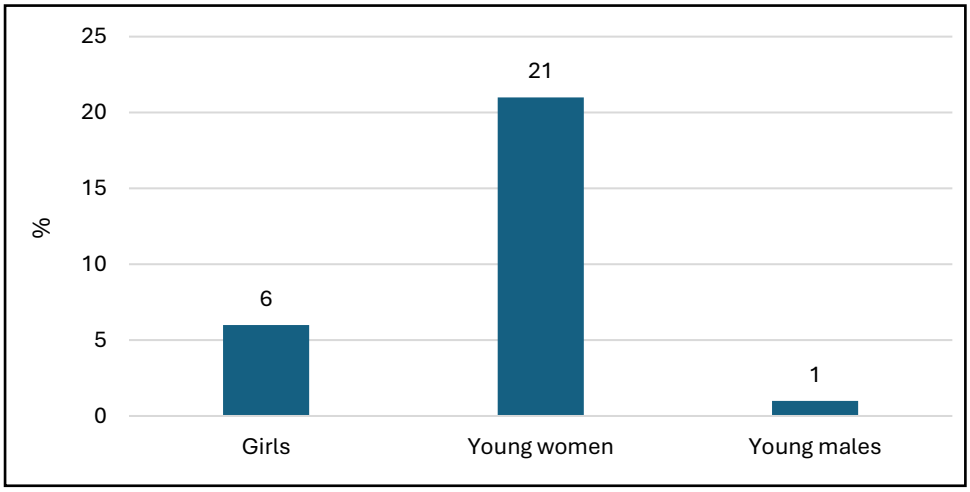


Figure 10: Proportion of young people married prior to age 18, at endline (by cohort and gender)

During qualitative interviews, respondents agreed that 'Early marriage is not prevalent in this locality' (25-year-old young man). Although a 16-year-old girl reported that many girls are still encouraged to marry early, nearly all agreed that girls who grow up in the city are generally at risk of child marriage only if they become pregnant. A 21-year-old young woman recalled:

One of my [secondary school] classmates had started a love relationship with a boy and got pregnant without the knowledge of her parents. Then the boy tried to send the elders to her parents. Her parents had no choice except to give their daughter to the boy for marriage since she already got pregnant.

A key informant agreed that premarital pregnancy does drive child marriage, and added that, as in rural areas, fear of premarital pregnancy also drives child marriage, especially for Muslims:

I think Christian religious leaders understand the problem more, and they are creating awareness, so the percentage of child marriage is lower within the Christian community. But most of the child marriage problem is related to the Muslim community and the Islamic religion.

Key informants reported considerable efforts to stop child marriage in Dire Dawa, with government officials and service providers detailing direct interventions with

parents, fines, and even jail time to ensure that child marriages are cancelled. A 16-year-old girl recalled that when a classmate was taken by her parents back to their village, to be married against her will, a teacher took a month off and travelled to that village to rescue the girl:

My teacher stopped a girl from getting married. Her parents live in a rural village, and the teacher went there to convince them not to marry her off, and she managed to do so. The girl has now completed 12th grade.

East Hararghe

The endline survey found that approximately half of young people know that child marriage is illegal in Ethiopia. When asked to identify the minimum legal age at which girls and boys may marry, 42% identified at least age 18 for girls and 54% identified at least age 18 for boys (see Figure 11).

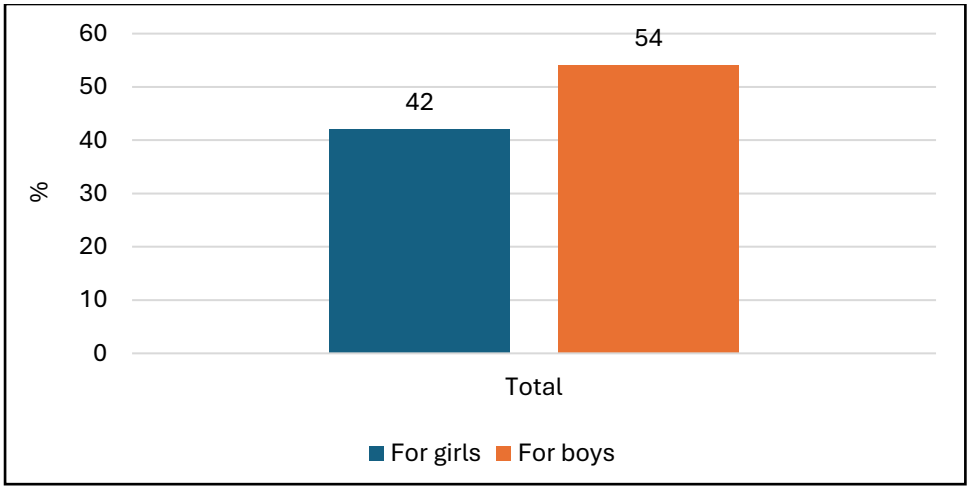


Figure 11: Proportion of young people who identify at least age 18 as the legal minimum age for marriage for girls and boys at endline

There have been significant improvements since Round 2 in young people's knowledge of the marriage law. For knowledge of the law about girls' age, the proportion of young people in the panel sample with who identified at least age 18 has climbed 25 percentage points (from 18% to 43%), with similar gains across groups (see Figure 12). Knowledge of the law for boys similarly climbed 32 percentage points (from 22% to 54%) (see Figure 13).

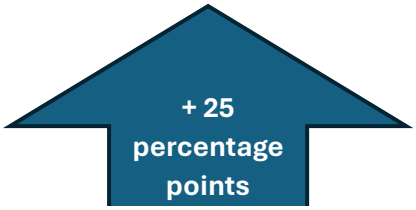


Figure 12: Change in young people's knowledge of the marriage law for girls, between Round 2 and endline

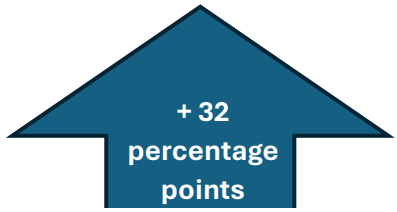


Figure 13: Change in young people's knowledge of the marriage law for boys, between Round 2 and endline

The endline survey found that child marriage is the norm for girls – and that many boys are also at risk. Among adolescent girls, who primarily ranged in age from 16 to 22,[8] 54% had already been married (if they were under age 18) or had married prior to age 18 (if they were over age 18) (see Figure 14). Of young women – and with the caveat that, as noted above, young women were disproportionately likely to be selected into the Round 2 sample if they were already married – 85% had married prior to adulthood. Of adolescent boys, who primarily ranged in age from 16 to 21,[9] 6% had already been married (if they were under age 18) or had married prior to age 18 (if they were over age 18).

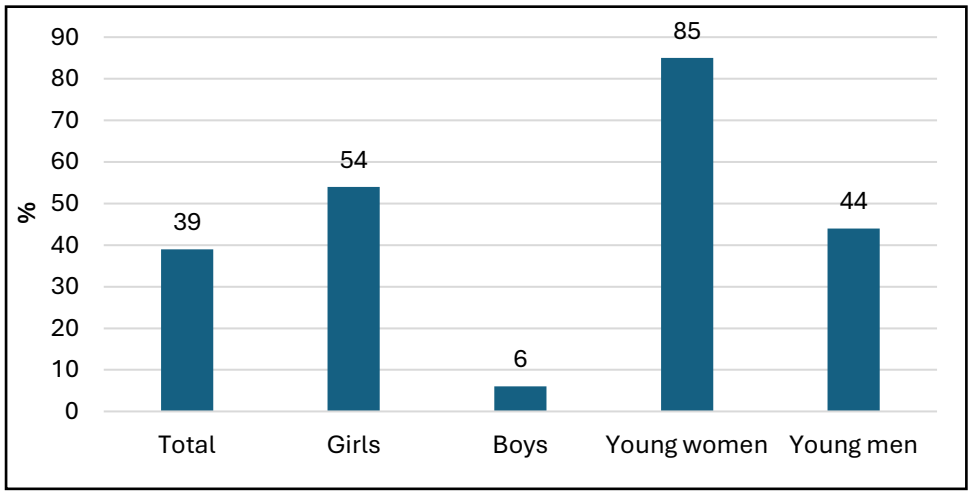


Figure 14: Proportion of young people married/married prior to age 18 at endline (by gender and cohort)

[8] There are 18 girls who fall outside of this age range.
[9] There are 16 boys who fall outside of this age range.

Of young men – who were again disproportionately likely to have been selected into the sample based on having been married – 44% had married prior to adulthood. Girls' and young women's odds of child marriage were much higher at endline than they were at Round 2 – when 'only' 17% and 74% respectively had married as children.

In East Hararghe, most marriages are decided by young people themselves. On the endline survey, 76% of ever-married young people – with no differences by cohort or gender – reported that they had made the decision to marry. Another 22% reported that their parents had made the decision (see Figure 15). Reflecting the pressure that parents put on young males to marry, young males were significantly more likely than young females to report that their parents had made marriage decisions (31% versus 19%). With the caveat that they married on average 2.4 years later, young males were also more likely than young females to report that they had been ready to marry at the time (87% versus 76%) (see Figure 16).

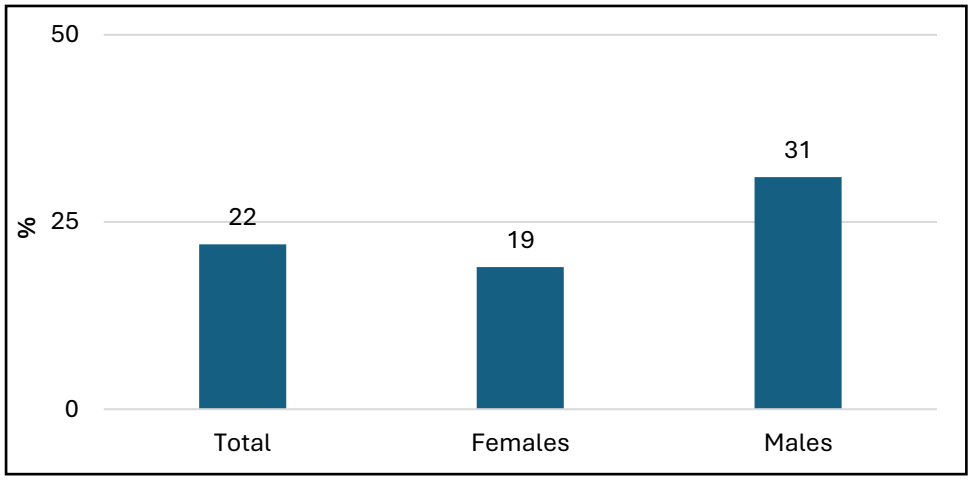


Figure 15: Proportion of marriage decisions made by parents at endline, of ever-married young people (by gender)

Since baseline (2017–2018), the prevailing narrative about child marriage in GAGE study sites has been that girls choose to marry in early or middle adolescence – due to peer pressure, to escape parents' unrelenting demands on their time, and in the context of relationships formed at cultural dances (shegoye) – and there is little parents can do to stop it. A 14-year-old girl from Community J summarised what happens: 'Girls mostly marry between 12 and 15 years old… They think, "My friend is married, I will marry too".' Narratives at endline, however, were far more complex.

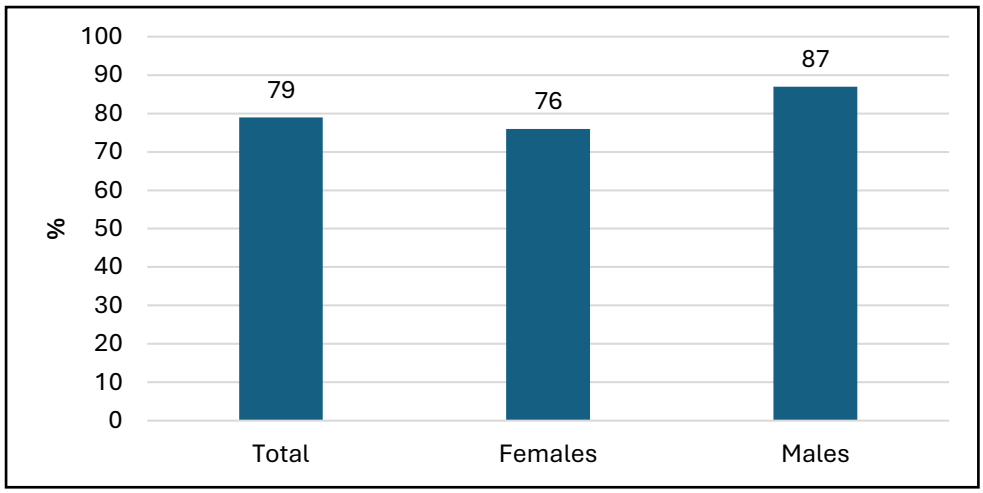


Figure 16: Proportion of young people ready to marry at the time of marriage, at endline, of those ever-married (by gender)

Many 'voluntary' child marriages are the result of relentless sexual harassment. Young males pursue girls in the community, and via mobile phone, and some use cash and other gifts to encourage girls to accede to their wishes. A key informant from Community H noted that young males' behaviour has driven down the age at which girls marry in recent years – because the youngest girls are the most vulnerable to manipulation:

It is because of the behaviour of males. Ahh… males' behaviour is that they want a girl younger than them… The mind of the young girl is not yet critical on issues. He wants to lead her as per his needs. That is the reason for preferring young girls.

Young females noted that because they are regularly reminded (both by their female peers and by the boys and young men who are harassing them) that they will never marry well unless they marry young, very early child marriage appears a rational choice, even when it means marrying a boy or young man they barely know. A 15-year-old girl from Community F, when asked why girls choose marriage over school, replied, 'Getting married is better than education… Because otherwise, you will have a chance of only falling in the hands of old husbands, and that is really bad.' A community key informant from Community G noted that girls' fears are not unfounded: 'When a girl turns age 15 without being married, she is considered non-marriageable.'

Young females added that even when they resist their peers – and refuse young males' proposals – they often find themselves required to marry anyway. In some cases, this is because young males abduct them, and once they have been abducted (or

sometimes merely made to stay out past curfew), they may not return home, because their honour is assumed to have been compromised. A 20-year-old young woman from Community H, who was abducted at age 14, recalled: 'In our community, returning home is taboo.' Respondents agreed that abductions are almost always facilitated by other adolescents – usually other young males and sometimes girls' own friends. A 14-year-old girl from Community I reported that she no longer trusts her peers, after a friend tried to help a jilted suitor abduct her: 'I used to have one friend, but after she tried to facilitate my abduction, I don't have any friends now.'

In other cases, girls are forced by their parents to marry a rejected suitor when he sends his parents to hers with a formal request, because a refusal would be seen as shameful. A 15-year-old girl from Community K stated that she not only refused her harasser, but fled to her grandmother: 'Though I was not interested, I could not resist my parents… I was with my maternal grandmother, and then they brought me back home to give me in marriage.' A key informant from Community H explained that girls' wishes are ignored by everyone, from parents to local officials: 'They don't support her decision not to marry if she doesn't want to… Because they don't want to abandon old habits.'

Narratives about parents' role in their children's marriages were highly variable. Some respondents reported that parents are genuinely supportive of child marriage. A key informant from Community H stated, 'The family wants their children to marry at an early age.' For the parents of girls, preferences for child marriage were almost always due to parents' concerns that unmarried girls could bring shame on the family by having sex and falling pregnant. For the parents of boys, preferences for child marriage were generally due to parents' wishes for grandchildren. A 20-year-old young man from Community K recalled that his parents had built him his own house, signalling that they considered him old enough for marriage, in middle adolescence: 'I married when I was 15… My parents decided it. I didn't have the intention to marry at that time… They wanted me to have children, that is why they arranged my marriage.'

That said, while many parents do appear supportive of marriage prior to age 18, endline research found that some are very unhappy that their children are marrying in early adolescence, but feel they have no way to refuse. A father from Community G, whose 14-year-old son abducted a 9-year-old girl, twice sent the girl back to her family before being made by clan elders – and the girl's parents – to allow the marriage, despite the children's age. He explained:

They told me I must let him get married… all the society will campaign against you [if not]. They will make you a crazy person to the extent of marginalising you in a corner… If you send her back home saying 'She is little!', her family will fight you… They will say 'How do you return to us a girl who has already run away?'

A mother from Community H, whose daughter was abducted at the age of 12, similarly reported that she was pressured by local leaders into allowing the marriage to stand. She recalled:

I was determined to bring her back home after the abduction, and we had serious conflicts with the kebele about this issue. However, there is a local norm that doesn't allow a girl to return home once she has been taken.

Afar

The endline survey found that a minority of young people know that child marriage is illegal for both girls and boys in Ethiopia. In aggregate, only 23% knew that it is illegal for girls to marry prior to age 18, and only 27% knew that it is illegal for boys to marry prior to age 18 (see Figure 17). Gender differences were highly significant: young males were much more likely than young females to know that child marriage is illegal for girls (28% versus 20%) and for boys (40% versus 28%).

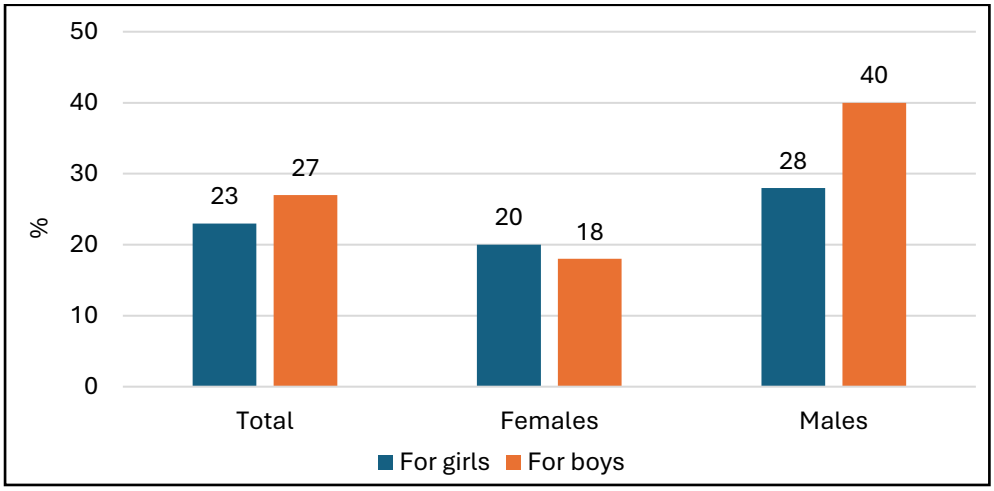


Figure 17: Proportion of young people aware that marriage before age 18 is illegal for girls and boys (by gender)

Young people's knowledge about the marriage law significantly improved between Round 2 and endline. In aggregate, they were 13 percentage points more likely at

endline to know that girls cannot marry before age 18 and 23 percentage points more likely at endline to know that boys cannot marry in childhood (see Figure 18). Young males' knowledge about the law for girls (23 percentage points, from 6% to 29%) and boys (36 percentage points, from 6% to 42%) improved more than young females' knowledge about the law for girls (7 percentage points, from 14% to 21%) and boys (14 percentage points, from 4% to 18%).

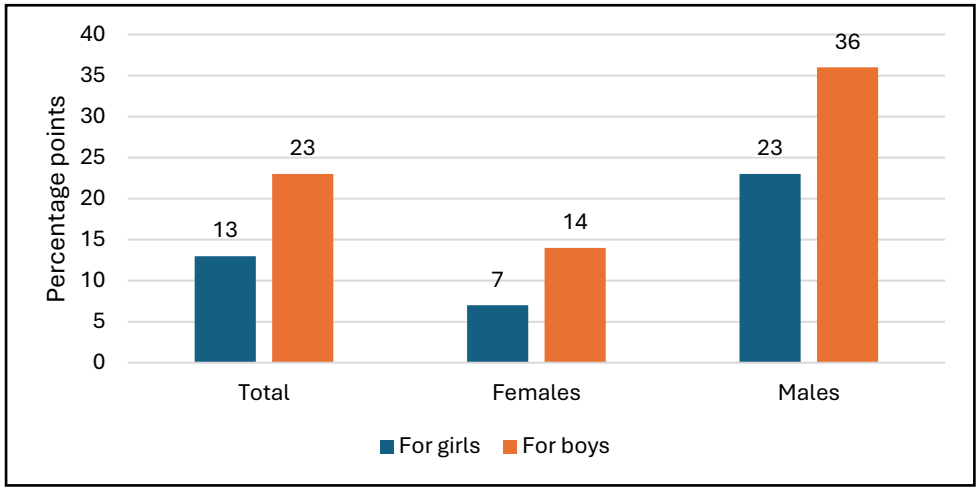


Figure 18: Change in young people's knowledge of the marriage law between Round 2 and endline

As in East Hararghe, the endline survey found that child marriage is the norm for girls in Afar, and that many boys are also at risk. Of adolescent girls, who primarily ranged in age from 14 to 20[10], 39% had already been married (if they were under age 18) or had married prior to age 18 (if they were over age 18) (see Figure 19). Of young women (and with the caveat that young women were disproportionately likely to be selected into the Round 2 sample if they were already married), 72% had married prior to adulthood. Of adolescent boys, who primarily ranged in age from 14 to 20[11], 6% had already been married. Of young men (who again were disproportionately likely to be selected into the sample based on having been married), 14% had married prior to adulthood.

[10] The sample includes 26 girls who fall out of this age range.
[11] The sample includes 20 boys who fall out of this age range.

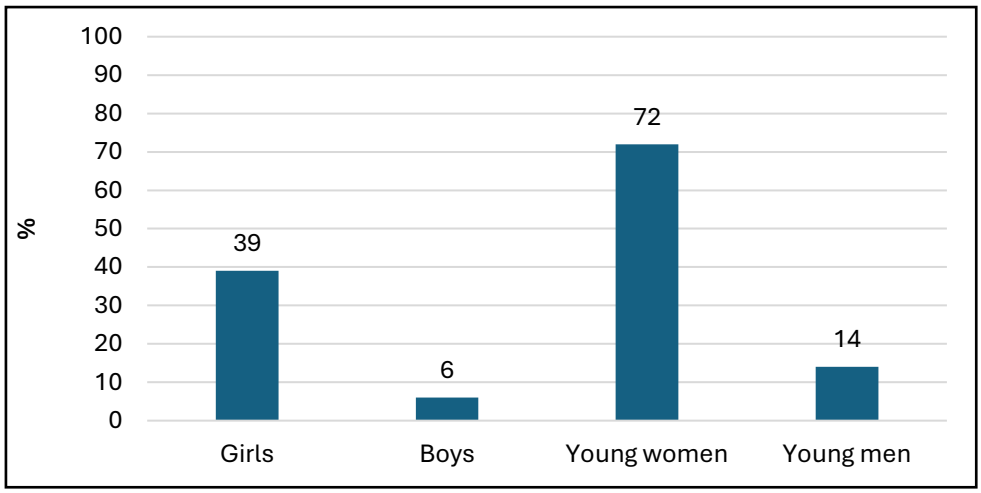


Figure 19: Proportion of young people married/married prior to age 18 (by gender and cohort)

Girls' and young women's odds of child marriage were much higher at endline than they were at Round 2 (see Figure 20). Of those in the panel sample, girls' rate of child marriage climbed from 11% to 39%; the rate for young women climbed from 52% to 71%.

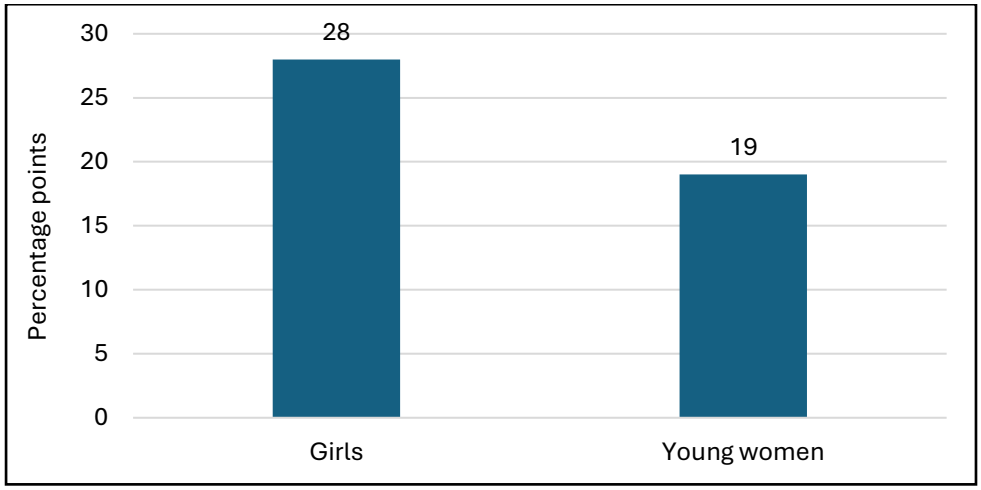


Figure 20: Change in the proportion of young females married prior to age 18 between Round 2 and endline

Marriage decision-making primarily lies with parents, according to the endline survey. Of ever-married girls and young women, 80% reported that their parents

made the decision for them to marry (see Figure 21). Of ever-married boys and young men, 53% reported the same.

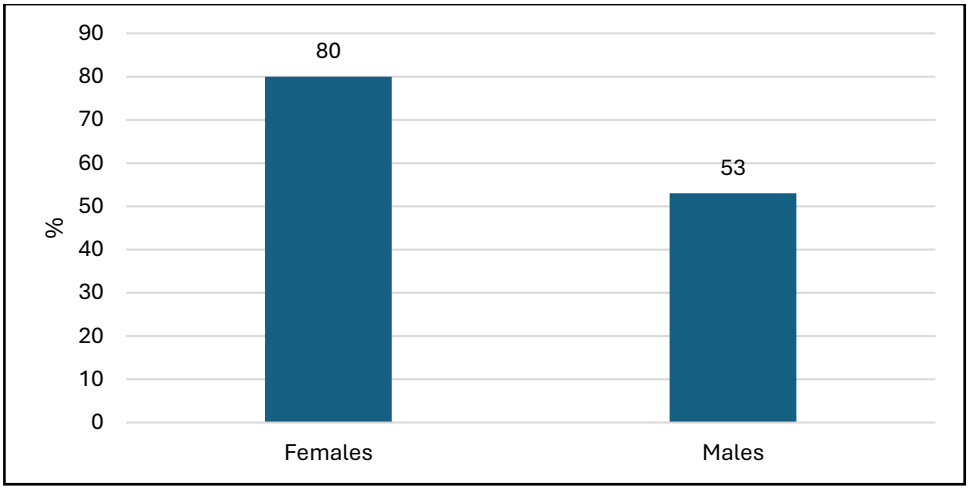


Figure 21: Proportion of marriage decisions made by parents, of ever-married young people (by gender)

Of young people married between Round 2 and endline, nearly all of the males (88%) but fewer than half of the females (40%) reported that they had been ready to marry at the time (see Figure 22).

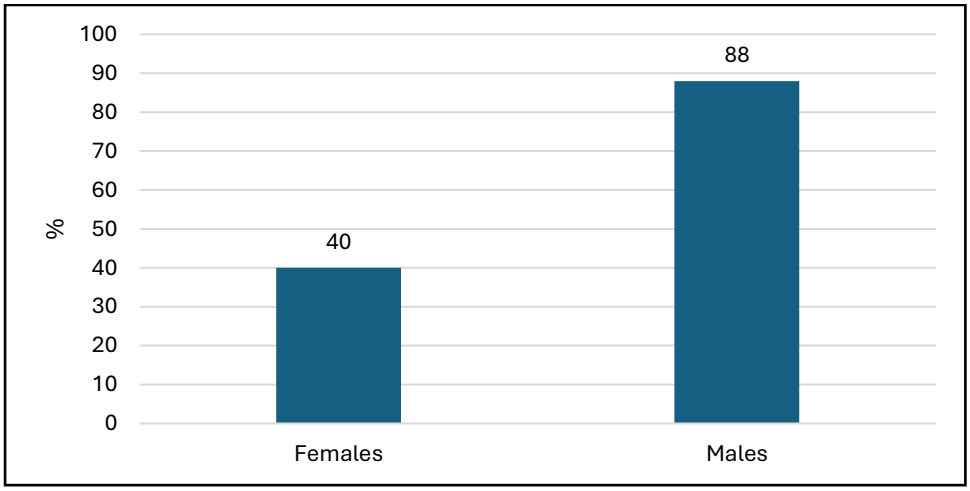


Figure 22: Proportion of recently married young people who were ready/not ready to marry at the time (by gender)

Child marriage in Afar cannot be understood without first explaining Afar marriage customs. Though practices are beginning to shift in more urban areas, marriage partners are traditionally first cousins (absumas), with girls (and young women) marrying the sons of their maternal uncles, and young men (and boys) marrying the daughters of their paternal aunts. Because families are large, young people can have multiple potential partners, though these are usually determined based on birth order.

During qualitative research, participants emphasised that girls are seen as ready for marriage as soon as they reach menarche. A militia member reported that, 'Most girls in our community will marry when they turn 12 or 13, because they will start menstruating and their nipples will start.' Preferences for girls' child marriage are partly driven by clans' demands for children – demands that have spiked after the recent surge in conflict-related deaths. More commonly, however, preferences for girl child marriage are shaped by parents' fear that girls will become pregnant before marriage, which is considered deeply shameful. One mother, who reported that she intended to have her 12-year-old daughter married within the next year, explained: 'Now is the time for marriage. If I leave her unmarried this time, she will get pregnant and give birth before she gets married.' The timing of girls' marriage is also shaped by who she is to marry, and how long he has been waiting for her to grow up. An 18-year-old young woman reported that she had married even before reaching puberty, because her cousin had been waiting to marry for many years: 'I got married when I was 10 years old. My absuma asked my parents to marry me and they said that it was impossible to refuse when the absuma requests marriage.' Several respondents added that should parents try to delay their daughter's marriage, it is not uncommon for young males to simply abduct their bride-to-be. A mother whose daughter was abducted into marriage at the age of 12 explained that she had tried to get her daughter back, but had been rebuffed:

I told them that my child is not ready for marriage, and I asked them to return her home. But they refused… I also went to the elders to help me bring Hawa home. The elders advised me … let the boy who abducted her marry her.

For young men, the timing of marriage primarily depends on the age of their absuma. Most families prefer their sons to marry young, so that he can produce children and so that his wife can contribute to domestic work. A militia member explained:

Boys in this community also marry at a young age, from the age of 15 or 16. If boys have absuma girls, they will marry even if they are young… It is only if a boy does not have an absuma girl that he will stay unmarried for a long time.

In line with survey findings, respondents in qualitative research agreed that parents make marriage decisions. Girls have no input into when or who they marry; should they protest, they are regularly imprisoned and guarded to ensure they do not escape. A 19-year-old young woman, married at age 15, reported: 'In our country, family makes you marry forcefully. You don't marry by your own decision.' A 16-year-old girl, married at age 14, elaborated:

A girl is told that she is getting married, and then if she refuses, she is beaten… She is protected so that she doesn't disappear or do anything else as soon as she hears. She is protected so that the wedding doesn't fall apart, doesn't get ruined.

With the caveat that young males occasionally have some input into which absuma they will marry, young grooms also regularly reported that they had married as their parents demanded. A 25-year-old young man, married at age 16, recalled:

I did not choose a girl to marry. I got married to my absuma girl who is my father's younger sister's daughter… I was not interested to get married to her and I even did not have the knowledge about marriage, but our parents arranged our marriage.

In stark contrast to young males, many of whom reported that they had been genuinely happy to marry as children (because it demonstrates to the community that they are now seen as men), it was rare for young females to express anything other than sadness and regret about their child marriage. A 26-year-old young woman, married at age 16, explained, 'In our culture, there is no one who wants marriage. When a hut for the bridegroom is built, you are simply waiting crying.' The young brides who expressed the least unhappiness with their marriages admitted in interviews that they were merely resigned to their fate. An 18-year-old young woman, married at age 15, when asked why she had accepted the marriage her father had arranged for her, replied: 'What could I do? Nothing! I just stayed silent.'

Conclusions

Our research reveals that the micro-level drivers of child marriage evolve in response to macro-level shocks based on distinct regional, cultural, and ecological patterns. In pastoralist and agrarian settings, local customs—such as tightly enforced parental betrothals or peer-driven, adolescent-initiated unions—interact directly with crisis dynamics. For instance, post-conflict survival strategies can prompt clans to enforce child marriages to rebuild kinship networks or protect a family's perceived social honour. These systemic shocks severely constrain girls' voice, bodily autonomy, and psychological well-being. The resulting marriages tightly couple with adolescent

pregnancy, driven by a simultaneous collapse in local reproductive healthcare infrastructure and a drop in modern contraceptive access.

Understanding these fluid, crisis-driven pathways is critical for developing multi-sectoral interventions. Addressing child marriage within humanitarian and fragile settings demands moving away from a singular focus on legal prohibition. Instead, our research suggests that policies must integrate adaptive social protection, targeted educational catch-up programming, and context-specific norms-shifting strategies, including community conversations, engagement with religious and cultural leaders, and targeted programming with adolescent boys and young men to shift conservative masculinities.

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