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FOREWORD

The Ethiopian Economic Association (EEA) and its Mekelle Chapter are happy to issue the proceeding of the Fifth Annual Conference on the Tigray Regional State Economic Development which was organized on May 14, 2016 at Sebean International Hotel Conference Hall, Aksum. EEA organized this important regional conference as one of its objectives of broadening its activities and coverage at regional level so as to contribute to the economic advancement of regional state through enhancing economic policy formulation capability; the dissemination of economic research findings; promotion of dialogue on critical socio-economic issues; promotion of education in economics in higher learning institutions; enhancing national, continental and global networks of professionals and institutions; and advancement of the professional interests of its members.

The Annual Regional Conferences that the Association has organized in collaboration with its Mekelle Chapter has created important forums for presenting and discussing development issues that are highly relevant to the Regional Socio-economy. These forums have also provided incentives for researchers to conduct research and present their findings on regular basis. Indeed, the Annual Regional conferences were organized in an interdisciplinary fashion, thereby widening the interactive coverage involving both economists living here in the region and those living outside the region and non- economists who are working and experiences on the region. The Fifth Annual Regional Conference on Tigray Regional State Economic Development has contributed towards a deeper understanding of the regional economy and the complex challenges it faces. It attracted about 115 participants including three higher officials from Tigray Regional State council office and expertise from Tigray Regional State Bureau of Plan and Finance, Aksum City Administration, Tigray Agriculture Research institute, DEDEBIT micro finance and different Banks, Universities of Mekelle, Adigrat and Axum, NGOs, private sector representative and EEA members in the Mekelle. The participants of the conference expressed their satisfaction on the organization of the conference and the content of the papers presented. They reflected that the papers largely focused on local

issue that can contribute to the development of the region. They also recommended that the issues raised in the discussion are critical that need due attention by policy makers and implementing organs of the region.

In this publication, Five papers which were presented at the Fifth Annual Conference reviewed by external reviewers and comments and suggestions including editorial comments were communicated to authors for improvement. Finally, three papers which passed all the review and editorial process published in the Proceeding of the Fifth Annual Conference on the Tigray Regional State Economic Development.

I would like to take this opportunity to express my heartfelt gratitude, on my own behalf and on behalf of the Ethiopian Economic Association, to the many people and organizations that made the conference resounding success. First and foremost, I thank the authors of the papers and the audience whose active participations made the Conference meaningful. The staffs of the Economics Department of the Mekelle University which runs the EEA Mekelle Chapter, participants from Adigrat and Axum Universities and the staff of EEA Secretariat deserve a special recognition for their passion and perseverance in managing the conference from inception to completion. Aksum University deserves great appreciation for co-organizing the Fifth Annual Conference on the Tigray Regional State Economic Development successfully.

Our special thanks go to our partners who have shared our vision and provided us with generous financial support to materialize the activities of EEA. These include; The Friedrich Ebert Stiftung of Germany, The African Capacity Building Foundation (ACBF), and The Think Tank Initiative of International Development Research Center (IDRC) of Canada.

Alemayehu Seyoum Taffesse (D Phil)
President of the Ethiopian Economics Association

Analysis of Honey Marketing: Its Opportunities and Challenges in Central Zone of Tigray, Northern Ethiopia

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Abstract

In Ethiopia, beekeeping is a promising non-farm activity for the rural community. It contributes to the income of households in particular and the economy of the nation in general. In Tigray region beekeeping has a long-standing tradition, dating back to ancient times during the kingdom of Abyssinia and plays a significant role as a source of cash income in the smallholder farming system. The overall objective of the study was to analyze honey marketing opportunities and challenges of in central zone of Tigray, Northern Ethiopia. A total of 135 beekeepers were proportionately and randomly selected from three districts. Results of descriptive analysis indicate that mean price of honey vary seasonally: 63.45, 61.77, 62.20 and 59.69 ETB/Kg in autumn, winter, spring and summer, respectively. Most of the beekeepers (62.5%) sold their honey at district market while the rest sold at farm gate, kebelle market, other kebelle/district market and regional market. The honey marketing in the study areas faced challenges such as poor extension services in honey marketing (96.6%), absence of local cooperatives

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engaged in honey marketing (89.8%) and limited participation of wholesalers and processors in the marketing system are the main among the others. Despite these limitations, the opportunities for honey marketing in the study areas are: stable honey price (100%), accesses to market information (87.5%), access to nearby market (87.5%), high market demand for honey purchasing (84.1%) and accesses to credit service (66.6%). Besides, presence of credit providing institution such as Dedebit Credit and Saving Institution (DCSI) in the study areas was among honey marketing opportunities. Hence, to make honey marketing systems more function, it is recommended that office of agriculture and rural development of the study districts in particular and the region in general has to strive more towards improving the quality and adequacy of extension services by increasing the number of beekeeping qualified man power at kebelle and district levels. Governmental and non-governmental institutions should give due attention in investing in honey processing and capacity building in order to boost the individual beekeepers income. In addition, more beekeeping cooperatives or associations should be established to facilitate honey production and marketing.

Key words: Central Tigray, challenges, honey marketing, Northern Ethiopia, opportunities

1. Introduction

Ethiopia is Africa‘s first honey producer and ninth in the world (FAO, 2010). In Ethiopia, beekeeping is a promising non-farm activity for the rural community. It contributes to the income of households in particular and the economy of the nation in general. The direct contribution of beekeeping includes the value of the outputs produced such as honey, royal jelly, queen and bee colonies and other products in cosmetics and medicines (EARO, 2000; Gezahegn, 2001). For many farmers beekeeping is a very profitable business and a high proportion of their annual income is earned from this sub-sector. Some beekeepers are able to earn 5,000 to 10,000 Birr annually from honey selling. In general beekeepers of the country are estimated to earn about 360-480 million Birr annually from the total annual honey production. Besides, the annual average value of beeswax produced in the country is about 125 million Birr (Seid and Solomon, 2015). Ethiopia has the

potential to produce 500,000 tons of honey and 50,000 tons of beeswax annually (GDS, 2009). However, the current production is limited to 54,000 tons of honey and 5,000 tons of beeswax (AGP-AMDe, 2012).

According to AGP-AMDe (2012), the role of apiculture for sustainable development in different Ethiopian agro-ecological zones is highly recognized as beekeeping is less affected by drought than other agricultural activities. There are about 1.5 million beekeepers in Ethiopia and 8 to 10 million bee colony hives. With its unique characteristics including its white, yellow and red coloration, Ethiopia is an important source for specialty organic honey. Currently, 80% of Ethiopian honey is used for *Tej* (honey wine), 5% for rural household consumption and 15% marketed as table honey. About 95.5% of the honey produced nationally is sourced from traditional beehives. The regional states of Ethiopia (Oromia, Amhara and SNNP) contributes 46%, 24% and 22% of Ethiopia's honey production, respectively and produce honey in colors ranging from light to dark amber. There are three types of bee hives used for practical beekeeping in Ethiopia: traditional, transitional or intermediate and modern hives. About 95.5% of the honey produced nationally is sourced from traditional beehives.

In Tigray region beekeeping has a long-standing tradition, dating back to ancient times during the kingdom of Abyssinia and plays a significant role as a source of cash income in the smallholder farming system. It has strong growing end markets making it feasible business for women and landless youth (USAID 2008). The number of bee colonies and honey production in Tigray region were estimated to be 219,036 and 24,326.52 quintals, respectively (CSA, 2012). Though, beekeeping practice in recent years is improving, the region contributes 5% of the country's honey production, which is of a distinct white color (AGP-AMDe, 2012; and Yetimwork *et al.*, 2014).

In Ethiopia, although thousands of tons of honey have been produced every year, the products obtained from the subsector are still low as compared to the potential (Edessa, 2005). The major constraints that affect beekeeping sub-sector in Ethiopia are: lack of beekeeping knowledge, shortage of skilled manpower, shortage of equipment, pests and predators, pesticide threat, poor

infrastructure, shortage of bee forages and lack of research extension (Kerealem *et al*., 2009). Haftu *et al.*, (2015) also reported that water scarcity, financial problem in relation to honey production and marketing, pests and predators, poor extension services, shortage of honeybee forages and high input cost are among the constraints of beekeeping in central zone of Tigray region, Northern Ethiopia. Despite these constraints, there are some opportunities to beekeeping development which includes access to all types of beehives, access to bee colonies, attractive market price for honey and its byproducts (Haftu *et al.*, 2015).

Hence, study of the existing honey marketing system, will help to give important and feasible recommendation for further improvement of the honey marketing system sustainably and to address quality of honey and to ensure fair price for the producers and consumers. Moreover, the legality issue in the honey market needs thorough consideration to tackle the problem like adulteration so that Ethiopia can benefit from the expanding export market (Gemechis, 2014).Therefore, the objective of this study was to analyze honey marketing opportunities and challenges of in central zone of Tigray, Northern Ethiopia.

2. Research Methodology

2.1 Description of the Study Areas

The study was conducted in Kolla-Tembien, Tanqua-Abergelle and Weri-Lekhe districts of the central zone of Tigray region, Northern Ethiopia. The three districts were selected for the study following purposive sampling approach considering potential in honey bee production and marketing. The latitude and longitude of the districts is N 130 37' 6.24" and E 390 0' 6.84" (Kolla Tembein), N 130 14' 06" and E 380 58' 50" (Tanqua-Abergelle) and N 140 00' 00" and E 390 10' 1.2" (Weri-Lekhe).

2.2 Sample Size and Sampling Techniques

A multi-stage sampling procedure has been employed for this study. In the first stage, the study districts were selected purposely considering potential in honey bee production. In the second stage, a total of 135 beekeepers

households were selected from the districts using quota method. In the third stage, 42 from Tanqua-Abergelle, 58 from Kolla-Tembien and 35 Weri-Lekhe were proportionately and randomly selected.

2.3 Type, Source and Method of Data Collection

For this study, both primary and secondary data were used. Primary data was collected from sample household heads (beekeepers) while secondary data was collected from office of agriculture and rural development of respective study districts. Semi-structured questionnaire was used to collect the primary data.

2.4 Method of Data Analysis

The data were analyzed using descriptive statistics such as percentage, mean and standard deviation using SPSS software version 16.0.Theresults are presented in figures and tables. T-test was used to compare spatial and seasonal honey price variation of beekeepers households in the study districts.

3. Results and Discussion

Demographic Characteristics of the Households

Average family size of the study areas was 6 heads per household and the minimum and maximum family size were 2 and 12, respectively. The respondents' age ranges from 23 to 89 and the mean age is 44.98 year (Table1). The average beekeeping experience of the respondents was 11.1+9.3 year. The result showed that beekeeping can be performed by different age groups who are economically active and the beekeepers exercised beekeeping from 9 to 36 years. Most of the respondents were male headed (89%) and the rest 11% were female headed households. Most of the respondents were married (89.7%) and the rest (10.3%) fall under the category of single, widowed, widower, divorced. Based on the survey result, the educational status of the households (32.9%, 14.1%, 35.3%, 15.3% and 2.4%) were illiterate, read and write, elementary completed, high completed and church school, respectively.

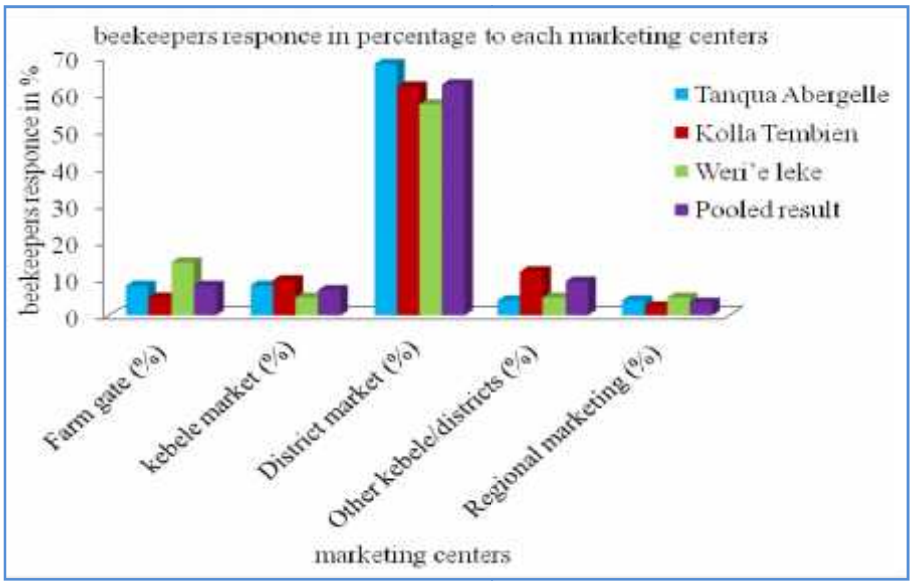
Table1: Age, family size, experience in beekeeping of household head

Variables	Minimum	Maximum	Mean	Std. Deviation
Age of respondent (year)	23.00	89.00	44.98	12.46
Family size (head count)	2.00	12.00	5.99	2.23
Experience in beekeeping (in years)	1.00	36.00	11.14	9.29

Honey Marketing System

According to the survey result, the sample beekeepers households of the study area sold their honey at different market places i.e. farm gate, kebelle[3], district and regional level markets. Most of the honey producers from Tanqua-Abergelle (68%), Kolla-Tembien (61.9%) and Weri-Lekhe (57.1%) sold their honey at district market. On average, 62.5% of the beekeepers sold their honey at district market (Figure 1). The respondents were also asked who their main costumers or buyers. They sold their honey to urban residences (67%), local farmers (19%), retailers (10%) and whole sellers (4%) (Figure2). This result shows that participation of local wholesalers and processors in honey marketing is limited in the study districts.

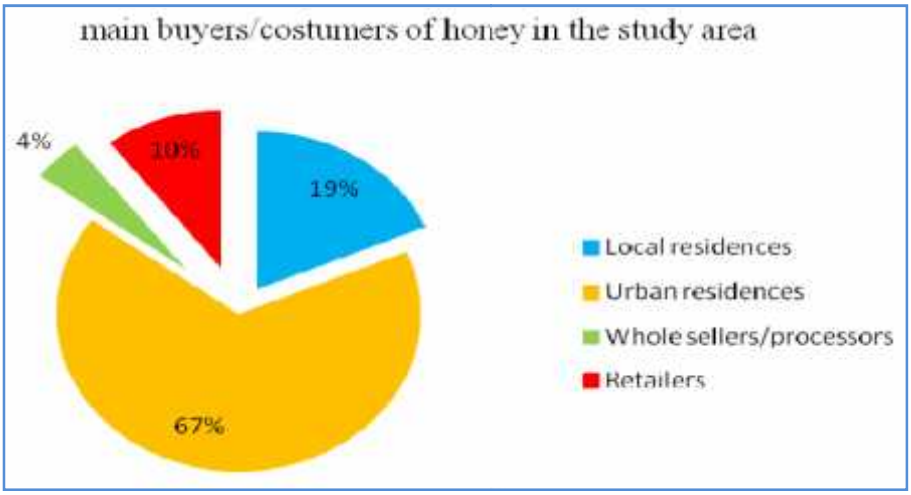
Figure 1: Honey marketing centers in the study areas



Source: Survey data, 2014

[3] Kebelle is the smallest administration unit with its own jurisdiction

Figure 2: Honey buyers in the study areas



Source: Survey data, 2014

Spatial and Seasonal Honey Price Variation

From the pooled results of the study areas, the price of honey was the highest from September to November which is about 63.45 ETB per Kg without considering color of the honey. The mean price of honey per Kg in Kolla-Tembien and Weri-Lekhe districts from December to February were (50.67 ETB) and (74.44 ETB), respectively. The price difference is between Kolla-Tembien and Weri-Lekhe was statistically significant at 5% particularly from December to February (Table2).

Gross income of the beekeepers' ranges from 500 to 13,750 ETB per annum across the study districts. But the mean gross income was 3,229.6 (Tanqua-Abergelle), 4,190.15 (Kolla-Tembein) and 3,345.50 (Weri-Lekhe) ETB per annum. The largest proportion of the respondents (44.44%) earned income ranged from 2,001.00 to 6,500.00 ETB and (37.78%) of the sample beekeepers obtained gross income ranged 500 to 2,000.00 ETB per annum. The rest (17.78%) of the respondents obtained gross income ranged between 6,501.00 to13, 750.00 ETB per annum.

Table2: Spatial and seasonal honey price variation of beekeepers in Tanqua-Abergelle, Kolla-Tembien and Weri-Lekhe districts

Seasons	Mean price of honey across districts			
	Tanqua-Abergelle (N=42)	Kolla-Tembien (N=58)	Weri-Lekhe (N=35)	Pooled Result (N=135)
Autumn (September to November)	61.25[a]	64.00[a]	67.50[a]	63.45
Winter (December to February)	63.89[a, b]	50.67[a]	74.44[b]	61.77
Spring (March to May)	66.00[a]	50.75[a]	77.50[a]	62.20
Summer (June to August)	55.56[a]	64.17[a]	70.00[1]	59.69

Source: Survey data, 2014: values in the same row not sharing the same superscript shows significant difference at $p<0.05$ in the two-sided test of equality for column means. Cells with no superscript are not included in the test. Value with superscript 1indicates that the category is not used in comparisons because the sum of case weights is less than two.

Honey Marketing Opportunities

Honey marketing system of the study area is not different from the national marketing system (That is honey marketing in Ethiopia is generally not well developed, mainly due to a limited number of buyers relative to the number of producers, poor market infrastructure and information, the local traders lacked basic business concepts, lack of facilities like container and processing materials (Beyene and David, 2007).It has many opportunities regarding to marketing situation of honey. About 100% of honey producers responded that honey price is increasing year after year (Table3). This might have occurred due to increasing domestic consumption (i.e80% of Ethiopian honey was used for *Tej* production (AGP-AMDe, 2012) and increasing volume of honey export (i.e in 2007/08 production season the volume of honey export was 219.89 tons and in 2010/11increased to 520.3 tons (CSA, 2012). This result is also in line with Gemechis (2014) that the national domestic consumption of honey is increasing from time to time due to an increasing demand of local beer known as *Tej*. He also explained that honey value is increased not only due to domestic consumption but also due to increasing export in the global market.

Among the respondents about 87.5%, 87.5%, 84.1% and 66.6% has access to market information, access to nearby markets, high market demand for honey purchasing and access to credit that boost honey marketing, respectively were also among honey marketing opportunities in the study areas (Table 3).Besides, presence of credit providing institution such as Dedebit Credit and Saving Institution (DCSI) in the study areas was among honey marketing opportunities. Hence, this finding is consistent with GDS (2009) that presence of micro-finance institutes at grass-root level was one of the opportunities of honey marketing in Ethiopia.

Table3: Honey marketing opportunities of the study districts

Honey marketing opportunities	**Numbers of beekeepers respond "yes" in percentage (%)**
Access to nearby markets	87.50
Accesses to market information	87.50
High market demand for honey purchasing	84.10
Attractive honey price and sustainable market for honey	100
Access to credit services	66.62

Source: Survey data, 2014

Honey Marketing Constraints

Depending on the assessment's findings, even though there existed good opportunities that can be exploited to boost honey marketing in the study area, there are challenges regarding honey marketing in the study districts. Thus are: low extension services and absence of local cooperatives that can actively participate in honey marketing are the main pressing factors among the others (Table 4). This study is also supported by GDS (2009) finding that inadequate extension service was one of the challenges of honey marketing in Ethiopia. Hence, improving extension services to produce quality honey and establishment of local honey collector cooperatives in an organized manner is mandatory in order to increase the small-scale honey producers' income. In spite of the districts high potential in honey production, there was also limitation in participation of wholesalers and processors in the honey marketing system. This study concurs with Gemechis (2014) findings that

the involvement of honey and beeswax processing companies is also an important factor to enhance the honey export volume.

Table 4: Honey marketing constraints or challenges of in study districts

Honey marketing constraints	Numbers of beekeepers respond "yes" in percentage (%)
Lack of cooperatives actively participate in honey marketing	89.80
Poor extension services to honey marketing	96.60

Source: Survey data, 2014

4. Conclusions and Recommendations

Given the existing natural base of Ethiopia, the government has given due attention on apiculture development as one of the strategies to reduce poverty and diversify the national exports. The study area, central zone of Tigray region has many opportunities that can be exploited to boost honey marketing and its by-products. These are: more or less stable honey market price, access to market information, access to nearby market and access to credit. On the contrary, honey marketing in the study areas had facing with different economically important factors which are negatively affecting the system: low extension services, absence of local cooperatives that can actively participate in honey marketing and limited engagement of wholesalers and processors.

Most beekeepers replied that extension services delivered to them regarding to honey marketing were found not well-organized. Hence, to make honey marketing systems more function, it is recommended that office of agriculture and rural development of the study districts in particular and the region in general has to strive more towards improving the quality and adequacy of extension services by increasing the number of beekeeping qualified man power at kebelle and district levels. Governmental and non-governmental institutions should give due attention in investing in honey processing and capacity building in order to boost the individual beekeepers income. In addition, more beekeeping cooperatives or associations should be established to facilitate honey production and marketing (collection, transporting, processing and retailing).

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Estimating Farmers' Adoption and Perception of Solar Photovoltaic Technology: The *Case Study of Tigray Region*

Mulugeta Tesfay[1], Muuz Hadush[2] and Hailay Tesfay[3]

Abstract

This study deals with the adoption of a solar photovoltaic system by famers in Tigray region. It mainly examines the factors determining adoption, assesses farmers' perception on certain traits of the technology, and compares the actual and predicted rates of adoption. In order to accomplish the task, it utilized the theoretical framework of random utility model through the probit method of estimation. It also used data collected from a sample of 150 households drawn from a multi-stage cluster sampling in the two districts of Enderta and Degua-Tembien in South-eastern Tigray. Based on the descriptive analysis, solar PV adopters indicated that the potential role of solar PV on student scores, environment, and health status motivated their action while the cost, inaccessibility, and availability of substitutes discouraged non-adopters. The probit analysis reveals that age, marital status, livestock wealth, family size, extension service, and distance to Tabias are the major determinants of solar PV adoption indicating that unique training, different modes of payment and credit facilities could contribute to enhance adopting the technology. Besides, the empirical analysis indicates that the predicted adoption rate exceeds the actual adoption rate implying an immense potential for better adoption through exploiting the heterogeneity of the respondents.

Key words: Photovoltaic Solar System, Adoption, Random Utility Model, Rural energy supply

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1. Introduction

Rural energy supply advances the social and economic progress of the people (GNESD, 2007). It is a critical, though not sufficient, input in addressing rural poverty and bringing about development (Cabraal *et al*, 2005). Rural people need electrical energy for irrigation, lighting, communication, and income generating activities (GNESD, 2007). Energy is an input to social services, such as education, health care and communication (Bardouille, 2004). Processing, storage, and access to markets and market information are not possible without the adequate supply of energy services (EAD, 2011).

Several studies document the role of better energy supply for sustainable human development. Clean and affordable energy supply contributes to attaining the MDGs targets (Modi *et al*., 2006; UN-Energy, 2005; UNDP, 2005, DFID, 2002). Access to modern energy sources greatly reduces fuel expenditure and biomass fuel collection time (Galitsky *et al*., 2006). Moreover, i rural power service improves lighting which promotes extended hours of study, improved access to information, reduction of burden on women and the environment, and enhanced farm output (WB, 2009).Studies by Barnes et al. (2010) and UNDP (2006) also show that modern and stable energy supply enhances employment, trade and value adding; and improves the quality of life through better diet and food intake, housing conditions, and health and education facilities.

Despite such social and economic benefits, supply of electrical energy greatly varies across and within regions. Access to electricity is extremely low in many developing countries. Close to 1.5 billion People, or more than one-fifth of the world population, had no access to electricity in 2008 (IEA, WEO, 2009). Some 85 percent of those without electricity live in rural areas, mainly in Sub-Saharan Africa and South Asia. The International Energy Agency estimates that about 621 million people in Sub-Saharan Africa do not have access to electricity and rural electrification is only 16 percent (IEA, WEO, 2014). Like most Sub-Saharan African countries, Ethiopia still lags behind in terms of access to basic energy services. Only 23 percent of the general population in Ethiopia, and not more than 10 percent of the rural

population had access to electricity in 2012 (IEA: WEO, 2014). More than 94 percent of the energy demand in Ethiopia is met through biomass fuels, such as wood, plant materials or agricultural wastes (GIZ, 2010).The National Grid Electricity (NGE) does not cover most rural areas due to high cost of supply owing to geographical dispersion, high percentage of poor households, and low demand often for residential and agricultural use (GIZ, 210b). For rural areas quite close to the main grid line, connection costs range from birr 500 to 1000 (UNDP 2 006). Rural people thus use kerosene for lighting and charcoal or firewood for cooking that cause many health problems and face the risk of house fires and suffocation. The cost of traditional energy sources such as kerosene, candles, fire wood and batteries exceeds birr 90 per month (GIZ, 2008) unaffordable for most two dollar-earners a day. Moreover, the huge reliance on biomass fuel sources and demographic facts worsen deforestation, land degradation and fall in productivity ending in environmental disaster (Mulugetta, 2007; Karakezi, 2003). In sum, huge reliance on biomass fuel, difficulty to access electricity and ruinous pressure on the environment characterize energy supply in Ethiopia.

In view of this, off-grid electrification, often with photovoltaic solar systems, provides an option to the evident energy gap, thus serving unconnected rural areas, and avoiding environmental catastrophe (GIZ, 2010b).It is an economically viable and environmentally sustainable energy source. Hence, the Ethiopian government energy sector planned to use off-grid electrification as a vital component of the energy supply program, and envisaged to distribute three million solar lanterns and solar home systems by 2015 (MOWE, 2010). Hence, studying the adoption process of solar photovoltaic systems emphasizing the determinants, perception and rate of adoption assists effective policy revision and scale up, and evaluation of public investments. To the best of our knowledge, no such a research has thus far been undertaken in Tigray. As a result, this study seeks to unravel factors that determine the adoption of PV solar energy, and elicits information about famers' perception towards the new technology in the districts of Degua-Tembien and Enderta in Tigray region by employing random utility model in its theoretical framework, and probit method for its estimation strategy. This paper might assist regional policy making by

presenting farmers' perception and adoption rate at the same time, and adds to the adoption literature by shedding light on the determinants of adoption.

2. Data and Methods

2.1 Data and Sampling Technique

In order to attain its objectives, this study uses both primary and secondary data sources. The primary data has been collected through a field survey based on a semi-structured questionnaire. The survey has been composed of relevant data variables related to general information, socio-economic conditions, energy use, and state of solar photovoltaic adoption concerning rural households. Secondary data retrieved from theoretical and empirical literature, and energy sector policy and performance reviews gathered from various earlier research works, books, and reports of different organizations has also been pertinent. With respect to the sampling technique, multi-stage (four-stage) cluster sampling procedure involving a combination of purposive and simple random sampling tools was used. Purposive random sampling strategy is chosen as it adds credibility of the findings when a potential sample is larger than one can handle, and helps to reduce bias within the purposive category (Patton, 2002).

Accordingly, the first three steps involved purposive selection of zones and districts, and random selection of Tabias and villages. The south-eastern zone and two respective districts of Enderta and Degua-Tembien were selected for resource, socio-economic similarity, and adoption trend considerations. Moreover, six Tabias (peasant associations) from Degua-Tembien and four Tabias from Enderta districts were selected proportional to the relative number of Tabias in each district. The fourth stage involved the simple random sampling of villages and households. Accordingly, 153 households were selected for the study from the 10 entire villages. As mentioned above, the selected sample households were interviewed using a semi-structured questionnaire.

The questionnaire was designed to include household, village and technology characteristics or aspects of rural technology adoption. The content of the questionnaire and inclusion of major variables is based on the

literature found in the works of Misra *et al*. (1993), Huffman (1977), Feder *et al.* (1985), Kimhi (1994) and Saha *et al.* (1994) about technology adoption in developing countries by rural households. In particular, human and physical capital endowment-related variables that include age, sex, education, training, exposure, farm size, livestock ownership and size of off-farm income, and marketing facilities and technology characteristics that determine the access and use of information, level of profit, and risk to be faced by farmers are essential components of the semi-structured questionnaire developed and used to gather data.

2.2 Analytical Framework

2.2.1 Theoretical Model

The rational choice theory is widely used as a framework to understand and model social and economic behavior of individual adoption decision (Lawrence and Easley, 2008). This theory assumes individuals to be rational in devising and choosing practices or technologies so as to improve their livelihood .Choice models are developed from economic theories of random utility in which decision makers choose the alternative for which the expected value of utility is the highest. Farmers are assumed to have objectives of utility maximization, and their choice of technology is hypothesized to be based on the premise of random utility (McFadden, 1981). Hence, the adoption of the solar light by farmers depends on different factors that influence the choice of solar technology defined by random utility function expressed as:

$$U_m = X_n \beta_i + \varepsilon_n \qquad (1)$$

Where; U_m is the utility to be derived from using solar technology, X_m is a vector of technology and household attributes, β_i is a parameter vector to be estimated, ε_m is the disturbance term, and m is the technology acoption choice. Farmers derive utility from adopting a technology, and denoting a farmer's choice to adopt or not to adopt by utility functions of U_a and U_n, respectively, the utility function can be expressed formally as:

$$U_a = (1, r, y) \text{ and } U_n = (0, r, y) \qquad (2)$$

Where; U_a and U_n are the utilities obtained from the choice of adoption and non-adoption of solar light, respectively, subject to the resource endowment constraint (r), and other observable attributes (y) that affect adoption decision of farmers. Assuming further that the utility function follows an additively separable form in the deterministic and stochastic component, it can be expressed as:

$$U_a = (1, r, y) = \mathbb{D}_{Uai}(1, r, y) + \varepsilon_a \text{ and } U_n = (0, r, y) = \mathbb{D}_{U_{ni}}(0, r, y) + \varepsilon_n \quad (3)$$

Where: U_a is the utility obtained from solar technology, Uai is the deterministic part and ε_a is the stochastic component unobservable to the researcher. Using the random utility framework for modeling the decision process of individual farmers, a farmer prefers to adopt solar technology if its return, minus its cost, is at least greater than the return from not adopting expressed by:

$$U_a \geq U_n = U_a(1, r - c, y) + \varepsilon_a \geq U_n(0, r, y) + \varepsilon_n \quad (4)$$

C represents the cost of adoption of the solar technology, and the existence of the stochastic component enables us to apply a probabilistic distribution about a decision-makers behavior where the probability distribution of adoption and non-adoption is defined respectively as:

$$P_a = P(choice) = Pr\big(\mathbb{D}_a(1, r - c; y)\big) + \varepsilon_a \geq Pr\big(\mathbb{D}_n(1, r; y)\big) + \varepsilon_n \quad (5)$$

$$P_n = Pr\big(\mathbb{D}_n(0, r; y)\big) + \varepsilon_n \geq Pr\big(\mathbb{D}_a(1, r - c; y)\big) + \varepsilon_a \quad (6)$$

The choice of a farmer to adopt the solar technology in terms of utility function of probability distribution can be shortly expressed as below. Besides, the binary dependent variable demands the use of either a *probit* or *logit* model as a proper estimation strategy (Wooldridge, 2006).

$$P(choice) = Pr\,(U_a) \geq Pr(U_n) \quad (7)$$

2.2.2 Estimation Strategy

We can use the probit model to understand in which the utility function *U* depends on attributes of the household and sources of information about the characteristics of the technologies that the household can adopt. Thus, the utility of technology t for household is defined by:

$$U_{th} = U_{th}(Z_h, I_h) \quad \textbf{(8)}$$

Where: Z_h= variables about household characteristics
I_h = variables for households' sources of information
Z = exogenous household characteristics following (Singh et al 1986)

The relationship between utility and the variables in Z and I is often assumed to be linear so that:

$$U_{th} = X_h\gamma_t + e_{th} \quad \textbf{(9)}$$

Where the X_h is a vector containing all the variables included in Z_h and I_h, $\gamma$is a vector of parameters relating to the variables X to the household's utility, and e_{th} is a zero-mean random error term assumed to be independently and identically normally distributed, i.e., $e_{th} \sim N(0, \sigma^2)$; Individuals are assumed to choose the technology that maximizes their utility. Hence, a household will in theory adopt a technology if the utility derived from the new technology exceeds the utility from a traditional technology. Putting in a mathematical form, adoption occurs when:
(10) $U_h^{new} \geq U_h^{old}$or if the latent random variable $D^* = U_h^{new} - U_h^{old} > 0$

If we define a binary adoption variable as:

$$D_h = \begin{cases} 1, & if U_h^{new} > U_h^{old} - when the new is adopted \\ 0, if U_h^{new} \leq U_h^{old} - when the new is not adopted \end{cases}$$

Then the probability that D_h= 1can be expressed as a function of the variables X as follows

$$Pr(D_h = 1) = Pr\left(U_h^{old} < U_h^{new}\right) = Pr\left(X_h\gamma^{old} + e_h^{old} < X_h\gamma^{new} + e_h^{new}\right)$$
$$= Pr\left[e_h^{old} - e_h^{new} > X_h\left(\gamma^{new} - \gamma^{old}\right)\right]$$
$$= Pr(\mu_h < X_h\beta)$$
$$= F(X_h\beta)$$

Where $Pr(.)$ represents a probability function, μ_h is a random error term, and $F(X_h\beta)$ is a cumulative distribution function for μ_h evaluated at $X\beta$. Thus, the probability of adoption of the technology can be expressed as a function of the variables X and parameters β. Moreover, the choice of the cumulative normal distribution for $F(.)$ defines the model as a probit model. The estimates of the parameters β are typically obtained using maximum likelihood methods, which use optimization methods to choose the values of β that maximize a likelihood function following the technical explanation in (Greene 1993) and the mathematical expression is:

$$Pr(D_h = 1) = 1 - \Phi(-X_h\beta), \quad \textbf{(11)}$$

$$\log L = \sum_{n=1\ldots N} D_n \log \Phi(X_h\beta) + \sum_{n=1\ldots N}(1 - D_n) \log[1 - \Phi(X_h\beta)]$$

Thus, the marginal effect of a variable X on the probability of adopting new technology can be calculated by differentiating D_h with respect to X, X_j:

$$\frac{\partial Pr(D_h = 1)}{\partial X_j} = f\left(X_h\beta_j\right).\beta_j \quad \textbf{(12)}$$

Consistent parameter estimates for the ~ vector that maximize the log-likelihood function can be obtained by applying the probit procedure available in Stata. Furthermore, descriptive statistics is used to analyze the perception of farmers on the characteristics of the technology such as effectiveness, easiness and expensiveness.

2.2.3 Empirical Specification

The dependent variable in the empirical estimation for this study is the adoption decision for solar PV. It involves a binary outcome in which it

assumes a value of 1 for adopters and 0 otherwise. The choice of explanatory variables is dictated by behavioral hypotheses, theoretical and empirical literature, and data availability. In view of this, there is vast literature on factors that determine technology adoption. The technology adoption literature tries to analyze adoption behavior in terms of technological, economic, institutional and household specific factors despite diverse categories (Margaret and Samuel, 2015). Social networks and learning has as well recently been included in the adoption literature (Uaiene, 2009). The choice of variables determining adoption depends on the type of technology, the location, researcher's preference, and even client needs (Bonabana-Wabbi 2002). The following section examines the empirical literature on the role of the variables that fall in one of the above categories as follows.

Adopters of technology tend to be keen about its characteristic. The ability of a technology to be tested on a small scale is a major determinant of technology adoption (Doss, 2003). Studies by Mignouna *et al*. (2011), Adesina and Zinnah (1993) and Wandji *et al* (2012) on different rural technologies showed that the characteristic of the technology plays a critical role in adoption decision process. Hence, involving farmers to evaluate the suitability of a technology is vital (Karugia *et al*., 2004).

Farm size, off farm income and net gain from adoption are economic factors that affect adoption. Farm size can affect and in turn be affected by the other factors influencing adoption (Lavison 2013). Margaret and Samuel (2015) state many studies revealing a positive link between farm size and adoption. Farmers with large farm size are likely to adopt a new technology as they can afford to devote part of their land to invest on it (Uaiene *et al*., 2009). The cost and thus net gain from adoption to the farmer of using the new technology is also crucial (Foster and Rosenzweig, 2010). High cost of labor and other inputs are constraints to adoption (Ouma *et al*. (2002). Off farm income also affects adoption in that it overcomes credit constraints faced by rural households (Reardon *et al*., 2007). It substitutes borrowed capital in rural economies with missing or dysfunctional credit markets (Ellis and Freeman, 2004; Diiro, 2013).

Social network, access to information and extension services, and access to credit are vital institutional factors to technology adoption. Social network enhances social capital allowing trust, idea and information exchange (Mignouna et al., 2011). Uaiene *et al*. (2009), Katungi and Akankwasa (2010) found that social network enhances social learning and individual decision. Acquisition of information about a technology also enables farmers to know and effectively use a technology affecting adoption. Access to information reduces uncertainty and promotes an objective evaluation about a technology (Caswell et al., 2001; Bonabana- Wabbi 2002). Access to extension service improves information about the presence, use and benefit of a technology. Extension agents target peers and exert massive influence on most farmers (Genius *et al*., 2010). Studies by Akudugu *et al*. (2012), Mignouna *et al*. (2011) and Karki and Siegfried (2004 strengthen the positive effect of extension services. Access to credit is also stated to stimulate adoption (Mohamed & Temu, 2008). It minimizes liquidity restraints and enhances the risk taking ability of farmers (Simtowe & Zeller, 2006). Access to credit then promotes farmers to shift from less risky and inefficient to risky and efficient investments (Simtowe & Zeller, 2006).

Finally, education, age, gender, and household size are household specific issues that influence adoption. Education is found to affect adoption positively as it enables farmers to obtain, process and use information easily (Mignouna *et al.*, 2011; Lavison 2013; Namara *et al.*, 2013). Better education improves openness, rational behavior and ability to analyze benefits (Waller et al., 1998). The explanatory variables considered in this study include age and sex of household heads and other family members, educational attainment, family size, wealth indicators, health and academic score indicators, and technology attributes.

3 Results and Discussion

3.1 Data and Descriptive Statistics

3.1.1 Description of the Study Areas

The study is carried out in the districts of Degua-Tembien and Enderta located in the south-Eastern zone of Tigray, Ethiopia. Degua-Tembien is located in between 39º10' E longitudes and 13º38' N latitudes about 50 km

west of Mekelle, the regional capital. It is bordered on the south by the southern zone, on the west by Abergele, on the north by Kola Tembien, and on the east by the eastern zone. It holds a total land area of 112,500 hectares with varied land use patterns. The district has a population of 113,528 people with 27,696 households and 77 villages. It has latitude ranging from 1400-2700m that results in three types of agro-ecology known as almost near Kola, Weyna-degua and Degua with a proportion of 26 percent, 30.5percent & 43.5 percent of its total area, respectively. The annual amount of rainfall ranges from 600-800m, and the minimum and maximum annual temperatures are $15C^0$ and $24C^0$, respectively.

Likewise, Enderta is situated at 13.5^0 latitude and 39.5^0 longitudes in the vicinity of Mekelle, with a total area of 1339.93 sq.km. It is bordered on the south by Hintalo-Wejerat, on the west by Seharti-Samre, on the northwest by the central zone, on the north by the eastern zone, and on the east by the Afar region. With a population of 114,297 people in 2007, Enderta had a population density of 36. Besides, the altitude of the Woreda is 1,500-2,300 m.a.s.l, and the mean annual rainfall and temperature range from 400-799 milliliters and 15-20 ^{0}c, respectively.

Land ownership on average was 1.22 hectares, and 96 percent land was under cultivation. Of this land, 85.11% was planted with cereals, 6.16% in pulses, 2.16% oilseeds, and the rest with vegetables. Agriculture is the mainstay of the economy of the districts (Woredas). Crop and livestock mixed farming systems characterize agriculture in the districts (WoARD, 2005). People in the districts depend on traditional sources of energy. They use kerosene for lighting and charcoal or firewood for cooking despite the introduction of Photovoltaic solar system recently. Not more than seven villages obtain electricity service from the national grid in each district including district capitals.

3.1.2 Descriptive Statistics

3.1.2.1 Demographic and Socio-Economic Attributes

The descriptive analysis of the socio-economic attributes examines the demographic, social, economic and informational features of adoption. It

will mainly attempt to statistically compare adopters and non-adopters of solar photovoltaic energy through their average demographic, social, economic, and access to information characteristics. Variables such as sex, age, marital status, education and family size fall in the category of demographic and social traits while total livestock unit, contact with development agents (DA) and distance to Tabia belong to the economic and information traits. Accordingly, Table 1 below reveals that the adoption groups contain statistically indifferent mean ages, family sizes, education levels, distances travelled, and statistically different mean TLU values and contact frequency with development agents.

Table 1: Demographic and socio-economic contrasts of adopters and non-adopters

Variables	Pvusers			Nonpvusers			Mean Diff.	p-value
	Obs	Mean	SE	Obs	Mean	SE		
Sex	97	0.783	0.42	56	0.732	0.597	0.051	0.473
Age	97	43.948	1.25	56	41.642	1.424	2.306	0.246
Marital	97	0.804	0.040	56	0.785	0.553	0.019	0.786
edu	97	0.463	0.050	56	0.517	0.673	-0.054	0.523
Fsize	95	4.8	0.215	56	4.892	0.268	-0.092	0.790
TLU	97	4.397	0.241	56	3.418	0.370	0.979	0.022
contactDA	97	0.658	0.044	56	0.203	0.045	0.455	0.000
Distabia	95	8.807	1.666	54	5.537	1.036	3.27	0.165

Source: STATA output based on own survey data, 2015

In particular, the solar PV users and non-users contain statistically comparable mean ages of 43.9 years and 41.6 years, and education levels of 0.46 and 0.51 grades, respectively. Likewise, the adoption groups have statistically indifferent mean family sizes of 4.8 and 4.89 people, and mean distance to Tabia of 8.8 and 5.5 km. Moreover, the mean livestock wealth and contact frequency with development agents are statistically different for users and non-users (4.39 and 3.41) and (0.6 and 0.2 times), respectively. Male headed households have greater tendencies for solar PV adoption both within and across households that 78 percent the total adoption is accounted for by male heads. In contrast, we see that there are not significant differences in adoption tendencies if a household head is married or single

and that 20 percent of the adopters and 21 percent of the non-adopters are married.

3.1.2.2 Perceptions of Households about Attributes of Solar PV

a) Drive for Adoption and Non-Adoption of Solar PV

Knowledge on the driving forces for adoption and non-adoption of the technology gives a clue as to what set of policy interventions are required to promote diffusion. Accordingly, a simple tabulation of the data on the reasons for adopting solar PV reveals that the potential role of solar light in improving the average academic performance of children, reducing deforestation, and betterment of the average health status of women are the major three factors that motivated them to adopt the solar photovoltaic system. The easiness, less costliness and time saving characteristics of the technology are only additional reasons in the decision process to adopt. Likewise, Table 2 shows that the relative expensiveness, greater difficulty of access, and the availability of other alternative sources of energy are the three most vital explanations for the non-adoption of the solar light technology. Although some respondents indicated that lack of information, and difficulty involved in using it as major contributors for not adopting the technology, most of them tend to imply their preference for the existing sources of rural energy. Hence, we observe that the social and environmental concerns are the vital driving factors for adopting solar PV while cost and attributes of the technology are important variables for not adopting.

Table 2: Summary of the motives for adoption and non-adoption of solar PV

Reasons for adoption	Number of adopters/ non-adopters	Percent of adopters/non-adopters
Better child score	34	35.05
Reduces deforestation	25	25.77
Better maternal health	23	23.7
Reasons for non-adoption		
Relatively expensive	42	75
Access difficulty	30	53.57
Better alternative	31	55.36

Source: STATA output based on own survey, 2015

b) Household Perception about Characteristics of Solar PV

The perception of solar PV adopters based on the easiness, effectiveness and cost of the technology is central for suitable technology diffusion policy revision and implementation. It also contributes to modifying the characteristics of the technology to suit preferences of adopters. The perception of the households is evaluated against solar PV's easiness of access, maintenance, and its effectiveness in time and energy usage, intensity of light, health condition, student performance, reliability, and resource conservation and pollution. Furthermore, the relative cost of the technology in terms of the purchase price, operating cost and maintenance cost is also considered. In view of that, the table below reveals that 95 percent of the adopters suggested that solar PV compared to other traditional sources of energy involves lower purchasing, operating and maintenance costs. Similarly, 79 percent of the adopters agree with the idea that solar PV is more dependable than other optional sources at their disposal in case of unusual events. With respect to the role of solar PV in natural resource conservation and reducing pollution, 74 percent of the adopters stated that solar PV reduces the amount and frequency of firewood collection and burns and emission of pollutants. Moreover, the adoption of solar PV is stated by 89.5 percent of the households to have direct effects on women health and academic achievements of children. They indicated that it raises the time and efficiency of study for students, and reduces the frequency of emission, related eye and respiratory organs diseases. In contrast, most non-adopters (58 percent) are found to be pessimistic about the easiness and accessibility of solar PV which is consistent with the above finding about the reasons for non-adopting the technology. In sum, the solar PV is found to have qualified for effectiveness, low cost, reliability and its role to better health and student scores while it involved problems of inaccessibility and difficulty for maintenance.

Table 3: Perception of households on the characteristics of solar photovoltaic systems

Scale	Characteristics (traits) of the technology (frequency)					
	Strongly disagree	**Disagree**	**Neithernor Agree**		**Strongly agree**	**(4)+(5), % of E**
Economical	0	2	3	61	29	95
Reliable	0	2	18	58	17	79
Environment friend.	0	1	20	57	17	74
Healthy	0	1	13	46	35	84
improves education	0	3	1	25	66	95
Cheaper	17	48	13	11	06	18
accessible	13	37	25	11	09	21

Source: Own computation based on own survey, 2015

E= the sum of the 6 scales= 100

3.1.3 Econometric Analysis: *Estimation and Interpretation*

This section analyzes the adoption of solar PV among rural households using the econometric approach. In particular, it exploits the theoretical framework of random utility model through the probit method of estimation. It intends to fathom the empirical connection between solar PV adoption and its various drivers, and evaluate the actual and predicted probabilities of adopting solar PV. For this purpose, it made use of data gathered through a questionnaire survey conducted in the districts of Enderta and Degua-Tembien in south eastern Tigray. The data set contains information about the demographic, social, economic and informational characteristics of 153 sample households. Above all, data on variables that include age, sex, marital status and education level of household head, family size, land size, total livestock ownership, network and access to information is required for the purpose of the empirical estimation. The details of the econometric estimation and the interpretation of results are presented in the succeeding parts.

3.1.3.1 Determinants of Solar PV Adoption

The solar PV adoption model specified in section four above is estimated through the probit method of estimation. The dependent variable involves a binary choice that indicates a respondent either adopts or fails to adopt the solar PV. The regressors include sex, age, education, marital status, total livestock ownership, contact with DA, and distance to Tabia center. The estimation of the model involved vital diagnostic tests such as mulit-collinearity, omitted variables test and hetheroschedasticity, the details of which are given in the appendix. No serious threat was observed implying unbiased estimators and a guaranteed interpretation of the results. In view of that, the regression result in Table 5.5 reveals that variables that include age, marital status, family size, livestock ownership, contact DA, and Distance to Tabia are found to be statistically important in determining solar PV adoption. Gender and education of the household head however are revealed to be statistically insignificant to explain adoption.

To be specific, changes in age positively affect the likelihood of adoption by 0.8 percent as older household heads have better knowledge and experience over time to better evaluate information on new technology such as solar PV. The marital status of a household head strongly and negatively relates to adoption. The fact that the probability of adoption for married heads declines by 25 percent may be due to the fact that single heads find it easier and efficient to buy solar PV. The size of a family is similarly negatively related to likelihood of adoption with a marginal effect of 8 percent possibly due to the need to buy more solar PVs for different rooms. The pressure to buy two or more solar PVs may lead to avoiding it altogether and sticking to existing traditional sources of energy. The total livestock ownership unit (DTLU) is significantly and positively linked to the probability of adopting solar PV with a marginal effect of 0.6 percent. The DTLU is an index for ownership of livestock that constitute a vital element of household wealth. It raises the source of finance, overcomes credit constraints and reduces risk for adopting new technologies.

Table 4: Probit estimation output for solar PV adoption

Regressor	Pvuse	Regressor	Pvuse
Sex (male = 1)	0.456	TLU(in TLU)	0.212***
	(0.593)		(0.0619)
Age(years)	0.0276*	Distabia (minute)	0.0324*
	(0.0137)		(0.0160)
Marital(married=1)	-0.674	contactDA (frequency)	2.054***
	(0.588)		(0.325)
Edu(literate=1)	-0.189	_cons	-1.330*
	(0.280)		(0.593)
Fsize(number)	-0.246**		
	(0.0918)		
		Number of obs = 147R-sq	
		LR chi2(8) = 66.57	
		Prob > chi2 = 0.0000	
		Pseudo R2 = 0.3444	

NB: Standard errors in parentheses show * p<0.05, ** p<0.01, *** p<0.001Sources: regression output based on own survey data, 2015

The extension service rural households receive from their contacts with the development agents is found to be strongly and positively affecting the probability of solar PV adoption with a likelihood coefficient of 70 percent. The development agents inform farmers about the existence, the effective use and benefit of new technology through meetings, demonstrations and best practice visits. They use networks, development groups, adopters and other social institutions to exert a direct or indirect influence on the entire village population. Finally, the distance the households travel to reach Tabia center positively affects the adoption of solar PV with a likelihood coefficient of 1 percent. This seems to be a contradiction whereas closeness to Tabia center is supposed to improve access to information, exposure and training about the technology, or remoteness implies a better access to traditional energy sources limiting adoption. However, remoteness may imply lack or difficulty of access to other alternative sources of light such as kerosene, candle and flashlights, and create greater propensity to adopt solar PV once knowledge is available about the new technology that greatly reduces transaction cost.

3.1.3.2 Actual and Predicted Probability of Adoption for Solar PV

Estimation of the predicted probability of adoption and comparing it with the actual probability of adoption is decisive to recognize the different possibilities that might raise the adoption of solar PV. The predicted probability indicates the potential adoption rate that could be attained if information, expositions, credit and training regarding solar PV are based on the heterogeneity of the various characteristics of sample respondents. The success of technology dissemination efforts boosts if interventions put emphasis on exploiting the diverse characteristics of various groups of rural households. In relation to this, the predicted probability of adoption for the sample data is found to be 77.55 percent which is greater than the figure for the actual probability of adoption (approximately 64 percent). This implies that the actual adoption rate could rise as large as 78 percent if different interventions on informing the availability, use and benefit of solar PV target different groups in a community. The development agents may target different social and religious institutions, locations, age groups, modes of payment, family sizes and so on. Hence, efforts focusing on the heterogeneity of variables that are found to be statistically significant in the model estimation output could raise the likelihood of adoption.

4. Summary and Recommendations

4.1 Summary

This study employed both descriptive and empirical approaches to explore the determinants and perceptions of solar PV adoption in Tigray region based a sample survey data gathered from the districts of Enderta and Degua-Tembien in South Eastern Tigray. On the bases of the descriptive and econometric analyses carried out, the following summary can be drawn.

First, the descriptive analysis reveals that the adoption groups contain statistically indifferent mean ages, family sizes, education levels, distances travelled, and statistically different mean TLU values and contact frequency with development agents. Besides, male headed households have greater tendencies for solar PV adoption both within and across families while no adoption difference is observed if a head is married or not. Second, regarding the drives for adoption and non-adoption, the potential roles of solar PV to

raise student scores, reduce deforestation, and improve health status are the main reasons for adopting solar PV while the relative expensiveness, greater difficulty of access, and the availability of other better alternative sources of energy are the three most vital reasons for the non-adoption of the solar PV. Besides, the perception of the adopters against the characteristics of the solar PV shows that a vast majority of them are happy with the effectiveness, low cost, reliability, role to better health and student scores while they are dissatisfied with the problems of inaccessibility and difficulty for maintenance. Third, the empirical analysis reveals that variables such as age, marital status, livestock wealth, family size, extension service, and distance to Tabias are the major determinants of solar PV adoption. All these variables positively affect the likelihood of solar PV adoption but family size and marital status do have negative effects. In contrast, the education level and gender of household heads are found to have statistically insignificant effects on adoption. Finally, the predicted probability of adoption (78 percent) was found to be greater than the actual probability of adoption (64 percent) implying that that the actual adoption rate could be increased if different interventions on informing the availability, use and benefit of solar PV target different groups in a community. The development agents may target different social and religious institutions, locations, age groups, modes of payment, family sizes and so on.

4.2 Recommendations

Based on the estimations, interpretations, discussions and summary of the major findings about the determinants and perceptions of solar PV adoption, the following comments and proposals which are helpful for policy making and implementation can be forwarded.

The descriptive analysis indicated difficulty of access, and relative expensiveness of adopting solar PV while ease of access to traditional energy sources as the main reasons for non-adoption. Hence, better access to solar PV through more and better information on the availability, relative cost and benefit, know how to use and supply of the technology promotes adoption.

The perception of adopters also reveals that the difficulties involved to get the technology and obtain maintenance services are enormous. Hence, informed and interested households should be able to easily purchase and maintain the solar PV as quick as possible.

The fact that age, livestock wealth and family size determine adoption implies that unique training is required for younger heads, and a different mode of payment or credit facility must be tailored to households with small or no livestock wealth and larger family size.

The greater predicted probability of adoption implies that technology diffusion efforts that consider the heterogeneity of the households or groups could raise the actual adoption rate. Hence, the concerned office and mainly the development agents should target different social and religious institutions, locations, age groups, modes of payment and family sizes to exploit potential adoption via reaching special interests and attributes.

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Land Transfer Right restrictions and Seasonal Migration: Panel Data Evidence from the Tigray region of Ethiopia

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Abstract

Land is the major asset in the life of the Ethiopian rural communities. In Tigray region all land is owned by state but user rights are given to farmers and pastoralists and its cultivable land is scarce with growing population. Land is reallocated for changes in population and the formation of new households due the fact that when farmers are not properly cultivating their land or when their income from off farm is higher. This situation creates manifest uncertainty for rural households about the durability of their land tenure, which limits the security of land tenure. Migration is a decision of household members to migrate when the benefit is higher at household level. This paper examines restrictions on land transfer right and seasonal migration in the Tigray region of Ethiopia based on the panel data collected in 16 communities on a stratified sampling system using Hausman Taylor regression.

The result of the study shows that there is a negative effect the land use certification on migration. This negative effect of land use certification encourages household members to migrate. This behaviour is also consistent with earlier findings which show land right improvements encourage own land investments assuming land and on-farm labours are complementary inputs. Moreover, it is consistent with finding of robust evidence that improving land security through the certification program robustly encourages investment in trees, superior soil conservation practices, and enhances land productivity. The outcomes of the analysis show that household members distance to near town, education, household head age and number of oxen are negatively and statistically significant in influencing household members to give decision of allocating labour on off-farm activity (migration).

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While variables like household size and shock can positively contribute to household members to migrate in favour of off-farm activities.

The restriction of land use transferability affects the welfare of rural households by limiting the opportunity of income diversification. Hence, having flexible regional restriction on land use transfers, taking in to account the landless society that can benefit from land redistribution may lead to income diversification strategies that may prevent the likelihood of being poor in the future.

Key words: Migration, land transfer right restrictions, land use certification and Hausman Taylor regression**.**

Acronyms

EDRI - Ethiopian Development Research Institute
EEA- Ethiopian Economic Association
EEPRI - Ethiopian Economic Policy Research Institute
EPRDF- Ethiopian People Republic of Democratic Front
ESSP II - Ethiopia Strategy Support Program II
HT- Hausman Taylor
IFPRI - International Food Policy Research Institute
LDV- limited dependent variable
OLS- ordinary least square
PA- Peasant Association
2SCML -two-stage conditional maximum likelihood
2SIV - two-stage Instrumental Variable

1. Introduction

1.1 Background of the Study

Migration is considered as a household decision to send out a migrant in the context of the allocation of all household labour between farm, off-farm, and domestic activities. Migration has treated as a household decision, comparing the returns to total household labour from on- and off-farm activities.

Loosely speaking, there are two possible solutions of labour allocation decisions: first; it is more profitable for the household to spend all its working time in the rural area, if the marginal productivity of rural labour is higher than the marginal income of migration that is the urban informal sector wage. Second, it is more profitable for the household to spend all its working time migrating, if the marginal productivity of its rural labour is lower than the marginal income of migration.

Mobility of people could be attached with some of this agricultural seasonality, exogenous shocks, when a better job opportunity in other places and, the desire of rural households to spread risks among sectors and localities. However, on the empirical side, studies on the reasons of temporary migration remain scarce. In this paper, we aim to show that this temporary feature of migration can also be linked to land rights security[2].

So that the optimal migration decisions are made as a function of many factors to list some: the quantity of land and of the productivity in the rural activity, outweigh of the migrant wage and of mainly land rights insecurity.

Land is the major asset in the life of the Ethiopian rural communities. Land Tenure is one possible mechanism of enhancing the productivity of the land. In addition to enhancing the productivity, it has an advantage in conflict resolution. Secure land and resource rights facilitate long-term planning, investment and the adoption of sustainable production methods (Knife, 2007).

In Tigray region all land is owned by state but user rights are given to farmers and pastoralists and its cultivable land is scarce with growing population. Land sales are prohibited and land rentals are rare in most of rural Tigray, as are sharecropping arrangements. No documented land purchase in sample of households in Tigray was found in the study (De Brauw A and Mueller V, 2011) and only one household reported renting land. Sharecropping rates in Tigray are also below the average for the rest of

[2]The Ethiopian government has recently attempted to improve land security more formally through various land registration and certification programs.

Ethiopia (4.69 and 9.23 percent of households in 2004 and 2009, respectively). The majority of the population in Tigray relies largely on peasant agriculture, but becoming (slowly) market oriented. The pressing environmental issues include soil erosion as well as reduced fertility and productivity, gully formation, deforestation, pressure to cultivate slopping land, and use of dung for fuel rather than as organic fertilizer. The peasant society unable to afford inputs (because of high risk of crop failure) and there is also in Vicious circle of over-use of land in order to meet basic food security causing decreased fertility.

Alarming population growth on the one hand and the small size of land, in many areas of the country, leads to raise the number of landless people in Ethiopia and the enabling environment for agricultural development creates a challenge to land policy in the country (Mitiku, *et al* (n.d), as cited in Knife, 2007). Even with this complication land policy is important in Ethiopia in order to achieve the agricultural transformational planning and to reduce rural-urban migration because the national policies discourage households from exploiting external employment opportunities through the distortion of capital markets.

Land is owned by the government with farmers' use right. Since 1976, after a dramatic land reform in the wake of the overthrow of the emperor, the state owns all land, and rights to cultivation are handed to rural households. In principle, rights to the stream of benefits were offered, but as land redistributions continued regularly throughout the 1980s, their horizon and security were severely undermined. When a new government i.e. EPRDF came to power after a civil war in 1991, a commitment was made to strengthen individual land rights via offering more long-term tenure security and broader transfer rights, as reflected in the new constitution of 1996. However land rights become restricted through different assumptions[3] and at

[3] Land restrictions: 1) it is still forbidden by national law to sell, mortgage, or exchange land in Ethiopia, 2) Tigray regional law prohibits households from renting out over half of their allocated land, 3) households leaving their residential village for more than two years are prohibited to use their land, 4) the law also prohibits households if their income is more than 1000br per month.

last the perception of continuing tenure security rests in doubt (Dercon and Ayalew 2007).

An important characteristic of the rural land property right is a nature of periodic reallocation of land at the caution of the village leader to account for changes in population and the formation of new households. This situation creates uncertainty for rural households about the durability of their land tenure, which limits the security of land tenure. If land use rights are not secure, that generates a new migration cost. This cost is marginal income loss caused by the loss of land due to out-migration. However In the case where land rights are secure, the time spent out-migrating when the migrant want to do on urban areas does not affect the quantity of land available.

Transferability of land rights have long been identified as a key element to bring about higher levels of investment, facilitate reallocation of production factors those from rich land resource to rich non-land resources in order to maximize allocative efficiency in resource use, and allow the development of an off-farm economy through migrating to urban in order to earn by participating on off-farm activities (Deininger, *et al* n.d.). For the existence of insecure transferable land rights which lead to the risk of losing land will create a disincentive for households to undertake investments. This fear of expropriation through the impact of migration has on the probability of continuing to farm the same land in the future and its associated future stream of returns will reduce.

Therefore, having strategic land reform[4]has remarkable contribution in the economy and it is also an economic wise decision of policy makers that benefits the life of the society.

[4] *In this context reform means a structural change and in any agrarian society, land is always, the most important factor of production. Moreover, land and its characteristics inevitably determine the agrarian structure and directly bear far-reaching implications upon the economy as a whole. Land characteristics are physical, social, economic and even political. They include the distributive pattern of landholdings and landownership, the size of farms, the man-land ratio, the production structure etc. In developing countries, where rural poverty is the rule of the game, structural change in land and its associated characteristics is basic and fundamental to successful rural development. Reform involves some kind of*

Therefore this paper considers dealing the impact of the current systems of rural land property rights on household migration decisions.

1.2 Statement of the problem

In developing countries mobility of household members is considered as pathway (source of factor production) out of poverty for many rural households. Due to the existence of climate variability and macroeconomic shocks and at the same time inaccessibility to credit, labour is considered as their main productive asset. If migration is taken from household decision strategy it can potentially improve the wellbeing of the entire household (de Brauw and Harigaya 2007) and from the former perspective, households can diversify income risk pre-emptively by allocating labour spatially to areas where risks to income are not correlated with rural income shocks (Rosenzweig and Stark 1989).

Increased internal migration to cities in Tigray region of Ethiopia could therefore improve overall living standards by relaxing land constraints in rural areas, diversifying an opportunity in different income generating activities, and enjoyment of life through utilizing provided access to services, including education and other life changing activities. Moreover, the frequency of droughts due to global warming and limited endowment of natural resources happen covariate shocks in Tigray of Ethiopia causes uncertainty in income from agriculture and which potentially leads to underinvestment (Dercon 2004, Dercon et al. 2007). Therefore through increasing the share of migrant earnings could potentially encourage long-term growth.

Unlike of the benefits, households living in the rural areas of the developing countries often do not send out migrants for different reasons. 1) Households might not have member inappropriate demographic categories, as the experience of youngsters is low. And due to information asymmetry households do not know about potential return of labour market. 2) Another

transfers, in our case, of land and other resources with or without compensation. But transfers themselves do not ensure a long-lasting solution of poverty eradication (Holden et al. 2009b).

reason why most households fear to send out migrants is that they lack complete control over their landholdings. Specifically, households might fear that if one or more members of the household were absent for a certain period, then other claimants of the land, such as the local government, might expropriate it. If land expropriation can occur without compensation, households might be dissuaded from sending out migrants for fear of signalling that they do not need all of their landholdings (Yang, 1997). So that farmers do not enjoy complete land transferability rights and may fear that the government might take land that is not being used or that officials might perceive is not being used adequately.

In Tigray, the land tenure system before 1975 was largely considered as hindrance to the region's development. Studies show that the land tenure system that was operating throughout Ethiopia was the most important cause of political grievances that finally led to the overthrow of the Imperial regime in 1975 (Knife, A 2007).

The few studies that have considered the potential relationship between migration and land transferability rights: Yang (1997), clearly describes the explicit trade-offs a household without permanent transfer rights to the land must make upon deciding to send a migrant elsewhere. Since there are no formal land markets, which are potentially exposed for expropriation, the household make a decision to leave the village by sacrificing a future stream of land earnings in farming. Due to this effect farmers are not encouraged to invest in their land. Holden et al (2009), which is also performed one of the first evaluations of tenure security on investment in Ethiopia as measured by household participation in the land certification program. They apply several forms and find robust evidence that improving land security through the certification program robustly encourages investment in trees, superior soil conservation practices, and enhances land productivity.

Previous studies in Ethiopia related to land transferability rights find positive relationships between improvements in property rights and investments related to agricultural productivity (Deininger et al. 2006, Dercon et al. 2007, Holden et al. 2009a) but it doesn’t clearly show the effect of household decision of labour allocation. And a recent study undertaken by De Brauw A

and Mueller V, (2011) also indicate that there is a negative effect from increasing the transferability of land rights on migration. However the same authors who studied by De Brauw A and Mueller V (2009) come up with different finding that the empirical estimates support a robust positive effect from increasing the transferability of land rights on migration. And their findings are suggestive that the promising land certification and registration programs[5] in regions of Ethiopia may potentially promote poverty reduction by increasing incentives to migrate. But yet there is little or no clear evidence about the effect of land restriction right on seasonal migration on Tigray region in Ethiopia. So it motivates me to know on particular study area about the influence of land use certification on mobility rate because in the one hand we are saying there is low urbanization of sub-Saharan Africa (World Bank, 2008) on the other hand there is a restriction on land transferability rights. By transferability rights, we mean that households perceive they can transfer the use rights from the household given the land to use by the government to other households at least in the medium term, but not ownership, as the state remains the nominal owner. If on-farm labour and land are complementary, then we might expect that improving land security (in this case land registration and ownership certification) will encourage households to retain family members on the farm. If it happened the other way round, labour and land are substitutes, improving security of land rights would potentially lead to additional family members leaving the farm.

1.3 Research objectives

The main objective of this paper is to analyze the potential impact of land right restrictions on migration behaviour in rural Tigray of Ethiopia.

1.4 Specific objectives

- To analyse the effect of land tenure security (land use certification) on the pattern of households labour decision to migration.

[5]Land certification yields net benefits in the form of high demand for certification, reduced unsettled disputes, and increased investments in the short term.

- To explore whether the pattern of migration changes in response to size of land in rural areas of Tigray.

1.5 Hypothesis

This paper tries to test the following null hypotheses.

H_1: Possession of land use certificates[6] makes households to participate more on outside labour activities. Thus the existence of land use certificate has an increasing effect over migration.

H_2: There is a negative relationship between size of land holding and migration.

1.6 Research question

The background provided in the foregoing work motivates the following research key questions:

- Does plot level land certification facilitate farm household's participation in the off farm activity through a seasonal migration?
- Does small size of family land affect rural household's decision of labour allocation for migration?

2. Review of Related Literatures

2.1 Land tenure system in Tigray

In Tigray, the land tenure system before 1975 was largely considered as hindrance to the region's development. Studies show that the land tenure system that was operating throughout Ethiopia was the most important cause of political grievances that finally led to the overthrow of the Imperial regime in 1975 (Knife, 2007).

[6]Land certificates serve for purposes of: 1) to secure the right to compensation if land is reallocated and 2) to secure the right to the land during disputes. In addition, land certification benefits in the form to get reduced unsettled disputes, and increased investments in the short term.

When the new federal constitution was adopted in 1995, the land issue was proclaimed settled in favour of public ownership. *In Article 40 of the* Federal Constitution of Ethiopia (which is about property rights) it is provided that the right to ownership of rural and urban land, as well as of natural resources is exclusively vested in the state and in the peoples of Ethiopia (Knife, A 2007).

However, the current working regional land policy which was released through proclamation No. 136/2000 E.C is about land use right talks about land use right restrictions for the households out of tabia for more than two years, renting out more than half of their total land size, that participate on both off-farm (their monthly income is more than birr 1000) and farm activities and other points with some modifications (TNRS 2008).

2.2 Empirical study

In accordance to De Brauw and Mueller, (2011) even though the national policy does not support the mobility of households which in turn exploit external employment opportunities through the distortion of capital markets, migration is considered as a means out of poverty for many rural households in developing countries. The empirical estimates of this study support negative effect from increasing the transferability of land rights on migration. These findings suggest the absence of land rights leads people to migrate. However they found different result in one region, Tigray, which land transferability does not appear to affect negatively for migration. Their possible explanation for this different result its low land holdings combined with high population densities in Tigray (the land per capita in Tigray is 0.15 compared to the sample average of 0.34 hectares per person) could explain why securing property rights raises the value of sending household members elsewhere. And while they investigate possible determinants of migration at the household level, they compare household characteristics among migrant and non-migrant households in the 2004 and 2009 rounds. And the result shows migrant households appear to be richer in terms of land holdings (2004); however, their holdings have grown less over time. Another key determinant of migration in their study was demographic characteristics and wealth. However the same authors in their study in 2009 had come up with

different finding that the empirical estimates support a robust positive effect from increasing the transferability of land rights on migration. And their findings are suggestive that the growing land certification and registration programs in regions of Ethiopia may potentially promote poverty reduction by increasing incentives to migrate. In their work also use the share of land held by the household that the household reports as being transferable as their primary measure of transferability rights, as a question had been asked about whether each plot held by the household is transferable in most survey rounds. After over viewing this work it motivates me to look again the effect of land rights transferability restriction on household migration pattern of Tigray region.

De la Rupelle *et al* 2009 used a methodology of land rights heterogeneity across household plots in a model with village fixed effects to capture the impact of village land rights manipulation on out-migration. And then come up with empirical result of substantial impact of land insecurity on China's temporal migration based on 2002 rural data. As village land use remains collective and as land use rights can be periodically reallocated, individual out-migration can result in deprivation of those rights.

The study which was undertaken by Mullen and Kontoleon (2008) in China depicts using a model of the relationship between land tenure arrangements and migration of household members, they examine whether those with greater tenure security and formal rental rights for agricultural or forest land are more likely to participate in labour markets outside the village. Where land is at risk of reallocation, rural households may not allocate labour to migration. The finding that greater tenure security increases migration suggests that the current system of China's property rights, in which land is periodically reallocated, acts as a constraint on migration. This strengthens the case for further tenure reform for agricultural and forest land.

Using a unique panel data set including data on land right perceptions over time, Dercon and Ayalew (2007) investigated whether land rights affect household investment decisions, focusing on land allocation to coffee trees and other perennial crops. And the estimates suggest a robust, causal negative impact of transfer rights on long-term investment in Ethiopian

agriculture, contributing to the low returns from land and perpetuating low growth and poverty.

While the finding of Deininger et al (n.d) shows that land security leads to investment in trees but not for terraces. In Ethiopia, government action to increase tenure security and transferability of land rights can significantly enhance rural investment and productivity. This empirical estimation is based on a nationally representative survey of 8,540 farm households conducted in 2001 by the Ethiopian Economic Association's Economic Policy Research Institute (EEA/EEPRI). The sample was chosen to represent the country's main agro-ecological regions and to account for differences in population density, farming systems, and access to markets. They use them to provide descriptive statistics, for the country as a whole and its major regions, Tigray, Amhara, Oromia, SNNPR, and the mainly pastoral areas of Benishangul-Gumuz, Afar and Somali which also be classified under "others". Descriptive evidence demonstrates the importance of tenure security but also suggest that changes in these arrangements could have an important impact on economic outcomes.

The study by De la Rupelle et al (2009) on land rights insecurity and temporary migration in rural China shows based on Empirical results of 2002 rural data representative demonstrate substantial impact. In China as village land ownership remains collective and as land use rights can be periodically reallocated, individual out-migration can result in luck of land security rights. And off-course that shows this temporary feature of migration can be linked to land rights insecurity. Moreover, the intensity of this insecurity varies according to the village-level management of land and the contractual status of land plots. They use these variations to identify the effect of land rights insecurity on migration behaviour. Empirically, this approach is made possible by the width and the quality of the Chinese Household Income Project (CHIP) household survey, which gives detailed individual-level and village-level information on almost 9200 rural Chinese households distributed in 961 villages all over China. Using Honoŗé (1992)'s semi-parametric identically censored least squares estimator, they actually find that the interaction between the indicator of village-level insecurity and a measure of the exposure of household plots to administrative seizure has a

significant impact on rural households migration decisions: land rights insecurity does constrain migration behaviours and shortens out-migration durations for Chinese rural workers.

Another study which was undertaken by Besley (1995) finds that improvements in property rights, measured by land transfer rights, increased tree planting investments in some areas of Ghana. He further attempts to test which channel is affecting investment, finding support against the land collateral hypothesis due to field-specific rights weighing more importance than household rights for investments.

Holden et al. (2009) which is also perform one of the first evaluations of tenure security on investment in Ethiopia as measured by household participation in the land certification program. They use plot-level data of households over 1998, 2001, and 2006 in the Tigray region. They apply several forms of sensitivity analysis in terms of the analysis of outcomes, specifications, and instrumental variable approaches, and find robust evidence that improving land security through the certification program robustly encourages investment in trees, superior soil conservation practices, and enhances land productivity.

As stated by Vialykh K Using data for 25 Ukrainian regions (oblasts) for the period 2002-2008, two estimation procedures were performed: fixed effect and Hausman-Taylor estimations. The main aim of this research is to analyze how regional representation, measured as the number of parliamentary deputies associated with a certain region of Ukraine, affects the development of this region, measured by real gross regional product per capita and grants to regions from the Ukrainian State Budget per capita. Empirical analysis suggests that the composition of region's delegates in the Verkhovna Rada has no implications on the variation in real gross regional product per capita; however, it has negative effect on the state budget allocation.

The paper studied by Jacoby *et al* (2002) uses household level data from Northeast China to examine the link between investment and the risk of farm land expropriation. China's agriculture provides an ideal case-study of tenure insecurity because of its system of village-level land reallocations, the timing

of which is uncertain and exogenous from the farmer's perspective. They quantify expropriation risk using a hazard analysis of individual plot tenures and incorporate the predicted "hazards of expropriation" into a tractable empirical model of investment behaviour. The empirical results indicate that higher expropriation risk significantly lowers investment in soil quality through reduced application of organic fertilizer. However, their analysis shows that policies designed to reduce tenure insecurity in this part of China would produce minimal efficiency gains.

Another study by Jacob (2001) also extend three existing cross-sectional limited dependent variable (LDV) estimators, that allow for endogenous regressors, to a panel data model. He focused on estimation of effects of time invariant endogenous regressors. He compared their small sample performance of estimates of marginal effects to i.i.d. LDV estimators as well as to linear estimators by means of Monte Carlo Studies. Some notable differences in the performance of the LDV estimators appear. One estimator, the 2SIV, performs reasonably well in terms of bias, even with weak instruments. Another type, the AGLS estimators, has a large small sample bias when no endogeneity is present. The 2SCML estimators seem to perform reasonable in most scenarios even under some types of misspecification. In addition, 2SLS performed relatively well, but had a substantial MSE with weak instruments and substantial bias in mis-specified scenarios. Although potentially important because of heterogeneity bias, our extension of LDV models to the panel case did not give improvements in small sample performance over the cross-sectional estimators.

3. Data Source and Methodology

3.1 Data source

This paper utilizes Household panel data survey that was collected by Mekelle University in collaboration with the Norwegian University of Life Science. Secondary data was also collected from the study areas. The primary data were collected covering the survey years of 1998,2001,2003,2006 and 2010 using stratified random sample of 330

households in 16 communities[7] (tabia's). While the secondary data was collected in 2011 through provided check list from 11wereda's[8] of Tigray, the author was also involved in collecting the data set a data. However we primarily draw on the past two rounds focusing to explain the change in migration behaviour in 2006 and 2010 because the recent modified regional rights land reform was released in 2008 so by taking 2006 as pre-migration household character we can focus on explaining the pattern of migration in 2010.

By transferability rights, we mean that households perceive they can transfer the use rights from the household given the land to use by the government to other households at least in the medium term, but not ownership, as the state remains the nominal owner. However if the household has land use certification then the household become confident (in their perception) to migrate in order to earn extra income from participating in off-farm activities. So that in this study land use certification is considered as a proxy of land security.

3.2 Theoretical framework

To reveal the effect of land holding on migration decisions in Tigray of Ethiopia, we model the problem from the perspective of Unitary Household Model, as head of the household is considered representative of the aggregate choices made by the individuals in a household as though they were made by a single optimizing agent, the preferences of these agents must be characterized by some form of utility transferability (Bardhan P, 1999). The main objective of the household is to maximize profit and then maximize utility subject to a standard budget constraint which includes the value of these profits, thus:

[7] 1. Hintalo, 2.Samre, 3.Mahbre-Genet, 4.Mai-alem, 5.Seret, 6.Kihen, 7.Genfel, 8.Emba-Asmena, 9.Hagere-selam, 10.Debdebo, 11.Mai-Keyehti, 12.Adi-selam, 13.Hadegti, 14.Tsaeda-Ambora, 15.Mai-adrasha, 16.Adi-Menabir

[8] 1.Hintalo wajirat, 2.Seharti samre, 3.Enderta, 4.D. Tembien, 5.Wukro, 6.Tsaeda-emba, 7.Gulo Mekeda, 8.Ahferom, 9.Mereb-leke, 10.L.Adiabo, 11.T.Koraro

$$\text{Max } U(c, \ell) \quad (1)$$

Subject to:

$$P(c) + wL^h + rA^h \leq PF(L, A) + w(L^m) + rA^m \quad (2)$$

$$L = L^f + L^h \quad (3)$$

$$A = A^f + A^h \quad (4)$$

$$E^A = A^f + A^m,\ E^L = L^f + L^m + \ell \quad (5)$$

$$C, \ell, L^f, L^m, L^h, A^f, A^m, A^h \geq 0 \quad (6)$$

Where

C = consumption, ℓ = leisure, p = price of consumption good, w = market wage rate, r = market rate for renting land, L = labour, L^f= family labour, L^m =marketed labour, L^h =hired in labour, A = land, A^h = hired in land, A^m = marketed land, F (L, A) = production function for consumption good, E = family endowment (exogenously given)

Consider a rural household that maximizes its total labour income by allocating its labour resource between farm and off farm activities. And further lets us assume for simplification that off farm activities are only available in this case through migration to urban areas and wage employment. We assume that household income has three components. First, Income from the output that can therefore be written as $Q=f(L, A)$, as output price is normalized to one and also land rentals and sharecropping are rare in Tigray. Which can be reflected in the production function as $Q=f(L, \bar{A})$, as land area is fixed in the short term. So the intention of production function maximization lies on labour only. Second, the household can send out migrant labour to earn income $w\ M$, where w is the market wage. Migrants cannot work on the farm, so the household labour endowment must be split between migration (off-farm) and farm labour. The third source of income represents the value of future agricultural production to the household. It can be written as the discounted future return from the land $\delta p\ (L, S)[f(L, \bar{A})]$, where δ is the discount rate, and S measures tenure security. Important here is the function $p(L, S) \in [0, 1]$, which represents the probability that the household will continue to hold the land in the future. We assume that the function $p(.)$ depends on the number of people cultivating the land and tenure security.

Other things remain constant as the probability that the household will continue to hold the land in the future increases income of household will rise. So the issue land security is decisive in being productive level of farming and farming related investment.

The household's objective is to choose *L* ($L = L^f + L^h$) and *M* (L^m) in order to maximize the total income from these three components:

$$\max\big(1 + \delta p(L, S)\big)\,[f(L, \bar{A})] + wM \qquad (7)$$

Subject to $\bar{L} \geq L + M$ **(8)**

Where $\bar{L}$ represents the total labour endowment, M represent for migration and while S is represented by land security.

Fundamentally, the third part of income illustrates the trade-off faced by the household. The household can send household members elsewhere to generate income off the farm, at the expense of agricultural production in the present and through a decrease in tenure security for future agricultural production. Equation (7) can be further simplified by assuming that able-bodied workers are employed at all times, reducing the constrained optimization problem to:

$$\max_{M}\ (1 + \delta p(\bar{L} - M, S))[f(\bar{L} - M, \bar{A}] + wM \qquad (9)$$

The solution to *M* must satisfy the following first order condition:

$$w = (1 + \delta p) f1 + \delta p 1 f \qquad (10)$$

Thus, the household allocates labour efforts outside of the farm such that the discounted stream of the marginal product of migrant labour on the farm over time is equal to the wages generated off of the farm. Before we proceed to the empirical modelling it is better to develop theoretical model of how land constraint aspect influence migration.

How does migration vary with the existence of land holding? First we totally differentiate equation (10) to determine the sign of $\frac{dM}{d\bar{A}}$:

$$\frac{dM}{d\bar{A}} = \frac{(1+\delta p)f12+\delta p1f2}{(1+\delta p)f11+2\delta p1f1+\delta fp11} < 0 \qquad \textbf{(11)}$$

If we assume that the objective function is well-behaved and there is an interior solution, then the denominator in equation (11) must be less than zero due to the concavity. If we make the additional assumption that $f_{12}>0$, then it must be that $\frac{dM}{d\bar{A}}<0$. This result simply suggests that an increase in the land available to farmers will marginally reduce migration efforts.

The theoretical model captures this fear of expropriation through the impact migration has on the probability of continuing to farm the same land in the future and its associated future stream of returns, following similar studies on China (Yang 1997, Lohmar 1999, de la Rupelle *et al*. 2009).

How does migration vary with the development of land rights? Next, we totally differentiate equation (10) to determine the sign of $\frac{dM}{dS}$:

$$\frac{dM}{dS} = \frac{\delta[p2f1+p12f]}{(1+\delta p)f11+2\delta p1f1+\delta fp11} \text{--} \qquad \textbf{(12)}$$

The numerator in equation (12) represents the expected increase in the future marginal product of labour given an increase in land security plus an increase in the marginal probability of farm labour caused by an increase in tenure security. The sign of $\frac{dM}{dS}$ will depend on the cross derivative of the probability function p_{12}. If $p_{12}\geq 0$, then $\frac{dM}{dS} < 0$. This expected sign is somewhat consistent with studies that have examined the relationship between property rights and investment in Ethiopia. For example, if on-farm labour and investment are complementary, then households are less likely to sacrifice on farm labour with improvements in land rights. If $p_{12}<0$, then the sign of $\frac{dM}{dS}$ is indeterminate.

Therefore it is now a turn to see empirically whether land shortages and/or tenure insecurity affect migration decisions using the household panel data.

3.3 Empirical model

A major motivation for using panel data is that it allows us to control for unobserved heterogeneity. The idea is that firms or individuals have some unique characteristics that are known to the firm or individual but not to the econometrician that needs to be taken into account (Petra Todd 2007).

To test the theoretical predictions empirically, we use a unique panel data set (by assuming that there are unobservable variables that can affect the pattern of migration i.e. informal land practices) that has been collected by Mekelle University, in collaboration with the Norwegian Life Science University. There could be many possibility of undertaking panel data analysis: random and fixed effect, examining extension of fixed and random effects models to limited dependent variables – xtlogit, xtprobit and Hausman-Taylor regression.

- **Random/fixed effect**

Individual specific effects can influence some of the explanatory variables which lead to inefficient and biased estimates of the parameters. This can lead to treat the individual effects as fixed. Given the unobservable effects, the next step is to choose either a fixed effects model (FE) or a random effects model (RE). So as stated in Baltagi *et al.* (2002) using the Hausman (1978) specification test it is possible to determine whether some of the regressors are correlated with the individual effect (the fixed effect) or all regressors are not correlated with the individual effect (random effect). The intuition behind the Hausman test is that if the two estimates differs much the random effect is rejected where as if the two do not differ much, in practice it does not matter that much which one you use. The test statistic for the hypothesis that the individual effect and explanatory variables are uncorrelated is the Hausman chi-square statistic.

If the work fulfill with the basic fixed effect estimation we can estimate a model that explains household migration flows in the 2006 and 2010 survey rounds, using first-differencing to control for household unobserved effects. In other words analyzing changes of dependent and independent variable has the effect of controlling for variables that are constant over time, thereby eliminating this source of omitted variable bias (Stock and Watson, 2007).

As stated theoretically about the potential effect of land holding and security of land over migration of equation (11) and (12) respectively. However the author is motivated to know the existing situation of household land holding and land use certification effect on migration decision, while controlling for the household labour endowment and potentially other observables that will affect the returns to labour within the household.

The fixed effects model is simply a linear regression model in which the intercept terms vary over the individual units *i*, i.e.

$$y_{it} = c_i + x'_{it}\beta + \varepsilon_{it}, \varepsilon_{it} \sim IID\ (0, \sigma^2{}_{\varepsilon}) \text{-} \qquad \textbf{(I)}$$

We eliminate the individual effects C_i first by transforming the data. To see this first note that:

$$\bar{y}_i = c_i + \bar{x}'_i\beta + \bar{\varepsilon}_i \text{-} \qquad \textbf{(II)}$$

Consequently, we can write

$$y_{it} - \bar{y}_i = (x_{it} - \bar{x}_i)'\beta + (\varepsilon_{it} - \bar{\varepsilon}_i) \qquad \textbf{(III)}$$

This is a regression model in deviations from individual means and does not include the individual effects C_i. The transformation that produces observations in deviation from individual means is called the within transformation.

We can write down a simple linear model consistent with these observations as follows:

$$M_{ijt} = a_i + C_i + \beta_1 A_{ijt} + \beta_2 S_{ijt} + \beta_3 L_{ijt} + \beta_4 W_{ijt} + \beta_5 H_{it} + \varepsilon_{ijt}, \textbf{(13)}$$

Where:

M represents the migration decision of household i in village j at time t i.e. 1=if migrate, 0=otherwise

A represents the total household land holdings (cultivated land area)in timad

S represents the household's land security, which is measured by if the household has land use certification i.e 1= if has land use certificate, 0= otherwise. Thus land use certificate may be a more suitable proxy for land security.

L represents its labour endowment including the number of children (age 6-15) and the number of adults of working age (16-40) present in the household.

W represent wealth which was taken the number of household oxen holding as a proxy measure

H represent the household characteristics

The variable C_i represents fixed unobservable about the household that cannot be measured and

ε_{ijt} is a mean zero error term.

In accordance with our theoretical model, our interest is to measure β_1 and β_2. The main coefficient of interest is β_2, which measures the effects of the land transferability on migration decisions, and has an indeterminate sign in the theoretical model. Unfortunately, if we were simply to estimate equation (13) using ordinary least squares the coefficient estimates $\widehat{\beta 1}$ and $\widehat{\beta 2}$ would almost certainly be biased, because we cannot measureC_i and it is likely correlated with A_{ijt} and S_{ijt}.

We therefore take advantage of the panel nature of the data set to eliminate some potential sources of bias. We first difference equation (13), which removes the fixed unobservable at the household level. The resulting equation can be written as:

$$\Delta M_{ijt} = \beta_0 + \beta_1 \Delta A_{it} + \beta_2 \Delta S_{it} + \beta_3 \Delta L_{it} + \beta_4 \Delta W_{it} + \beta_5 H_{it} + \Delta \varepsilon_{it} \quad \textbf{(14)}$$

A major concern with measuring either the amount of land held by the household or the tenure security is that unobservable at the household level might affect both the explanatory variable and migration, rendering the estimated coefficients on both variables biased.

- **Random/fixed logit effect**

Though stated more in the above we can't proceed with household fixed effect as the household fixed effects are used through differencing to control for any factors that might affect both migration behaviour and land transferability rights but do not change over time. The first problem is serious when the time invariant variables are important in explaining the pattern of migration. And the other best reason not to use is the applicability of household fixed effect is with only of continuous dependent variable.

The next option is to use an extension of random and fixed effect which is random/fixed logit effect. However this model has its own limitation as it keeps only the observations with (y_1, y_2) equal to (0, 1) or (1, 0). Then generate a dependent variable taking the value 1 for positive changes (0, 1), and the value 0 for negative changes (1, 0). Then, regress (by an ordinary logit) the transformed dependent variable on the first differences for the regressors. This obviously drops many and many observations which lead to have biased estimates of parameters (Ricardo 2008).

- **Hausman Taylor estimation**

Therefore as an alternative to either of the fixed-effects or the (ordinary) random effects models we used Hausman Taylor regression as an extension of fixed/random effects. This method is a random effects instrumental-variable technique that uses only information contained in the model to eliminate the correlation between the error term and the included variables (the cause of the rejection of the random-effects model). As a result, estimation of time-invariant variables is possible without compromising the estimates for time-varying variables. Thus, the most appealing characteristics of the fixed-effects technique (consistent estimates of time-varying variables) and the random effects model (the inclusion of time invariant variables) are combined. Because of these beneficial characteristics, we use the Hausman-Taylor estimation technique in our analysis.

The resulting estimator, the Hausman-Taylor estimator, allows us to estimate the effect of time-invariant variables, even though the time-varying regressors are correlated with C_i. The trick here is to use the time averages of those time-varying regressors that are uncorrelated with C_i as instruments for the time-invariant regressors (Verbeek M. 2004).

The strong advantage of the Hausman-Taylor approach is that one does not have to use external instruments. With sufficient assumptions instruments can be derived within the model. Accordingly, we classified the explanatory variables into: time variant and time invariant exogenous variables that are not correlated with the unobserved household effect and time invariant endogenous variable that are correlated with the unobserved household effect as of Hausman and Taylor (1981) suggest economic intuition (Verbeek M.2004).

We also note that our panel specification allows the use of instrumental variables generated from exogenous variable as suggested by Hausman and Taylor (1981) i.e. using individual means over time and deviation from means as instruments (Jacob N. Arendt. November 2001).

As stated by Jacob 2001in order to obtain some robustness against the assumed normal distribution of regressors, he conducted a final set of simulations using a design with real panel data. The point in his paper contains results where both school reforms and Hausman-Taylor type of instruments are used. So that in a linear regression model, as shown in the paper it can be solved using the approach due to Hausman and Taylor (1981).

Hausman-Taylor estimation fits panel-data random-effects models, in which some of the covariates are correlated with the unobserved individual-level random effect. The Hausman-Taylor estimation is also performed in order to deal with possible endogeneity problem (Vialykh K n.d).

Therefore due to the conditions the Hausman Taylor estimation was taken as a tool for analysis of this thesis work.

4. Results and Discussions

4.1 Econometric Estimations

The dependent variable in the following estimation is the households decision of migration (mobility) that explained by the independent variables such as age of household head, family size, gender of household head, literacy level of household head, skill of household head, own land size in tsimad[9], shock happened during lag of survey period, distance to near town, if land has rented out continuously, land use certification, own oxen holding, access to irrigable land, with five zone dummies (Zone1, Zone2, Zone3, Zone4, and Zone5) representing South eastern, Southern, Eastern, central, and Western. The fifth dummy i.e. Western did not appear in the regression result as it is deliberately left to serve as a reference Zone and to protect a dummy variable trap.

***Hausman* Taylor estimation of selected variables**

Mobility	**Coef.**	**Mobility**	**Coef.**
TVexogenous		TVexogenous	
distanceto~t	-.0006617**	distanceto~t	-.0007273***
certowners~p	-.0298344	certowners~p	-.0339952
Hhsize	.0282878***	Adults	.0211376**
Education	-.0635225**	Education	-.0651413**
Oxcurrent	-.0409306***	Oxcurrent	-.0408659**
Hhage	-.0039571*	Hhage	-.0048518**
plotsizets~i	-.0054358	plotsizets~i	-.0056355
Irrigd	-.0167979	Irrigd	-.0181395
Shock	.0720171***	Shock	.0778051***
TIexogenous		TIexogenous	
Hhsextaylor	-.0061584	Hhsextaylor	.0053867
TIendogenous		TIendogenous	
landrented~t	.0611875	landrented~t	-.0306641
_cons	.250734	_cons	.4029977***

Significant levels: * 10 percent, **5 percent, ***1 percent.
Note: TV refers to time varying; TI refers to time invariant.

[9]Tsimad is an area of land that can be ploughed by a pair of oxen in a day approximately equal to a quarter of a hectare

On the above table it shows the result of distance to near town, education, number of oxen and household age are negatively and statistically significant that influence the decision of household member to migration. While household family size and shock are positively and statistically significant in influencing the decision of household member to migration. However land use certification and size of plot land, has got insignificant result on decision to migration.

Hausman Taylor estimation results, with adult and dummy zones

Mobility	HT with zone dummy		HT of adults		HT of hhsize	
	Coef.	P>z	Coef.	P>z	Coef.	P>z
TVexogenous						
distanceto~t	-.0007103***	0.008	-.0007273***	0.007	-.0006617**	0.013
certowners~p	-.0258204	0.360	-.0339952	0.228	-.0298344	0.287
Hhsize	.0285608***	0.000	.0211376**	0.043	.0282878***	0.000
Education	-.0540148**	0.039	-.0651413**	0.013	-.0635225**	0.014
Oxcurrent	-.043258***	0.007	-.0408659**	0.011	-.0409306***	0.010
Hhage	-.0037355	0.111	-.0048518**	0.034	-.0039571*	0.086
plotsizets~i	-.0057079	0.610	-.0056355	0.608	-.0054358	0.619
Irrigd	-.0223804	0.664	-.0181395	0.727	-.0167979	0.745
Shock	.0552578**	0.045	.0778051***	0.004	.0720171***	0.007
Zone1	.0869599	0.019				
Zone2	.0009639	0.992				
Zone3	.0968099	0.340				
TIexogenous						
Hhsextaylor	-.0170014	0.854	.0053867	0.954	-.0061584	0.948
Zone4	.0434675	0.662				
TIendogenous						
landrented~t	.0633867	0.790	-.0306641	0.898	.0611875	0.808
_cons	.2022748	0.249	.4029977***	0.008	.250734	0.121

We identify a migrant household based on the following two conditions. First, migrants are individuals who were present in the household before 2006 and 2010 of the survey but not present in the current survey round, excluding household members that died. Second, we further limit migrants to

only include individuals who were at least fifteen years of age when they moved (to rule out children leaving for school). To deal on this issue it has estimated on the above right side table. On the above table it shows the result of distance to near town, education, number of oxen and household age are also negatively and statistically significant that influence the decision of household member to migration. While adult household family size and shock are positively and statistically significant in influencing the decision of household member to migration. However a negative coefficient the result of land use certification and size of plot land, has got insignificant on decision to migration.

Distance to the near town: is one of the determinants of decision to migration. The coefficient for distance to near town is negative and significantly different from zero, *ceteris paribus*. That shows when the distance of residential place of household members increase by one minute household member decision to migrate decrease by 0.0006617 amounts which is significantly and negatively affecting migration decision at 95 % confidence interval. This might be due to difficulty to communicate about the economic and social return in far distance. Households might also lack information about the potential returns to labour in distant markets. As Carrington et al (1996) have pointed out that as the information flow increase through migrant networks migration increases. However when the distance is much far away from their residential are people can't easily communicate what is going on about off-farm and other activities so they may not be sharp to give decision of migration.

Land use certification: Even though the estimation result of this important variable is insignificant the sign of the coefficient is negative, which is not expected to be so. This could be because of the fact that the overall level of mobility is small (8%). This is much different with statement stated in the hypothesis. This means farmers that have land use certification are not willing to migrate. This could be because they feel as if they are owners a given plot of land and this encourages working continually and intensively on their land to increase productivity through spending their time and effort. So this land use certification instead helps to exert their physical cooperation and also willing to invest in order to increase productivity. As depicted in

different research works this land use certification has also positive impact on land productivity among thus the point stated by Holden, Deininger, and Ghebru (2009) perform one of the first evaluations of tenure security on investment in Ethiopia as measured by household participation in the land certification program. They use plot-level data of households over 1998, 2001, and 2006 in the Tigray region. They apply several forms of sensitivity analysis in terms of the analysis of outcomes, specifications, and instrumental variable approaches, and find robust evidence that improving land security through the certification program robustly encourages investment in trees, superior soil conservation practices, and enhances land productivity. These findings suggest the absence of land use certification encourages migration. Moreover, this behaviour is consistent with earlier findings which show land rights improvements encourage productivity investments assuming land and on-farm labour are complementary inputs.

Labour endowment: Even if cultivating number of crops requires diverse activities, diversification has an advantage of full utilization of family labour through the diversified activities required for the different income generating activities. As depicted in the table 4.6 household family size has positively and significantly affecting at 99% confidence interval. Thus a unit increase in household family size lead to increase migration by 0.0282878 units. When the estimation goes only to adults (15-64) , just we further limit migrants to only include individuals who were at least fifteen years of age when they moved (to rule out children leaving for school) we get the result significant and positively affecting migration at 95% confidence interval, *ceteris paribus*.

Education: education has negatively and significantly affecting migration at 5% significance level, *ceteris paribus*. This is when farmers are getting educated they prefer seriously to treat and cultivate their land by themselves. Even though the sign of the coefficient is different from what is expected it has a significant role to give decision of migration in farmers life.

Oxen: Oxen play a substantial role in agriculture in smallholder farms. It is the main source of agricultural power. That is why oxen have negatively and significantly affecting migration, *ceteris paribus*. That when farmers have

oxen for cultivation they do not need to migrate instead stick doing on plot of land in order becomes productive.

Age of the household head: The estimated coefficient of age is negative and significant at 90% confidence interval, *ceteris paribus*. Thus old age farmers are not willing to migrate. Because migration needs more power and ability to involve, this is difficult with old age households. This indicates that age of the household has a negative effect upon the decision to migrate. As stated in the above table a unit increase in age has a decrease effect of 0.00395 amounts. This means the older farmers tend to stay in their village than younger farmers. This is possibly because the old aged farmers are more of weak to go here and there.

Cultivated land/plot size: Land is an important asset in the rural areas of northern Ethiopia. We find that regardless of the empirical specification, there is no significant relationship between the changes in the amount of landholdings by households and the measures of migration. Although the theoretical model would suggest that additional land holdings should have a negative effect on migration, the point estimates on the land variable are not significant. Since the land area variable does not adjust much over time, however, the negative effect of landholdings suggested by the theoretical model may simply be absorbed into the Hausman Taylor regression. Though not significant it has a negative effect on migration. The finding of De Brauw A and Mueller V, (2011) was also give insignificant effect of land holding over migration but with positive coefficient. The average size plot land is 1.565 tsimad with standard deviation of 1.456. However holding of land does not give significant change on the pattern of migration. The same is true when we talk about access to irrigation the coefficient of access to irrigation is negative and which negatively and insignificantly affecting decision to migration. The negative coefficient suggests that access to irrigated land and labour are complementary commodities. So that when household members have irrigation access it can negatively influences the migration decision of household members, *ceteris paribus*.

Shock: the happening of shock has a positive and significant effect on household member decision to migrate. From the former perspective,

households can diversify income risk pre-emptively by allocating labour spatially to areas where risks to income are not correlated with rural income shocks (Rosenzweig and Stark 1989).Shocks could be thus of drought, too much rain/floods, pests or diseases leading to crop loss, theft of crop, theft of livestock, death of animals, destruction or theft of farm tools, theft of cash, death of household member, serious illness of household member, loss of job of a household member, imprisonment, home damaged, loss of land due to conflicts, loss cash in deal.

Household sex: Technically speaking gender of farmer was found to have no significant effect on migration decision. Though, there is insignificantly affecting the migration decision the sign of the coefficient is become negative for household sex (1=male). That shows females are migrating more than male. Although Hausman Taylor estimation might suggest that there is a negative relationship between migration and sex (1=male), we have not yet provided a theoretical justification for a potential relationship.

Land renting out: as depicted in the above table renting out of land has a positive and insignificant effect on migration decision. But if there are only adult members of the household participants its sign become negative. This has its own theoretical justification; as farmers are renting out their land due to lack of oxen, income diversification through participating on off-farm activities, and other related reasons after renting out they become idle and become willing to work in distant in order to earn money through providing labour in the labour market which by imply increase migration.

Zone: Differentiating by zone, we observe the growth in the decision of migration is insignificant in all zones, except zone 1(south Eastern). I presume nearness of zone1 (south easterner) to Mekelle which brought about significant effect on migration as a theoretical justification for a potential relationship of the reason why zone1 (south Eastern) has got different result.

Estimation of OLS, Fixed effect and HT

mobility	OLS result		Fixed effect		HT estimation of hhsize	
	Coef.	P>t	Coef.	P>t	Coef.	P>z
landrented~t	.0249494	0.408	(dropped)		.0611875	0.808
distanceto~t	-.000264	0.291	-.0004963	0.190	-.0006617**	0.013
certowners~p	.0109547	0.657	-.0588401	0.141	-.0298344	0.287
Hhsize	.0226824***	0.000	.0276443**	0.020	.0282878***	0.000
Education	-.0508088*	0.054	.0402969	0.357	-.0635225**	0.014
Hhsextaylor	-.0471458*	0.087	(dropped)		-.0061584	0.948
Oxcurrent	-.0073976	0.563	-.0502675**	0.022	.0409306***	0.010
Hhage	.0000173	0.983	-.0402866***	0.000	-.0039571*	0.086
plotsizets~i	.0024284	0.744	-.0106639	0.515	-.0054358	0.619
Irrigd	.0074872	0.887	-.0190538	0.789	-.0167979	0.745
Shock	.0807823***	0.002	-.0255154	0.557	.0720171***	0.007
_cons	-.0125567	0.846	2.359064	0.000	.250734	0.121

Significant levels: * 10 percent, **5 percent, ***1 percent.

As stated in methodology part of this work we prefer to use Hausman Taylor estimation for dealing limited dependent variable and to estimate time invariant endogenous variable. Even though putting of the regression results of OLS and fixed effect is not much feasible we fix to do this for sake of comparison (had it been). Therefore we don't expect to have an interpretation. Because if we were simply to estimate equation using ordinary least squares the coefficient Estimates would almost certainly be biased, because we cannot measure the fixed individual effect and it is likely correlated with main interest of this work, land holding and land use certification.

5. Conclusion and Policy Implications

5.1 Conclusion

This paper utilized Household panel data that was collected by Mekelle University in collaboration of Norwegian Life Science University. The secondary data was also collected from the study areas in order to have reliable data. The primary data were collected covering the survey years of 2006 and 2010 of using stratified random sample of 330 households in 16 communities (tabia's). The researcher has estimated the possible sources of migration or factors that enable household member to decide to migrate.
In order to undertake the estimation the research preferred to use Hausman Taylor (HT) regression on STATA 10 version. As the HT helps using of method of instrumental-variable technique that uses only information contained in the model to eliminate the correlation between the error term and the included variables (the cause of the rejection of the random-effects model). And also its estimation of time-invariant variables is possible without compromising the estimates for time-varying variables.

The study results of some variables illustrate that household size and shock can positively contribute to household member migration in favour of off-farm activities. While variables like household members distance to near town, education, household head age and number of oxen are negatively and statistically significant in influencing household members to give decision of allocating labour on off-farm activity.

On gender differences, the empirical findings indicate that there are no significant differences in decision to migrate between male and female headed households.

Other points like those of irrigated land and rented out land are insignificantly and negatively affecting decision towards migration. However there are significant regional differences in decision to migrate. South Eastern zone is associated with more decision of migration than Western zone. Generally speaking all zones, except south Eastern are not significantly influencing migration.

5.2 Policy implications

Given these results the author tried to suggest main focuses of the future and is in line with the policy highlight. Based on the econometric result it is believed that this paper has provided some important indications towards the identification of factors influencing decision of migration.

Since the findings of land use certification and size land holding have both insignificant results. We could not deal about policy implication here. But the findings have shown household land use certification is negatively correlated with migration. Therefore the restriction of land use transferability affects[10] insignificantly the welfare of rural households by limiting the opportunity of income diversification. Hence, having flexible regional restriction on land use transfers, taking in to account the land less society that can benefit from land redistribution may lead to income diversification strategies that may prevent the likelihood of being poor in the future.

[10]The recent land transfer right restrictions in Tigray region are like thus of if migrating out for more than two years from wereda and renting out more than half of the total land size of owned have hindered the rural household from using an opportunity of income diversification.

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