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DYNAMIC MONEY DEMAND FUNCTION FOR ETHIOPIA[1]

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Abstract

This study has estimated stable long run and dynamic money demand equations for Ethiopia. However, the study shows some portfolio demand adjustment by agents after liberalization of asset prices after 1992. The study, by estimating money demand using disaggregated price level, shows that livestock, money and housing items are complements, and money and all other goods are substitutes in the portfolio demand of Ethiopian agents.

The study suggests that the government should follow a sound trade policy, strengthen the development of exchange oriented rural economy, use depreciation of currency than domestic credit control, facilitate conditions for the development of capital market and strengthen policy of indirect monetary control, and privatization to achieve sustainable growth and development. The study also suggests that the government should look for an alternative higher rate of inflation rather than targeting it to a low rate of single digit, which might hinder accelerated growth.

1. Introduction

The demand for money is a heavily researched area of economics. This is due to the important role of private economic agents' behavior in determining the outcome of economic policy reform that target monetary aggregates. However, much of the empirical research has focused on developed economies. This study focuses on a developing country. Empirical research has also concentrated on the identification of the appropriate key economic variables that determine the amount of real money

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balances that economic agents want to hold. Thus, the most common money demand specification includes real income as a measure of scale variable, one or more measures of the opportunity cost of holding money, lagged value of the dependent variable and dummy variables to account for seasonal variations and regime shifts. Most of the empirical studies have employed aggregate real income, the rate of general inflation and other variables as explanatory variables. However, some researchers have used disaggregated income as non-monetized and monetized components in studies on developing countries, see Arize, Darrat and Meyer(1990), Driscoll and Lahiri (1983), Laumas (1978). This study also employs disaggregated income as rural and urban income and both components of income are included in the model. It is to be noted that the Ethiopian economy is agriculture dominated and the change in the share of rural and urban income can have a significant influence on the demand for money. In addition to the agrarian nature of the economy, livestock ownership is of greater importance in the asset portfolio of the representative household. Thus the study employs disaggregated rate of price level as price of livestock, prices of housing and housing items and prices of all other goods. The finding of the study is expected to improve information on the estimation approach in money demand studies in developing economies.

During the last decade of the 20th century, most of African countries south of the Sahara started to implement economic liberalization measures and structural adjustment programs (SAP). This changed situation has made empirical investigation of money demand to remain of interest to researchers.

Ethiopia is one of the sub-Saharan African countries which have embarked on structural adjustment program. The reform measures implemented so far have changed the prices of assets and this change might have affected the demand for cash balances. Furthermore, Ethiopia is a small developing economy with heavy dependence on external assistance. This situation makes the behavior of domestic agents to be strongly influenced by external economic and monetary development. This makes it appropriate to include a variable that measures changes in foreign interest rat + exchange rate.

The purpose of the study is to identify the demand for narrow and broad money with particular attention to the ongoing policy change, the agrarian nature of the economy, the important role of livestock, the heavy external dependence and the long instability and civil war in the country.

The objective of the study

The main objective is to estimate dynamic money demand equations for narrowly defined money (m_1) and broadly defined money (m_2) in order to provide information for monetary policy makers.

The specific objectives include:

a) To estimate the elasticity of money demand with regard to explanatory variables in the money demand function for Ethiopia,
b) To study the effect of dis-aggregation of income and price level on the aggregate demand function.
c) To provide policy recommendation.

The study is organized as follows: Section II presents a review of selected theoretical and empirical works on the demand for money in Africa. Section III deals with issues of methodology. Section IV discusses empirical application, data sources, and data description. Section V presents empirical findings and analysis of the findings. Finally Section VI concludes the paper with a brief implication of policy and conclusion.

2. Empirical studies on demand for money in Africa

One of the major studies on money demand in Africa is the work of Domowitz and Elbadawi (1987). The authors estimated the demand for narrow money (currency + demand deposit) for the Sudan. The data are annual and the sample period is 1956:1982. The explanatory variables are real GDP, the rate of inflation and the official exchange rate of the Sudanese pound against the dollar. Domowitz and Elbadawi specified a stable demand function for money by employing the error correction modeling (ECM) for data on a small open economy. Due to the undeveloped financial sector of the Sudan, the authors attached a greater importance to the rate of inflation in their analysis.

Another important study on money demand on Africa is that of Adam (1992). Adam uses quarterly data to estimate the demand for M0 (currency in circulation), M1 (currency demand deposit), M2 (M1 + Time and Savings deposit), M3 (M2 + deposit liabilities of non bank financial institutions). In the case of M3, both its simple aggregate and the Divisia version are used.

The explanatory variables in Adam include GNP adjusted for changes in the terms of trade (the quarterly figure is obtained by interpolation), the consumer price index (CPI), the government regulated Treasury bill rate, and the expected rate of domestic

currency depreciation, which is approximated by the rate of change of the domestic parallel market exchange rate. Adam's findings show that there is a long run stable relationship between the demand for the different aggregates of money on the one hand and the explanatory variables on the other.

Simons (1992) undertook an important work on African economies. Simons estimated the demand for narrow money (M1) for five African countries. The countries included in the study were Congo, Cote d'Ivoire, Mauritius, Morocco and Tunisia. The findings show that in three of the countries the rate of interest plays an important role. On the other hand, the rate of inflation and exchange rate are significant in explaining the demand for money in countries where information on the rate of interest is lacking, and the rate of inflation is higher. Simons argues that it is irrelevant to exclude the rate of interest from money demand in the developing countries during the present era of financial liberalization and structural adjustment.

A further important study on Africa is that of Fielding (1993). Fielding used quarterly data to estimate the demand for money function in four African countries- Kenya, Nigeria, Cameroon and Cote d'Ivoire. Fielding estimated the demand for M2 (money + quasi money) for the sample period 1978-1989 (the sample periods are slightly different for the different countries). The explanatory variables considered include GDP (the quarterly figure is obtained by interpolation), the central bank discount rate or Treasury bill rate, the parallel market exchange rate and the consumer price index.

The findings show significant variations among the countries studied. Consequently, Fielding concludes that it is impossible to formulate a single monetary policy applicable to the different countries, implying the potential difficulty of a possible monetary union. Fielding's study indicates the necessity of further investigation of money demand function in the developing countries.

An important study was also conducted for seven African countries (Egypt, The Gambia, Mauritania, Morocco, Niger, Nigeria and Somalia (see Arize, Darrat and Meyer, 1990). The authors found that domestic money holdings are significantly related to monetized income and external influences.

Hoffman, D and Tahiri, C. (1994) are among those who studied money demand in Africa. They made use of a foreign (Swiss) Treasury bill rate to estimate the demand for money for Morocco. The authors reported their success in specifying a stable long run demand function for M1 & M2, implying that it is advisable to use a foreign rate of interest rather than completely ignoring the rate of interest in the developing countries.

Sriram (IMF, 2001) presented a survey of empirical money demand studies with error correction model approach, which were conducted in the 1990s across different countries. The paper presents a summary of the cointegration technique used, the variables, the data period and frequency, unit root test, long run income elasticity and elasticity or semi-elasticity for opportunity cost variables and other variables. The paper is of greater importance as a reference for further research.

Studies on money demand in Ethiopia are rare, and even the few work studies undertaken are in the form of unpublished MSC theses. Of these the most representative ones are discussed below.

One of the few studies is Samuel Mulugeta's (2005) 'The Demand for Money and Monetary policy in Ethiopia.'

The sample period for the study is 1970q1, to 2003/04q4. The variables included in the study are real narrow money balance, real GDP, the saving deposit rate, the inflation rate, the parallel market depreciation rate of the birr. Both the long run and short run functions were estimated.

The Johansen procedure was used in the process. The study found a 1.12 long run income coefficient and an inflation rate coefficient of -12.5. Income and past money holdings were found to affect the short run function. While this can be taken as a good work, there are some points of gaps. The first point relates to the author's rationale for dropping out the depreciation rate. The author a priori determined that the depreciation rate should take a negative sign. This is incorrect, since the variable can take either positive or negative values. Another point of contention can be the way the author used the dummy variables. Rather than mentioning the names of the dummies, the values they were given were not explicitly presented. This is necessary since the Johnson test is affected by the type of the values the dummies take. For instance, the 0/1 seasonal dummy is not appropriate for the Johansen procedure. There should be centered seasonal dummies the value of which should add up to zero. The use of step dummies may also generate trends on the levels of variables, (see Doornick, Hendry and Nielson, 1998, Arize, Malidretos and Shwiff, 1999)

Still another point of weakness relates to the way stationarity is established. In Johansen procedure individual unit root test using DF/ADF prior to the estimation of the co integrating vectors are identified. However, the multivariate test is more appropriate in Johansen approach (see Johansen 1995). Also the result of income homogeneity imposition was not presented. This is necessary since the reported income coefficient of the long run equation is in excess of unity. However the paper contains a number of interesting findings and good information on the financial sector of Ethiopia.

In conclusion, the following points can be made about empirical studies in money demand on developing economies.

a) There is still room for empirical studies of the subject in order to cover the many developing countries in the face of the changing economic and policy environment.

b) Past studies show the fact that modern econometric technique can be applied to data on developing countries.

c) The choice of explanatory variables should be left to empirical test rather than apriori netting out of some variables such as the rate of interest.

d) There are variations across countries and this implies variations in monetary policies of the different countries.

3. Model specification and theoretical considerations

The money demand function must be defined before undertaking any empirical analysis. In economic theories of money demand, there are at least two reasons why money may be demanded. The first is as an inventory to smooth differences between income and expenditure streams, and the second is as one among several assets in a portfolio.

Money in the representative agent model

The conceptual framework for money demand functions can be sought in the representative agent models. These models deal with the portfolio holding of agents. Money is entered in the utility function, and the demand for money is derived from the utility maximizing behavior of the representative agent. Such an approach was used by Tobin (1965), and Sidrauski (1967). Both of these works investigated money demand in relation to economic growth. Tobin concluded that agents allocate a fixed amount of saving, whereas Sidrauski argued that money demand was to be derived from utility maximizing behavior of agents.

The asset portfolio approach has been employed in the study of money demand in Sub-Sahara African countries. Among those who applied the approach are Adam (1999) and Randa (1999) in their studies on Zambia and Tanzania respectively.

The same approach is used in this study to identify money demand function for Ethiopia.

The demand function for narrow and broad money balances can be expressed as:

$$\left(\frac{M_t^d}{P_t}\right) = m(y_t, R_t, \omega) \qquad \textbf{(3.1)}$$

where M^d represents the amount of money held by the private sector, y is a scale variable which serves as a proxy for the amount of transactions, R represents a vector of rates of return on the assets in the portfolio of the agent, ω represents other factors such as technological innovations, impact of change in policy, etc.

Equation (3.1) above represents the general framework for the demand for money. However, in empirical studies both the inventory and portfolio demands for money lead to specifications such as equation (3.2); see Arize, Malindretos and Shwiff (1999).

$$m_t^* = \alpha_0 + \alpha_1 y_t + \alpha_2 i_t + \alpha_3 \pi_t + \varepsilon_t \qquad \textbf{(3.2)}$$

Where $m^{\bullet}$ is the logarithm of desired holdings of of real money balances (real M1 or real M2); real M1 consists of currency outside the banks and demand deposits divided by the consumer price index; real M2 consists of M1 plus quasi-money divided by the consumer price index, y_t is the logarithm of real GDP; i_t is the interest rate variable, proxied by the money market rate; π is the inflation rate variable; and the stochastic disturbance is ϵ_t.

According to equation (3.2), real money balances are assumed to be an increasing function of real income (i.e., real GDP) as the usual budget conditions dictate; that is, (α_1) is expected to be positive. On the other hand, the opportunity cost of holding money relative to financial assets (i) is expected to yield a negative influence on money demand, so (α_2) is expected to be negative. Also, an increase in expected inflation (i.e., the opportunity cost of holding money relative to real physical assets, e.g., houses, farms or durable consumer goods) should lead to substitution away from money to real assets, so α_3 is expected to be negative.

Although the above framework may be appropriate for a closed economy, it is unlikely to be adequate for developing economies because foreign sector considerations play a key role in determining their domestic money demand. Therefore, given the heavy dependence of Ethiopia's economy on external resources

and funds, appropriately specified money demand models should take account of foreign monetary developments, such as variations in exchange rates and foreign interest rates. The currency substitution literature (Agenor and Khan, 1996) suggests that portfolio shifts between domestic and foreign money provide a role for a foreign exchange variable. In contrast, the capital mobility literature (McKinnon, 1982) focuses on the foreign interest rate variable.

To provide a background on how variations in exchange rates and foreign interest rates could affect the demand for money in an open economy, we start by noting that it has generally been assumed that the demand for money depends, in addition to scale variables such as real income, on the rate of return on money holdings relative to the return on alternative assets. The alternative assets include a wide array of financial instruments, such as bonds and saving accounts, and also real assets, such as real estate.

In an open economy, however, individuals can choose to hold wealth in a portfolio of four assets: domestic money, foreign money, domestic bonds, and foreign bonds so that the foreign exchange of major trading partners is likely to become an important component of domestic portfolios (Arango and Nadiri, 1981). Thus, expected depreciation rate measures the rate of return on foreign bonds. The resulting demand for real money balances is equation (3.1) augmented with the net return on foreign bonds (I^f+x) and the foreign exchange rate (e), that is

$$m_t^{\bullet} = \alpha_0 + \alpha_1 y_t + \alpha_2 i_t + \alpha_3 (i^f + x)_t + \alpha_4 e_t + \alpha_5 \pi_t + \varepsilon_t^{\bullet} \qquad \textbf{(3.3)}$$

Where (I^f+x) is the rate of U.S. certificate of deposit plus the annualized change in the domestic per dollar exchange rate (i.e. = expected rate of depreciation) and e is the exchange-rate variable, defined as the number of units of the country's currency per unit of U.S. dollar; and ε_t^* is a random error term.

An increase in foreign interest rates *ceteris paribus* may raise the attractiveness of foreign bonds and induce domestic residents to transfer their financial assets to the high yielding capital markets. Such a transfer will be financed by drawing down domestic money holdings (i.e., the capital mobility effect). Therefore, it can be postulated that an increase in foreign interest rates will have a negative impact on money demand, so the sign on (α_3) is expected to be negative.

At least two effects on the demand for domestic currency will result from variations in the foreign exchange rate. On the one hand, there is a wealth effect; see the

discussions, for instance, by Arango and Nadiri (1981). Assume that wealth holders will evaluate their asset portfolios in terms of their domestic currency. Therefore, when domestic currency depreciates, there will be an increase in the value of foreign assets held by domestic residents (i.e., wealth-enhancing effect). This in turn leads to a rebalancing effect because, in order to maintain a fixed share of their wealth invested in domestic assets, they will repatriate part of their foreign assets to domestic assets, including domestic currency (i.e. rebalancing). As Arango and Nadiri (1981, P.79) have argued, it is because of the "rebalancing effect" brought about by changes in the exchange rate, that an exchange rate depreciation has a positive effect on the demand for money. Hence, exchange rate depreciation would increase the demand for domestic currency.

On the other hand, variations in the exchange rate can generate a currency substitution effect in which a key role is played by investors' expectations. According to the currency substitution literature, as a weak domestic currency develops expectations for further weakening, asset holders will respond by shifting some of their portfolios away from domestic currency into foreign assets. So, if depreciation of Ethiopia's Birr reflected by an increase in exchange rate induces a decline in money holding by domestic residents, the estimate of α_4 should be negative. To summarize, the expected signs for equation (3.3) are α_1 >0, α_2 , α_3 , α_4 , α_5 < 0, α_4 > 0. Based on the above discussions, an increase in the exchange (i.e., depreciation) could have a positive or negative effect on the demand for money; therefore, which effect dominates is an empirical issue, see Arango and Nadiri (1981), Arize(1989), Bahamani and Pourheydarian (1990), Arize, Darrat and Meyer(1990), Arize and Shwiff(1998), Arize, Malindretos and Shwiff(1999).

Equations (3.2) and (3.3) have assumed that the money market is in equilibrium, and they may be viewed as co integration models. The basic idea of co integration is that two or more non stationary time series may be regarded as defining a long-run equilibrium relationship if a linear combination of the variables in the model is stationary (converges to an equilibrium over time). Thus, if the money demand function in equation (3.2) or (3.3) describes a stationary long-run relationship among the variables in these equations, this can be interpreted to mean that the stochastic trend in real money balances is related to the stochastic trends in the real income, the interest rate and external monetary factors. In other words, even though deviations from the equilibrium should occur, they are meant reverting.

4. Empirical application

4.1 Data description

The data set used in this study consist of seasonally unadjusted quarterly M1 (narrow money), M2 (broad money), real Gross Domestic Product (Y), the consumer price index (PI), the parallel market exchange rate (bdep), the inflation rate (dinfr), rural income(yr), urban income (uy), deposit rate (i), and a combination of foreign interest rate and the rate of exchange, the price of live animals (Pa), price of household items (Ph), prices of all other goods (Px), a measure of domestic credit as a ratio of GDP (ci), centered seasonal dummies, blimps(impulse) and shift dummies. Only real variables are used in the analysis in order to maintain long run price homogeneity of the demand for money.

The sample period is the period (1974Q1: 2004Q4. The data are obtained from the National Bank of Ethiopia (NBE) and the Picks World Currency yearbook. The quarterly figures for GDP are constructed from annual figures using Goldstein's interpolation technique (see Goldstein, 1976).

Quarterly monetary aggregates have been constructed from monthly figures obtained from the National Bank. Quarterly prices have been formed from annual figures using the equation

$P_n = P_{n-1}\left(\frac{P_2}{P_1}\right)^{\frac{1}{n}}$,that is, the nth root of the ratio of change during the year multiplied by the preceding value where "n" stands for quarter period(n = 1…4), P_1 and P_2 represent the price level at the beginning and at the end of the year respectively. Quarterly prices of live animals have been calculated from export value index and quantity index for live animals since a reliable time series data are not available.

Value index (relative) = $\frac{P_t Q_t}{P_0 Q_0}$ X100, Quantity index (relative) = $\frac{Q_t}{Q_0}$ X100

Price index = $Valueindex \div Quantityindex = \frac{P_t Q_t}{P_0 Q_0} \div \frac{Q_t}{Q_0} = \frac{P_t}{P_0}$ X100

The price index of livestock obtained in this manner should be treated with caution. The scale variables after 1992 include the figures for Eritrea which have been

obtained from the Economic Intelligence in part and by estimating the missing years. The end of the "Birr Zone" has been taken care of by adding a dummy variable for the year 1997. The nominal figures for GDP, GNP and GDE are deflated by the consumer price index CPI, to obtain real figures.
The CPI is preferable in that it includes imports which consumers buy while it excludes exports which are not consumed domestically. The weakness of the CPI is that it excludes expenditures on investment but these are a smaller proportion of the total expenditures.

Despite the fact that the rate of interest in Ethiopia has been state regulated for a long time, it is included as an explanatory variable due to the importance of the variable in money demand functions and for monetary policy exercise. The rate of domestic inflation is included in the equation as a domestic opportunity cost of holding money.

The parallel market exchange rate is also included in this study in order to capture the external opportunity cost of holding domestic currency. The exchange rate is expressed in terms of units of domestic currency per unit of foreign currency. Hence, a rise in the rate of exchange means depreciation of the domestic currency.

Ethiopia has been under unstable political and economic condition. These changes are assumed to be exogenous and are accounted for by dummy variables. Thus dummy variables are included to account for the changes in political power in 1974, 1991, the Ethio-Eritrean conflict in 1997 and several additional liberalization measures in 1998. 1974 was the year when the military deposed Emperor Haile Sellasie and seized power. The dummy variable for this year is denoted as D974. The year 1991 was the year in which the military government entered its final phase of countrywide crisis and power passed into the hands of the EPRDF. The dummy variable for 1991 is denoted by D991. In 1997 a crisis started between Eritrea and Ethiopia. A dummy variable denoted D997 is used to account for this change. All of these dummy variables are impulse or blimp dummies taking the value of 1 for the year of the changes and 0 otherwise. Thus D974 is given 1 for 1974Q1 and 0 for other periods. D991 takes the value of 1 for 1991Q2 and 0 for other years. D997 is given 1 for 1997Q2 and 0 for the remaining years. The quarters represent the periods of the changes. Three other dummies, D992, D994 and D998, are also included to account for the 1992 devaluation of the Birr, the 1994 monetary and banking reform and the 1998 further liberalization of the foreign exchange operations and the lending rate. In 1998, measures like the abolition of the ceiling on the lending interest rate, redenomination of T-bills from birr 50,000 to birr 500, the move from retail forex auction to wholesale auction, elimination of the foreign exchange surrender requirement, and the liberalization

of the restrictions relating to foreign exchange transactions for education business travel and health. These dummies are transitory dummies and take the value of (1) for the years of the changes and the value of (-1) in the year following the change and zero for the remaining years. Hence D992 takes 1 for 1992 and (-1) for 1993 and (0) for the other years. D994 takes (1) for 1994, (-1) for 1995 and (0) for the rest of the years. In addition to these shift dummies, seasonal dummies in the form of sc1, sc2, sc3, and sc4 are used to account for seasonal variations in the variables. The seasonal dummies are centered dummies taking the value of 0.25 for the first three quarters and -0.75 for the fourth quarters.

4.2 The time series characteristics of the data

The first step in testing for co-integration in a set of variables is to test for stochastic trends in the autoregressive representation of each individual time series using the augmented Dickey and Fuller and Johansen tests. It is found in Table 3 below that the null hypothesis of non-stationarity is accepted when the variables are in levels. In addition, for the Johansen test, the null hypothesis of stationarity is rejected in each case. Hence, all the variables are assumed as non-stationary in levels for the purpose of estimating the demand for money.

4.3 Estimation method

The long run money demand is estimated using the following equation:

$$m^d{}_t = \alpha + \beta y_t + \gamma R_t + \phi_t + \varepsilon_t \qquad \textbf{4.3.1}$$

Where y = log of real income

R_t = a vector of the opportunity cost of holding money and includes the expected rate of inflation, the rate of interest on interest bearing deposits and foreign (US) treasury bill rate as well as the parallel market rate of depreciation.

ϕ = a vector of deterministic variables which include seasonal and other dummies as well as variables like time trend that captures regime shifts in money demand, α is a constant, β is constant income elasticity, and γ is constant elasticity or semi elasticity of the opportunity cost variables (R_t). And with the assumption of long run price homogeneity, real money balances increase in real income and decrease in inflation.

The vector can be defined as $X_t = \left(m, y, i, ifex, \left(\frac{\inf}{1+\inf} \right), \left(\frac{exr}{1+exr} \right) \right)$ **4.3.2**

The dynamic money demand function is represented by the multivariate co-integrating-vectors approach within the error correction framework. The error correction vector auto regression model is in the following form:

$$\Delta X_t = \Phi_1 \Delta Xt_{-1} + \alpha\beta' X_{t-1} + \delta Z_t + \Omega_t + \varepsilon_t \qquad \textbf{4.3.3}$$

Where: ΔX_t represents the first difference of I(1) variables

$\alpha\beta' X_{t-1}$ denotes the reduced rank matrix of long run co-integrating vectors of I(1) variables,

Z_t represents other stationary variables that are restricted to lie outside the co-integrating space, α represents the speed of adjustment towards long-run equilibrium by the variables whenever there is deviation from equilibrium,

Ω_t denotes a vector consisting of an intercept, three centered seasonal dummies, and other dummies accounting for regime shift.

5. Empirical findings

5.1 The demand for narrow and broad money

The long run demand for narrow and broad money has been specified using Johansen's approach. Both the likelihood ratio, based on Eigen values, and trace statistic show the existence of three co-integrating vectors combining log of real narrow and broad money (m_1,m_2), real gross domestic product(y), the rate of inflation, parallel market exchange rate, log of deposit rate and log of (US certificate of deposit + domestic parallel market exchange rate), lifex. Of the three co-integrating vectors, the ones with the theoretically acceptable sign of coefficients are presented below for analysis.

	m_1	y	dinfr	bdep	i	ifex
β	-1.00	0.7999	– 1.5954	7.06	-	-.2209
α	0.08	-0.03	0.03	-0.011	-	0.01
ß	-1.00	.816	-2.821	1.362	27.6	-1.813
α	(0.114)	(-0.044)	(0.03)	(-0.012)	(-0.009)	(0.009)

The β vector represents the long-run equilibrium linear combination of I (1) variables whereas α represents the speed of adjustment towards long-run equilibrium when economic agents are out of equilibrium. Thus about 8% of the disequilibria in the demand for narrow money and 11% of the demand for broad money are corrected per each quarter, and this is relatively a lower speed of adjustment. However, the coefficients are signed as expected. The coefficient for income is expected to lie

between 0.5 and just over 1. In the present case the income coefficient is about 0.8 for both narrow and broad the figure for broad money being slightly higher than that of the narrow money. The rate of inflation is of the expected negative sign. It has a coefficient about -1.6 for M_1 and about -2.8 for M_2. As to the size of the rate of inflation, neither economic theory nor empirical studies provide a clear guidance on the acceptable size of the coefficients of opportunity cost variable in money demand. The relevant information is that the sings should conform to theoretical priors. The parallel market rate of exchange is with a positive sign. This situation conforms with some empirical findings on developing countries, see Arango and Nadiri (1981) and (Adam, 1999). The possible explanation seems, as Arango and Nadiri argued that the depreciation of domestic currency will have a wealth-enhancing effect which results in increased value of the wealth of domestic residence in foreign assets. This in turn will result in a situation where domestic agents undertake a rebalancing of their portfolio holdings in order to allocate a fixed proportion of their wealth to domestic assets. Thus, they repatriate part of their foreign assets to domestic assets including domestic currency. This will result in increased demand for the domestic currency as indicated by the positive coefficient of the exchange rate. On the other hand, Adam (1999) gives three possible reasons. First, the correct variable of interest should be the expected rather than the actual rate of depreciation. However, this could not change the situation. Second, agents shift out of domestic financial assets but simultaneously increase their currency balances in order to operate in the cash only illegal parallel market of exchange. This seems more plausible. Adam also ascribes the positive sign of exchange rate to a high co-linearity between inflation and the rate of exchange. The deposit rate (i) is with a negative sign and this is as expected in the case of narrow money but positive in the case of broad money. As the rate on savings deposit increases, agents shift their money from narrow money to interest earning broad money. The combination of foreign rate of interest and exchange rate, which measures capital mobility, is also with a negative sign as expected. When foreign interest rate rises, domestic residents will increase their foreign asset component by shifting out of domestic assets. Restrictions are imposed on the parameters of the vectors to see the validity of the coefficients. Thus for narrow money, income homogeneity test was imposed and the LR with $\chi^2(3) = 2.6305\ [.452]$ could not reject the null hypothesis of income elasticity of unity. Imposition of zero value on the rate of exchange $\chi^2(3) = 13.57[.004]$ and on capital mobility measure $\chi^2(3) = 15.4245[.000]$, was rejected. The test on the rate of inflation showed $\chi^2(3) = 70.09[.000]$ strongly rejecting the null hypothesis of zero coefficients. On the other hand, imposition of zero coefficients on the deposit rate (i) was individually accepted $\chi^2(3) = 1.2155[.749]$ but joint test with income

homogeneity was rejected $\chi^2(3) = 13.02[.043]$. However, the variable is included in the function because of its important role in monetary policy. In the case of m_2, LR test for income homogeneity, $\chi^2(3)$ = 3.6912(.718), could not reject the null hypothesis. The restriction on the deposit rate was rejected, $\chi^2(9)$ = 128.7246(.000). However, this restriction on interest rate jointly with income homogeneity was rejected, $\chi^2(6)$ = 13.02(.043). Imposition of zero value on the parallel market exchange and the measure of capital mobility was rejected, $\chi^2(3)$ = 16(.001), $\chi^2(3)$ = 17.4866(.000).

Finally, Johansen's multivariate unit root test was conducted to see the stationarity nature of the data. The result is as follows:

Variable	Hypothesis	LR Test
lrm1	is I(0)	$\chi^2(6) = 140.4634[.000]$
lrm2	is I(0)	$\chi^2(9) = 124.1587[.000]$
lry	is I(0)	$\chi^2(6) = 145.9239[.000]$
dinfr	is I(0)	$\chi^2(6) = 65.670[.000]$
bdep	is I(0)	$\chi^2(9) = 103.9928[.000]$
li	is I(0)	$\chi^2(9) = 128.7246[.000]$
lifex	is I(0)	$\chi^2(6) = 117.3088[.000]$

In all cases, the null hypothesis of stationarity is rejected (see appendix for DF and ADF test results).

5.2 The demand for money with disaggregated income

The objective of this exercise is to see if there is a significant difference between the demand for money by rural and urban agents. For this purpose the gross domestic product has been disaggregated as agricultural and related activities, and non-agricultural income. The agricultural income is considered as rural income while the non agricultural component of gross domestic product is taken as urban income.

The long run cointegrating vectors for both m_1 and m_2 were estimated by including all the variables that were used in the estimation with the aggregate income except the rate of interest and the measure for capital mobility in the case of M_1 and the parallel market rate in the case of M_2. The test for cointegration was carried out with 4 lags for both m_1 and m_2. The eigen values indicate the existence of three vectors for both monetary aggregates. The vectors that adhere to theoretical assumptions of positive income and negative inflation coefficients have been selected for analysis and have been reported below. The two vectors are:

	m_1	yr	uy	dinfr	bdep	i
	-1.00	0.045	0.462	-	-.692	9.55
α	0.136	-0.21	-0.19	-	0.03	0.009
	M_2	yr	uy	dinfr	I	ifex
β	-1	0.325	0.496	-1.163	2.443	-.333
α	.20	-0.226	0.234	-0.095	-0.0025	0.035

Where: uy = urban income; yr = rural income

The coefficient of rural and urban income is positive for both m_1 and m_2. Rural income shows a lower coefficient in the demand for narrow as well as for broad money. The positive sign for the coefficient of rural income contradicts the findings of other studies (see Driscoll and Lahiri, 1982). The authors argue that growth in rural income leads to growth in barter opportunities and own consumption and since these components of rural income are non-monetized, growth in the components results in declining demand for money. This is hard to accept for it is just difficult to think of negative real income in a demand function for real money balances. On the contrary, it can be argued that growth in rural income might result in increase in rural surplus that may be marketed with the use of money, and thus an increased demand for money balances. Thus growth in the agricultural component of income results in increasing demand for money and in slower velocity of money. Urban income has also positive coefficient in the demand for both money aggregates showing that as urban components of income grow, the demand for money also increases. This once again results in a decline in the velocity of money. The urban component of income has a higher coefficient showing that the increase in the demand for money by urban agents is greater than that by rural agents. The higher coefficient of urban income in the demand for broad money shows the growing demand for inside money as urban income grows. The coefficient of inflation is of the correct negative sign in the demand for broad money. The speed of adjustment is higher than in the case of estimation with aggregate income. In both the demand for narrow and broad money, about 14% and 20% of the

5.3 Money demand with disaggregated rate of price change

Desegregation of the price level has been undertaken in order to see the effect of specific characteristics of developing economies on the aggregate demand for money. The rate of change of different prices can help us see the relative impact of the changes in different prices on agents' demand for money.

The question about the relation between the demand for money and the demand for

other assets stems from the simple two asset i.e., money- bonds, economy. This simplified approach suggests that agents decide to hold a smaller proportion of their wealth in the form of money as the return on bonds rises. The proportion of income held in the form of bonds increases as the return on bond rises or what amounts to the same thing, as the price of bonds declines. The two-asset approach is based on two assumptions, which are regarded as inadequate. One of the assumptions is that money is regarded as the risk-less asset. The criticism is that short-term securities are also risk free or at least with minimum risk. The other assumption is that change in money stock will also change the prices of risky assets. The criticism here is that many other factors, besides money can result in changing prices of assets.

Three alternative approaches to the study of money demand versus the demand for others assets can be identified. First, the money market and term structure approach holds the view that investors prefer to hold short term securities like treasury bills and time deposits in order to hedge against risk. Thus, the demand for money is dependent on income and savings and time deposit rates. Second, the capital market model approach builds its approach on the basis of a linked capital-market system which takes into account the portfolio decisions by businesses, households and the government. The point is that the yield on assets determines the portfolio decision of agents. Third, Brunner and Meltzer approach splits the capital market into three as money market, the debt market and the market for real capital goods, and holds the view that the expenditures for goods and services (it can be the portfolio composition) depends on the relative prices of the assets in the three markets (Mayer, T et al, 1981).

From the above brief theoretical background, it can be seen that the portfolio holding of agents depends on the rate of yields on the assets in the portfolio. For empirical study therefore, it is possible to use the rate of change of prices of different goods to see the portfolio effect of change in the demand for money.

Based on the above theoretical background, this study has made an attempt to see the demand for money in Ethiopia within the framework of portfolio choice of agents. For this purpose, the peculiar feature of the Ethiopian economy has been taken into consideration. Ethiopia is mainly an agrarian economy with about 50% of GDP coming from agriculture. Within agriculture, livestock plays a significant role. Livestock ownership is considered as a substitute for capital assets. Also, the holding of deposits in the form of savings and time deposits is limited to an insignificant proportion of the population. Therefore portfolio choice of the Ethiopian agents is between cash and real goods such as cattle, household items, food items, etc. Such a portfolio composition will be affected by changes in the prices of the items. This makes it necessary to study agents' response to changes in the prices of vitally important assets in the portfolio holdings of agents. Thus, the dis-

aggregation of the general price level has been undertaken by splitting up the general price level into the prices of livestock, prices of housing items, and prices of all other goods. One problem in this exercise is that reliable data on the prices of livestock is difficult to obtain. To overcome this problem, price of live animals has been constructed by dividing unit export value index by unit price index. The data for the computation were obtained from the National Bank of Ethiopia. The estimation of the equations with disaggregate price has been done for the sample period up to 1997 because of the problem of the difficulty to obtain reliable data on price of livestock. The long run co integrating vectors appear as follows:

Estimated Cointegrated Vectors in Johansen Estimation (Normalized in Brackets)

β-Vector		α-Vector	+β-Vector		α-Vector
LRM1	.76366	-.27743	LRM_2	2.3811	-.1535
	(-1.000)	(.21186)		(-1.000)	(.36552)
LRY	-0.56851	.04033	LRY	-2.7397	.06455)
	(.74446)	(-.03080)		(1.1506)	(-.1537)
DLPX	3.0526	.01697	DLPX	4.7630	.01293
	(-3.9974)	(-.01296)		(-2.0003)	(-.03078)
DLPA	-0.85394	1.0510	DLPA	-.52452	.3746
	(1.1182)	(-.8264)		(.22028)	(-.8919)
DLPH	-3.1717	.05904	DLPH	-2.4256	.04539
	(4.1532)	(-.04508)		(1.0187)	(-.10809)
DBDEP	-9.7007	-.06538	LIFEX	1.9257	-.13945
	(12.7029)	(.04993)		(-.8087)	(.33204)
LIFEX	1.096	-.0808	I	-1.22	-.03272
	(-1.4354)	(.0617)		(.5121)	(.07791)

-+

---*The co-integrating vectors show positive income coefficient with a value more or less similar to the figures with aggregate price. The coefficient for the prices of other goods is negative whereas the coefficients for prices of livestock and housing items are found to be positive. This shows that livestock, housing items and money balances are complementary, whereas money and all other goods are substitutes in the portfolio holdings of Ethiopian agents.

This finding may not be surprising given the economic condition of Ethiopian rural population. The recurrent drought and the accompanying famine have made people to take any advantage of rise in the price of live animals by selling them and holding money which is risk free. Even under normal conditions, growth in the price of live animals means growth in the nominal income of the people; and this result in increasing money balances.

The finding can be analyzed more formally by considering income as a proxy for

wealth (Friedman, 1957). This can be seen from the equation:
y = rW or y ÷ r = W,
Where y = income,
r = a rate of return on wealth,
W = wealth

A rise in the prices of livestock and housing items is just a rise in the wealth of agents and it results in the growth of income (y). This situation induces a growing demand for real balances. A more plausible for the positive coefficients for the prices of livestock and housing items can be seen from the effect of wealth on money demand. In this regard the demand for real balances can be thought of as a function of real wealth (Harris, 1981). The demand for real balance within such a framework can be represented by the following equation. $\frac{M^D}{p} = f\left(y, r\frac{M_S}{p} + \frac{B_S}{rp}\right)$

Where: y represents real income, r is an opportunity cost of holding money, M_s and B_s are nominal supply of money and bonds respectively. The money and bonds are assumed as being outside assets and constitute net wealth of the private sector. It is further assumed that the government exogenously determines the supply of nominal money and bonds. Equilibrium in the money and bonds markets can be maintained if the demand for money and bonds is equal to the exogenously determined supply. A change in money balances, ceteris paribus, will result in real balances, which is one component of real wealth. This in turn brings about a shifts in real savings which declines and real investment which grows. Thus an excess demand is created in goods and bonds market while there is excess supply of money. This happens because the model assumes agents to hold a fixed amount of bonds. In the Ethiopian context, since physical assets are being considered rather than bonds, the demand due to wealth effect will be with respect to livestock, housing and housing items. Thus to maintain equilibrium, the prices of these items should rise. This explains the positive coefficients for the prices of livestock and housing and housing items in the demand for money with disaggregated price level in Ethiopia.

The coefficient of the other prices is negative as expected. Thus, when prices of other goods increase, agents substitute those goods for money as a hedge against the assets' rising price.

The portfolio effect of price change can be summarized as follows: As the price of livestock rises, people sell them and hold more of their wealth in money form. On the other hand, as the price of all other goods rise, people adjust their portfolio by reducing the money component and increasing the real asset part.

5.4 The short term demand for narrow money and broad money

In all the three cases of estimation with aggregate income, disaggregated income and price level, general models were estimated by including the lagged values of money, the other variables and the error term in the estimation. The models indicate the existence of an error correction model, which is significant at 5% level. The parsimonious equations are presented below.

Dependent variable is DLRM1
118 observations used for estimation from 1975Q3 to 2004Q4

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
INPT	.37194	.11992	3.1016[.002]
DLRM1(-1)	.63261	.083384	7.5867[.000]
DLRM1(-2)	-.55308	.10354	-5.3417[.000]
DLRM1(-3)	.42998	.088087	4.8814[.000]
DLRY	-.11976	.055848	-2.1444[.034]
DLRY(-1)	-.29179	.072176	-4.0428[.000]
DLRY(-3)	-.11377	.054280	-2.0959[.038]
DLRY(-4)	.16332	.072279	2.2596[.026]
DINFR(-1)	-.43971	.12825	-3.4284[.001]
DINFR(-4)	.34592	.12580	2.7499[.007]
T	.0031670	.8639E-3	3.6661[.000]
D998	.17260	.035405	4.8750[.000]
ECM1(-1)	-.075319	.023306	-3.2318[.002]

R^2 = .64112, F-statistic F(12, 105)= 15.6314[.000]
R^2-Bar = .60010, S.E. of Regression=.073914
RSS =.57364, Mean of Dependent Variable=.030309
S.D. of Dependent Variable= .11688, Maximum of Log-likelihood=146.8249
DW-statistic = 1.8319

Serial correlation χ^2 (4) = 6.2548 $[.181]$, F (4, 101) = 1.4133 $[.235]$

Functional Form χ2 (1) = .1557 $[.693]$, F (1, 104) = .13747 $[.712]$

Normality χ^2 (2) = 72.9969 $[.000]$,

Heteroscedasticity χ^2 (1) = 2.0236 $[.155]$, F (1, 116) = .00998 $[.1581]$

Predictive Failure χ2 (24) =20.725 $[.655]$, F (24, 56) =.8636 $[.645]$

Chow Test χ^2 (12) =8.337 $[.758]$, F (12, 93) =.69497 $[.753]$

Dependent variable is DLRM2

118 observations used for estimation from 1975Q3 to 2004Q4

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
INPT	.23622	.037764	6.2552[.000]
DINFR	-.46304	.069174	-6.6939[.000]
DINFR(-2)	-.14885	.063774	-2.3340[.021]
DLI(-5)	-10.7123	3.7078	-2.8891[.005]
T	.0032193	.4649E-3	6.9249[.000]
SC1	-.022358	.010632	-2.1029[.038]
D998	.050132	.017963	2.7909[.006]
ECM22(-1)	-.10735	.016380	-.5538[.000]

R-Squared .51746 F-statistic F (7, 110) 16.8518[.000]
R-Bar-Squared .4878, S.E. of Regression .05
Residual Sum of Squares .27578, Mean of Dependent Variable .018491
S.D. of Dependent Variable .069891, Maximum of Log-likelihood 190.0372
DW-statistic 1.6260, LM = $\chi^2(4)$= 3.5335[.473], F (4, 106) =.81804[.516]
RESET, $\chi^2(1)$ = 3.0136[.083], F (1, 109) =2.8567[.094], NORM $\chi^2(2)$ = 72.2063[.000],
Het, $\chi^2(1)$ = .024870[.875], F (1, 116) = .024453[.876]
Predictive Failure $\chi^2(24)$=23.8591[.470], F(24, 86)=.99413[.483]
Chow Test: $\chi^2(8)$= 9.2185[.324],F(8, 102)= 1.1523[.335]

The error correction (ecm) term is significant and of the correct sign. However, in both cases, it shows a somewhat lower rate of adjustment and it is about the same size as the value of the α in the long-run vectors. Lagged values of money demand, the rate of inflation, and real income as well as the current level of income significantly affect the demand for narrowly defined real money balances. Also a centered seasonal dummy, the time trend and a shift dummy of 1998 are found significant determinants of the demand for M_1. All the coefficients are significant at the 5% level. The income coefficient has a positive sign. Agents increase their real cash balances as their real income rises. The rate of inflation is found to have a rapid and positive impact on the model. Its one period lagged value shows a negative sign. This indicates that agents' response to the rate of inflation in the immediate past is a reduction of the demand for real balances. On the other hand, the impact of the holdings of money about a year ago, M(1-4), is positive. One possible explanation for such a behavior is that economic agents naturally try to reestablish their real balances, which had been depleted by the higher prices in the preceding period. A more likely cause is that after experiencing inflation in the preceding quarter, agents decide to hold more cash to take advantage in purchasing goods in short of supply whenever the goods become available on the market. The time trend and D998 have positive impact. Agents' initial response to the uncertainties of financial innovation and policy reform is increased holding of cash balances.

The parallel exchange rate, the measure of capital mobility, the impulse dummies of

1991, 1992 and the shift dummy of 1994 have all been found insignificant and cancelled out. In the case of broad money, only the rate of inflation, the change in the savings deposit rate during the past years and centered seasonal dummy, the time trend as well as the shift dummy of 1998 determine agents' demand for broad money balances.

Finally, the diagnostic tests show that the functions can be accepted as capturing the short run changes in the demand for narrow and broad money in Ethiopia. The residuals are not serially correlated, there is no functional mis-specification, and the assumption of homoscedasticity is fulfilled. The models were estimated over a different time period to see their forecast adequacy. The Chow's second test and the predictive failure test reported above prove the forecasting adequacy, stability and nonexistence of structural breaks in the models. Likewise, in the One observation to be made is that the normality assumption of the model is rejected by Jarque–Bera LM test. However, the test of normality is a test of symmetry and mesokurtosis, which do not tell what to do next (Greene 1977). Further, as Gujarati (1995) pointed out, the normality assumption of the central limit theorem might be regarded as applying to a few exceptional cases. Thus, even if the residuals are not normally distributed, the models can be accepted as unbiased.

The final parsimonious models of the disaggregated income indicate the existence of well behaved and higher error correction terms compared to the models with aggregate income. Both urban and rural income components are significant in the demand for narrow money whereas, rural income component has been found in the demand for broad money. In both models, past money holdings play significant role in defining the behavior of agents. The coefficients of past money balances are positive in both cases indicating that growth in the two components of income results in increasing demand for real balances. In both models, the time trend and a centered seasonal dummy have been found significant. The shift and the impulse dummies as well as the savings rate, the rate of inflation and parallel market exchange rate have been found insignificant in the models with disaggregated income. On the other hand, the models' degree of fit is improved as indicated by r^2 of 69% for M_2 although it remains the same for M_1 (64%) as in the aggregate income case.

Ordinary Least Squares Estimation
Dependent variable is DLRM1
119 observations used for estimation from 1975Q2 to 2004Q4

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
INPT	.35216	.11969	2.9422[.004]
DLRM1(-1)	.62689	.081550	7.6872[.000]
DLRM1(-2)	-.60868	.078686	7.7356[.000]

DLRM1(-3)	.33705	.073432	4.5899[.000]
DLRYR(-1)	.10905	.047742	2.2840[.024]
DLRUY	.26754	.044637	5.9937[.000]
T	.0023888	.8433E-3	2.8327[.005]
SC1	-.031853	015608	-2.0408[.044]
ECMD1(-1)	-.085277	.029873	-2.8546[.005]

R-Squared =.64913, F-statistic: F(8, 110) = 25.4382[.000], R-Bar-Squared =.62361,
S.E. of Regression = .071405, RS S =.56085, Mean of Dependent Variable = .030265
S.D. of Dependent Variable=.11639, Maximum of Log-likelihood=149.9133, DW-statistic=1.8537
LM: χ^2 (4)=8.4421[.055], F(4, 106)=1.5490[.063],RESET: χ^2 (1)=.26227[.609],F(1, 109)= .24076[.625]
Normality : $\chi^2(2)$ = 1.2935[.524], Het : χ^2 (1) = .15744[.692], F(1, 117) = .15500[.695]
Predictive Failure: $\chi^2(56)$ = 49.5041[.718], F(56, 54) = .88400[.676]Chow: ($\chi^{2)}$ (9)= 10.6903[.298], F(9, 101) = 1.1878[.311]

The models are congruent and the errors are independent. They pass all the diagnostic tests, and appear to be more stable. Finally, by estimating the equation over a different sample period, the stability of the model has been tested. The test statistics show no sign of instability and the models are found to be adequate for forecasting as indicated by the insignificant Chow and predictive failure tests. However, the normality assumption is rejected by the significant LR test in the model for M_2. However, since the function is well specified and all other desirable properties are tested as acceptable, the model can be accepted as unbiased.

When we turn to the short run models with disaggregated price level, one can say that the behavior of the short run demand for narrow and broad money in Ethiopia is better explained by including the price of livestock, and housing items separately from the prices of all other goods. The coefficients of the rate of change of the prices appear to be positive for some lagged values and negative for the rest. This shows that the adjustment process to disturbances is not smooth. It also shows the turbulent nature of the portfolio holdings of agents, switching from one portfolio to another with the quarterly changes in prices. The coefficient of income is of the correct sign. Only the current level of income is found significant in the short term function.

Ordinary Least Squares Estimation
Dependent variable is DLRM2
119 observations used for estimation from 1975Q2 to 2004Q4

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
INPT	.45719	.095634	4.7806[.000]
DLRM2(-1)	.68127	.072507	9.3959[.000]
DLRM2(-2)	-.46384	.083150	-5.5783[.000]
DLRM2(-3)	.21588	.069942	3.0865[.003]

DLRYR	.25875	.034396	7.5227[.000]
T	.0038001	.7876E-3	4.8252[.000]
SC1	-.027847	.012850	-2.1671[.032]
ECD2(-1)	-.12294	.025929	-4.7414[.000]

R-Squared =.69366, F-statistic F(7,111)= 35.9068[.000]
R-Bar-Squared =.67435, S.E. of Regression =.060218
RSS =.40251,Mean of Dependent Variable =.036740
S.D. of Dependent Variable =.10552,Maximum of Log-likelihood=169.6514
DW-statistic = 1.8410
LM:$\chi^2(4)$= 8.6560[.057], F(4, 107)= 2.3623[.058]
RESET : $\chi^2(1)$=.75528[.385], F(1, 110)=.70261[.404]
Normality: $\chi^2(2)$=16.8635[.000]
Heteroscedasticity: $\chi^2(1)$=.022194[.882],F(1,117)=.021825[.883]
Predictive Failure: $\chi^2(36)$=50.2402[.058],(36,75)=1.3956[.113
F: Chow Test: $\chi^2(8)$= 5.3389[.721], F(8, 103)=.66736[.719]

A change in the price of livestock (lpatd) has a significant impact which spreads over two quarters. Movement in the price of housing (lphtd) also has a prolonged effect. An initial change results in an effect that drags on for six months. The rate of parallel market exchange (dbdept/dbdep) and a measure of combination of foreign rate of interest and foreign exchange (dlifex/lifextd) have significant effect on the equations. The overall effect of the parallel market exchange is positive while that of the foreign interest rate is negative. In both cases the index of credit restraint (ci/citd) has a significant effect. The overall effect is positive. The dummy variables for change in government (D991) and for devaluation (D992) are significant with negative and positive coefficients respectively. This shows that in 1991 agents changed their money balances into real goods due to expected shortage of supply of goods. The 1992 devaluation resulted in increased domestic currency demand. This is probably due to the activities of some agents in the illegal cash only parallel market for foreign exchange.

Ordinary Least Squares Estimation
Dependent variable is DLRM1

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
INPT	.029791	.015107	1.9720[.052]
DLRM1(-1)	-.57784	.079145	-7.3011[.000]
DLRM1(-2)	-.37105	.079354	-4.6759[.000]
DLRM1(-3)	-.35995	.078028	-4.6131[.000]
DLRY	.24967	.087911	2.8400[.006]
DLPA	-.045325	.015001	-3.0214[.003]
DLPA(-1)	-.22532	.038187	-5.9003[.000]
DLPA(-2)	.037849	.015046	2.5156[.014]
DBDEP(-1)	-2.2517	.31590	-7.1277[.000]

DBDEP(-3)	1.1094	.35827	3.0965[.003]
DLIFEX	-.18860	.087911	-2.1453[.035]
DLIFEX(-2)	.27748	.098231	2.8248[.006]
DLIFEX(-3)	-1.1279	.37804	-2.9836[.004]
D991	-.12599	.043435	-2.9006[.005]
VOLP	-.29675	.11967	-2.4798[.015]
CI	.12397	.018886	6.5642[.000]
ECM1D(-1)	-.19692	.026537	-7.4207[.000]

R^2 =.69111, F (16, 74) 10.3477[.000]
R^2-Bar =.62432, S.E. of Regression = .039670
RSS =.11646, Mean of Dependent Variable =.010903
S.D. of Dependent Variable =.064723, Maximum of Log-likelihood = 173.9563
DW = 2.0124, A: Serial Correlation $\chi2(4)$= 3.8499[.427],F(4,70)=.77306[.546]
B: Functional Form $\chi2(1)$=.97257[.324], F(1, 73)= .78862[.377]
C: Normality $\chi2(2)$ = 1.3904[.499] Not applicable
D: Heteroscedasticity $\chi2(1)$=.28432[.594], F(1, 89)=.27894[.599]
E: Predictive Failure $\chi2$(24)= 35.9245[.056],F(24, 51)= 1.4969[.113]
F: Chow Test $\chi2$ (16)= 21.3288[.166], F(16, 59)= 1.3331[.209]

The measure of price volatility (volp) (for m1) and the error correction term are negatively signed as expected. The figure in both the narrow and broad models, are much higher than the figures with the aggregate models and models with disaggregated income. About 20% of disequilibrium in narrow money demand and about 37% of the disequilibrium in broad money demand is cleared each quarter. The diagnostic tests show no problem in the case of narrow money. Even the problem of normality is solved. However, in the case of the equation for broad money both the LM and F- test showed the presence of serial correlation initially, and the model presented above has been estimated with transformed variables. The transformed variables took the form of $X^* = X_t - \rho X_{t-1}$ (J. Durbin, 1960). The transformation has solved the problem of serial correlation. The model has been tested for stability and forecasting adequacy. There is no evidence of instability and predictive inadequacy. The models with disaggregated price level perform better as indicated by higher R^2, lower RSS and non violation of the assumption of normality.

Ordinary Least Squares Estimation: Dependent variable is M2TD 89 observations used for estimation from 1975Q4 to 1997Q4.

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
INPT	-.36343	.077418	-4.6945[.000]
YTD	.48614	.091471	5.3147[.000]
LPXTD	-.55523	.26378	-2.1049[.039]
LPXTD(-1)	.72220	.27907	2.5879[.012]
DBDEPT(-1)	.28790	.098053	2.9362[.005]
DBDEPT(-2)	-.79115	.32625	-2.4249[.018]
DBDEPT(-3)	1.3817	.33904	4.0754[.000]
LPATD	-.021501	.012552	-1.7129[.091]
LPATD(-1)	-.053155	.023695	-2.2433[.028]

LPATD(-2)	.059409	.012879	4.6127[.000]
LPHTD	-.72493	.18110	-4.0030[.000]
LPHTD(-1)	.88005	.25924	3.3948[.001]
LPHTD(-2)	-.47647	.17766	-2.6819[.009]
LIFEXTD	-.21652	.083709	-2.5866[.012]
LIFEXTD(-2)	.93539	.35650	2.6238[.011]
LIFEXTD(-3)	-1.5088	.36021	-4.1886[.000]
LIFEXTD(-4)	.18340	.080728	2.2719[.026]
D991	-.13023	.041984	-3.1019[.003]
D992	.049148	.016723	2.9390[.005]
CITD	.20622	.037187	5.5454[.000]
CITD(-1)	-.26269	.042421	-6.1926[.000]
CITD(-3)	.068430	.024322	2.8135[.006]
ECM2D(-1)	-.37942	.079058	-4.7993[.000]

R^2 = .73292, F(22, 66) = 8.2324[.000], R^2-Bar = .64389, S.E.R = .033393
RSS = .073597 Mean of Dependent Variable = .011159
S.D. of Dependent Variable = .055958, Log-likelihood =189.5658
DW = 1.9574,
A: Serial Correlation $\chi2(4)$= 1.2259[.874], F(4, 62)= .21648[.928]
B: Functional Form $\chi2$ (1)= 2.5771[.108], F(1, 65)= 1.9383[.169]
C: Norm. $\chi2(2)$=4.0197[.134], Het $\chi2(1)$= .0015442[.969],F(1,87)=.0015095[.969]
E: Predictive Failure $\chi2(24)$= 19.2037[.741], F(24, 44)= .80016[.717]
F: Chow $\chi2$ (21)= 15.0922[.818], F(21, 47)= .71868[.793]
DW-statistic = 1.8267
A: Serial Correlation $\chi^2(4)$ = 11.4189[.022], F(4, 75)= 2.6904[.037]
B: Functional Form $\chi^2(1)$ = .56083[.454] F(1, 78)=.48369[.489]
C: Normality $\chi^2(2)$ = .69855[.705] Not applicable
D: Heteroscedasticity $\chi^2(1)$ = .055141[.814], F(1, 89)= .053962[.817]
E: Predictive Failure $\chi^2(24)$= 26.9006[.309],F(24, 55) = 1.1209[.354]
F: Chow Test $\chi^2(12)$= 12.3475[.418],F(12, 67) = 1.0290[.433]

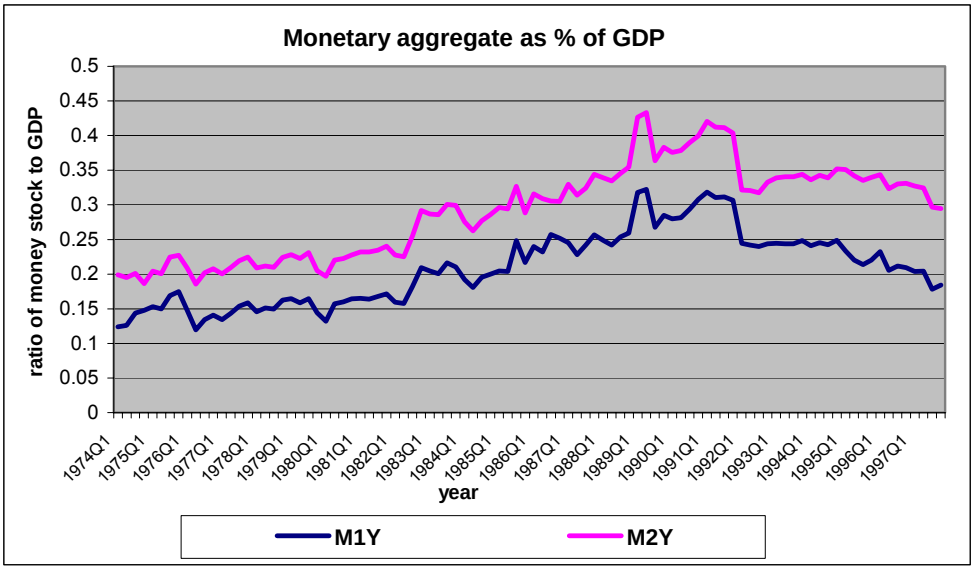
6. Conclusion and recommendation

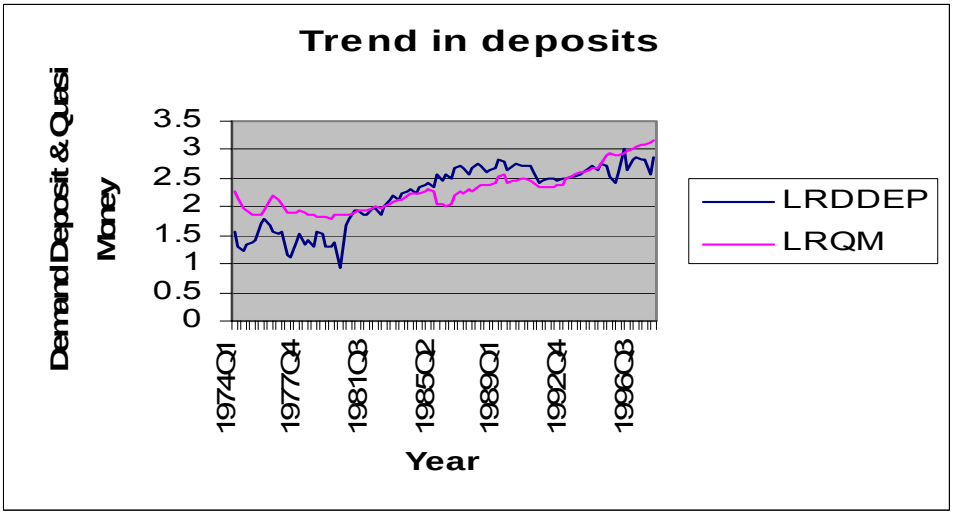
In this study, a money demand function has been estimated for Ethiopia. The sample period is from 1974q1 to 2004q4. The estimation has been done using Johansen's approach and the error correction model. The first step was the specification of co-integrating vectors for long run demand for narrowly and broadly defined monetary aggregates. Those vectors with coefficients, which conform to theoretical priors, have been used as a framework for the estimation of dynamic functions. The functions, which have been reported in the text, reveal the significant influence of lagged money stock, income, the rate of inflation, parallel market exchange rate and the variation in external monetary conditions, and the degree of credit restraint across the different models. The impact of deposit rate is found insignificant in most cases except in the model for broad money with aggregate income and price level. The degree of the

goodness of fit of the dynamic models and the OLS estimates of the levels improves with dis-aggregation of income and the rate of change of the price level.

Implication for stabilization policy

This study has estimated a stable demand for money for Ethiopia. However, there are shifts in the models starting with the devaluation of the currency and liberalization of asset prices with the onset of the process of SAP.





As the graphs show, there has been a significant movement in the demand for the different components of money. Following devaluation, the rate of interest was revised to raise the real rate. This resulted in a decline in demand deposit and a rise in the savings and time deposits. The long run negative and positive coefficients of the saving deposit rate for M_1 and M_2 in the cointegrating vectors with aggregate income and disaggregated price level testify to this fact. The growth in the savings deposit indicated in the above graphs and implied by the cointegration relations has resulted in the accumulation of excess liquidity in banks. Probably the rise in the lending rate in the post 1992 period might have contributed to the excess liquidity. A rising lending rate carries the possibility of crowding out private investors even if it is not deliberate. This is so because the crowding out of the private sector can be either direct or indirect (ex ante or post). The authorities were forced to reduce both the deposit rate and the lending rate again in order to counter the looming deflation. This repeated revision of the interest rate continued within short intervals. Up to 2002, the rate of interest was revised eight times, the final one resulting in the reduction of the deposit rate by 50%, from the previous 6% to 3%. It is to be recalled that after 1998, the ceiling on the lending rate was removed. The decision to reduce the deposit rate was based on the aim to improve the deflationary situation caused by a drastic fall in the export price of coffee and other food grains. However, it is yet to be seen whether the revision in the interest rate alone can eliminate the deflationary situation. Given the limited role of the rate of interest as a transmission channel, and the uncertainty created by repeated revision of the rate of interest, it may be difficult to expect a satisfactory response against deflation. Probably a more rational policy measure might be establishing domestic capital market and strengthening the implementation capacity of the reform measures and the further shift to indirect monetary control. The insignificance of policy variables like the rate of interest and the exchange rate in the models shows still structural obstacles in the economy as a whole and the financial sector in particular. And structural problems are caused not only by the composition of the economy but also by the policy make up. In this regard, there are still areas that need policy considerations. For example, the complete liberalization of the foreign exchanges operation, although there has been a growing step towards this after 1998 and the further deepening of the treasury bill trading.

Another policy issue concerns the impact of devaluation and trade policy of the government. The objective of devaluation was to improve the continuously growing deficit in the balance of payments. However, restrictions on imports were removed and the influx of import items increased tremendously. At the same time, the unsatisfactory performance of the export side and the international fluctuation of the prices of the primary products like coffee and hides reduced the foreign exchange earning of the country resulting in persistently enlarging deficit in the balance of trade.

Furthermore, it also seems possible that the growing demand for money in the post devaluation period might have been used in conducting the illegal trade that had become so rampant in the aftermath of political turbulence.

The massive resort to illegal cross border trade has greatly harmed the officially licensed businesses. Unable to withstand the almost dumping prices of the illegal traders, a number of businesses have been force to close down. The ever-expanding illegal trade has also a negative impact on government revenue in two ways. First, the illegal traders do not pay any tax since they are not legally registered. Second, the unlawful competition from the illegal businesses has reduced the earnings of the lawful businesses thereby resulting in reduced tax paid to the government.

The low revenue base is probably the major cause for growing fiscal deficit. The government has been tackling the problem of the deficit budget with the receipt from the sale of Treasury bill and external and internal borrowing. The auctioning of the Treasury bill was started with the aim of developing the inter-bank secondary market. However, this objective was defeated for the banks used their excess liquidity solely for the trade in the Treasury bill. Again a more rational policy might be the adoption of measures that may facilitate the development of secondary markets and strengthen the measures of indirect control. The government also needs to put in place a sound trade policy, which will balance between the liberalization of imports and the protection of domestic production. It must be kept in mind that liberalization of trade should take into account the specific conditions of countries. Boots of the correct size and quality are needed.

Another point of policy concern is the low (0.045)/0.3) coefficient for rural income showing that growth in rural income results in a modest demand for money. The explanation is that growth in rural income results in the growth of own consumption and non-monetized components of income thereby creating discrepancy between the growth in income and the growth in the demand for money. This tendency of a slow growth in the demand for money in rural areas must be countered with exchange oriented rural development policy. This demands, among other things, the expansion of off-farm activities and small-scale rural industries, which can serve as a bridge to integrate the rural and the urban areas. It seems more plausible to accept the view that the use of money and the development of exchange with money can bring about the desired improvement in the life of the rural population. Furthermore, a policy that creates a sound marketing facility for livestock, especially in the pastoral areas, is needed. The pastoral areas lose a lot as a result of illegal cross border trade in livestock. The creation of better marketing for other agricultural products is also of paramount importance. The recent experience in the country with the crisis caused due to inability of the rural population to sell surplus food grains is a signal for the Agricultural-led-development strategy about what is in stock for unbalanced growth

between agriculture and other sectors. Thus while it may be necessary to give greater emphasis to an accelerated development of agriculture, it is equally necessary to give emphasis to the growth and development of other sectors.

One of the findings is that the rate of inflation plays a significant role in shaping the short run behavior of agents. Hence the authorities have been targeting inflation to ensure macroeconomic stability. The authorities have been targeting inflation to a single digit rate. This has been so in accordance with the IMF principles of Enhanced Structural Adjustment Facility (ESAF prior to 1999) and Growth and Poverty Reduction Facility (GPRF since 1999). The average rate of inflation has been on average about 4% to 6 % between 1997 and 2003/2004. This seems to be partly the result of the decline in the prices of food grains as a result of good harvest due to favorable weather condition during part of the sample period. On the other hand, the government's commitment to tight fiscal and monetary policy as per the agreement with the IMF, has also limited the rate of inflation to the single digit low level. However, it is questionable whether the policy of the single digit inflation rate can result in accelerated growth as it has been expected. There are empirical studies, some of them by economists within the IMF, which indicate higher thresholds for developing countries (Khan, S). Such studies report different thresholds for developed and developing countries. The thresholds are lower for industrialized economies than for the developing economies. Khan reports that the positive effect of inflation on growth is below a 5% rate whereas it ranges up to 18% of inflation for the developing countries. Further, the present study gives about a 10% revenue maximizing rate of inflation. Thus, the authorities should negotiate for a rate of inflation of about 10% for growth to pick up from the present low level. Under the GPRF agreement, the government's borrowing from domestic banks has been limited to a mere one billion birr and monetary expansion has been further curbed by strictly observing the situation in the credit to the private sector. External borrowing is to be limited mainly to concessional loans. The demand for m2 has increased as a result of growth in all the components of deposit. There is also a build up in excess liquidity of banks partly due to a decline in the demand for credit. It seems that the achievement of macroeconomic stability is associated with the undesirable deflationary situation. The attainment of macroeconomic stability is a necessary policy objective. However, it is only one aspect of economic reform programs. The other equally important aspect is growth and development of the economy. There cannot be a sustainable stability without growth that can improve the life of the people. The trend in growth reported over the past couple of years should be complemented with policies that further strengthen the participation of the private sector.

Another important policy relevant finding of the study is the effect of the measure of capital mobility shown in the long run equations. A gap between domestic and foreign interest rates and exchange rate induces domestic agents' demand for foreign

assets. The measure of capital mobility has a significant negative coefficient. This shows the necessity to give due consideration to international monetary policy in the formulation of domestic policy. In sum, the econometric result from this study shows the existence of stable long run and dynamic money demand function for Ethiopia despite liberalization measures after 1992. However, there has been some adjustment in the asset portfolio holding of the private agents. But the preference for liquidity is still high showing slower response of agents to structural adjustment. A more rigorous policy that strengthens the process of privatization and a faster move towards more indirect control can be more rational to pursue. It is also of paramount importance to give due consideration to external monetary and financial development in the formulation of domestic stabilization policy.

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Summary of result of unit root test quarterly data

Variable	WITHOUT TREND		WITH TREND	
	DF value	ADF(4)	DF	ADF(4)
M1	.33304(-2.8849)	0.7508(-2.8857)	-2.0540(-3.4469)	-2.2539 (-3.4478)
M2	1.1620	1 .0954	-1.7958	-1.8193
Y	-.26192	-.28685	-1.2152	-1.701
Pi	-2.4298	-1.9822	-1.3648	-2.2877
Pmer	-1.1184	-1.2398	-1.3620	-1.3976
C	-2.3556	-1.5417	-2.2000	.8739
Yr	-.60914	-.71197	-1.4208	-1.4856
UY	-.037592	-.003091	-1.4583	-1.4089
LI	-1.6851	-2.2020	-1.8158	-2.2562
Lifex	-6. 1413(-2.8851)	-.3363(-2.8859)	-6.6603(--3.4576)	-4.1371(-3.4481)
Pa	-3.0341	-.79358	-4.63355	-1.7241
Ph	-2.7514	-2.2838	-1.2570	-1.5287
Px	-2.0883	-1.7945	-1.3653	-2.7064
Δm1	-10.3178	-4.689(-2.8859)	-10.3747(-3.4469)	-4.9621
Δm2	-9.6174	-4.5626	-9.8317	-4.9364
Δy	-109651	-4.6079	-11.438	-4.8833
π	-15.4017(-2.8853)	-7.8881	-15.337	-7.8536
Δprm	-9.5582	-4.1038	-9.5974	-4.2241
Δc	-12.8614	-3.1728	-12.9551	-3.4542
Δyr	-10.8432	-4.5139	-11.0587	-4.8228
Δuy	-11.1639	-4.4273	-11.4906	-4.8808
Δi	-10.1271	-4.2407	-11.4906	-4.2971
Δlifex	-16.4817	-6.8612(-2.8861)	-16.4119	-6.8366

The figures in parenthesis represent critical value at 95%

Test of cointegration for M_1

List of eigenvalues in descending order:

51247	30295	15308	10727	7517E-3

Null	Alternative	Statistic	95%CV	90% CV
r = 0	r>= 1	160.4405*	70.5980	66.4860
r<= 1	r>= 2	75.6698*	48.2800	45.2290
r<= 2	r>= 3	33.0836*	31.5250	28.7090
r<= 3	r>= 4	13.4779	17.9530	15.6630
r<= 4	r = 5	.088732	8.1760	6.5030

```
 * =significant at 5%.
```

LRM2 LRY DINFR BDEP LI LIFEX

List of additional I(0) variables included in the VAR:

T SC1 D991 D992 D998

List of eigenvalues in descending order:

.44617 .29323 .15529 .14106 .083732 .2983E-6

Null	Alternative	Statistic	95% CV	90% CV
r = 0	r = 1	69.1359*	39.4260	36.3460
r<= 1	r = 2	40.6041*	33.3190	30.8410
r<= 2	r = 3	19.7450	27.1360	24.7830
r<= 3	r = 4	17.7906	21.0740	18.9040
r<= 4	r = 5	10.2313	14.9000	12.9120
r<= 5	r = 6	3490E-4	8.1760	6.5030

LRM2 LRY DINFR BDEP LI LIFEX

List of additional I(0) variables included in the VAR:

T SC1 D991 D992 D997 D998

List of eigenvalues in descending order:

.44846 .29368 .16166 .14226 .081563 ` 1245E-4

Null	Alternative	Statistic	95% CV	90% CV
r = 0	r = 1	69.6204*	39.4260	36.3460
r<= 1	r = 2	40.6796*	33.3190	30.8410
r<= 2	r = 3	20.6304	27.1360	24.7830
r<= 3	r = 4	17.9537	21.0740	18.9040
r<= 4	r = 5	9.9546	14.9000	12.9120
r<= 5	r = 6	0014563	8.1760	6.5030

STOCHASTIC PRODUCER PRICES AND SHOCK PERSISTENCE IN AGRICULTURE: IMPLICATIONS FOR FOOD POLICY AND PRICE INFORMATION[1]

Kindie Getnet[2], Wim Verbeke[3] and Jacques Viaene[3]

Abstract

Unstable product prices arising from shocks increase the uncertainties of producers and bias their subsequent price expectations and production decisions. This problem is known to be at the back of declining use of improved techniques by food crop producers. This paper investigates the time series properties of producer price data observed during the post-liberalization period for two major food crops in Ethiopia in order to understand whether prices are stochastic and shocks are persistent. The results obtained suggest non-stationary stochastic price dynamics and shock persistence in which price uncertainty is inherent, with a possible impact of negative bias in the expectation and production decisions of generally risk averting farmers. From a food policy point of view, negative bias in farmers' price expectations and production decisions, whenever prices follow a downward scenario, implies that agricultural market policy instruments meant for the promotion of food crop production might have very few chance of success unless accompanied by a strong market information service on prices. Moreover, policy interventions are recommended only to the extent that their impacts are predictable under a condition of non-stationary stochastic product prices and they do not result in negative shocks.

JEL: Q11, Q13, Q18
Keywords: Producer price; Non-stationary stochastic series; Shock persistence; Food production; Food policy

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1. Introduction

The premise of the agricultural market reform process in place in the developing countries since the early 1980s is that positive price signals will prompt producers to respond positively and rationally (Kherallah *et al*., 2000). Though the results are mixed, evaluation studies well addressed the impacts of the reform process in terms of market integration, price level, and supply response (e.g. Goletti and Babu, 1994; Alderman and Shively, 1996; Jayne and Jones, 1997; Badiane and Shively, 1998; Chilowa, 1998). In terms of food crop production, it has become clear from the evaluation results that the reform process had only a limited impact. Lack of market information is mentioned as one of the problems contributing to this limited success.

One of the necessary conditions for the reform process to prompt positive and rational production response in the developing countries is that producers have access to appropriate market information, including information on the true dynamics of the prices for their products. A failure could potentially lead toward bias in expectation formation and production decision. Unbiased production decision-making depends on understanding the true dynamics of prices to guide expectation formation in a way that is consistent with informationally efficient practice. The focus of the evaluation literature on market reform in the developing countries was thus far mainly on the final impacts of the reform process, leaving a knowledge gap with regard to farmers' awareness and perception of the true dynamics of prices during the liberalization period. A relevant question is therefore how smallholder farmers in the developing countries perceive the true dynamics of the prices for their products so that there is no bias in their production decisions arising from discrepancy between their expectations and the true price dynamics.

Generally, biased production decisions in association with product prices may arise from two possible sources. First, from a discrepancy between the true price dynamics and the farmers' expectation formations or, second, from expectation formation consistent to price dynamics, but with inherent bias. Therefore, as a part of the evaluation process and as information source to the process of food policy making in the developing countries, it is important to investigate what the true dynamics of product prices are and how farmers perceive and incorporate these dynamics into their price expectations and production decisions. This paper addresses the first of these issues in the context of smallholder food crop farmers in Ethiopia by investigating the true dynamics of the producer price time series of two major staples (white teff and white wheat).

Farmers are responsive to price signals (Stevens and Jabara, 1988) and,

consequently, base their production decisions on price expectations. Errors from price expectations will generally be high and systematic when the expectations are uninformed (Ravallion, 1987). Therefore, taking the general lack of market information in the developing countries into consideration, it could be hypothesized that producers' price expectation formation is not rational and can be improved through providing them with appropriate market information. By doing so, producers can be led towards making informationally efficient and unbiased production decisions. This is important especially in circumstances of price volatility without any predictive structure. The idea was yet introduced by Dahl and Hammond (1977) who acknowledged that agricultural producers become able to make profitable production and marketing decisions only if they well understand the price movements for their products.

Price volatility and consequent financial risks have been reported as major obstacles for high yield input use in agricultural production (Crawford *et al*., 2003; Snapp *et al*., 2003). In a liberalized agricultural market where product prices are discovered by the market forces instead of price setting, prices become generally unpredictable and it remains uncertain for the farmers to have reliable expectations about the likely price scenarios that will turn out. Such phenomena would lead to large and systematic forecast errors and, as manifestations of biased decisions on the part of farmers, to boycotting the use of improved production techniques and, eventually, to a substantial reduction in the amount of food crop production. The latter is contrary to the food self-sufficiency and food security objectives of a typical developing country.

Ethiopia is a good example where agricultural prices are deregulated following the market liberalization policy in 1990, as a result of which food crop prices became volatile and adoption of improved agricultural technologies slowed down (ADE, 1999). The effect was devastating in the food production sub-sector of the country in 1997 and 2000 when farmers became discouraged to use improved techniques such as fertilizer for food crop production following the low level of producer prices in the previous years (e.g. DOA, 2000a; DOA, 2000b). Because they refer only to the negative past price scenarios, most smallholder farmers since then tended toward biased food crop production decisions (reduction of fertilizer use) in order to avoid risk of failure to pay fertilizer debt in case product prices remain low. This phenomenon was a major set back against maintaining the momentum of rising food crop production in the country in most of the 1990s. One of the possible explanations is probably lack of appropriate information to farmers on how prices actually behave as policy markers and public agricultural extension programs fail to design and enforce effective market information delivery in Ethiopia (Tschirley *et al*., 1995). Market information service, together with efforts aimed at raising the educational level of farmers (Knight *et al*., 2003), could make a positive contribution towards promoting

farmers to adopt modern production techniques.

In the theoretical context, it has nowadays become clear that forecasts and specifications of relationships among economic variables are successful only to the extent that the time series properties of the variables under consideration are known *a priori* and can be taken into consideration for policy and business decisions. Like other areas of business forecast, it is indispensable to understand the time series properties of agricultural prices to make successful price forecasts (Jin and Frechette, 2002). An important distinction is between stationary and non-stationary stochastic time series processes. The former are processes in which basic characteristics such as the mean and variance are constant, while they are not and even difficult to calculate in the latter (Enders, 1995; Patterson, 2000). In the world of economic fluctuations (non-stationarity), expectations simply based on previously observed value lead to a systematic forecast error with the forecast results suffering from bias and loss of optimality.

Consequently, assessing the salient features of a time series is taken as a pre-requisite standard approach in recent empirical works involving economic time series. The information obtained could be applied to agricultural market analysis and, most importantly, to food policy decision-making. Policy makers can make use of such information to know how effective price stabilization interventions and other pro-agricultural production strategies would be and whether shocks from their policies or from other sources will have a transitory or permanent effect on agricultural prices. Moreover, it would be helpful to have insight into whether policy instruments meant for the promotion of food crop production should be accompanied with additional market information to avoid potential failure due to inherent bias on the part of producers about prices.

Studying agricultural prices is not a new phenomenon despite the little attention given to studying time series properties of agricultural prices (Jin and Frechette, 2002). Though there are a number of studies conducted for agricultural products using time series price data during the post-liberalization period, most of them are devoted to studying market integration, with less coverage of the time series properties of product prices to understand the true price dynamics on their own right and in association with the farmers' expectation formation. In the agricultural price literature, time series properties of product prices are addressed for other study purposes rather than to be studied and interpreted on their own as determinants of price expectations and production decisions. Because of this, it remains unclear whether farmers and policy makers always know the true dynamics of product prices and decide accordingly.

In view of these gaps, this paper tries to investigate the time series properties of the

producer prices of selected food crops observed during the post-liberalization period in Ethiopia, through testing unit root hypothesis, with the aim of generating useful information on the price behaviors for expectation formation, production, and food policy decision-making purposes. Concerning the hypothesis testing, we describe in detail how the appropriate testing framework is specified and we discuss the successive steps followed to ensure robust results. Particular attention is paid to minimize the type II error, which is common in unit root tests[4.]

The remaining part of the paper is organized as follows. First, a description is provided about models helpful in testing hypothesis about price dynamics, followed by the development of the empirical models and by the explanation of the data used in this study. Second, the testing strategies and the test results of the study are discussed. Finally, a conclusion is set forth in which the main results of the study and their implications are outlined.

2. Analysis of producer price dynamics

A class of univariate economic time series models is used in this study to understand the time series properties of producer prices through autoregressive representation. In a first order autoregressive process $AR(1)$, the current producer price P_t can be represented as the sum of a one period lagged value P_{t-1} and of an independent random error term ξ_t:

$$P_t = \varphi_1 P_{t-1} + \xi_t \qquad \textbf{(2.1)}$$

where φ_1 is the lag coefficient. In an autoregressive process of order k, i.e., $AR(k)$, (2,1) can be rewritten as

$$P_t = \varphi_1 P_{t-1} + \varphi_2 P_{t-2} + \ldots + \varphi_k P_{t-k} + \xi_t \quad t = 1, 2, \ldots, k \qquad \textbf{(2.2)}$$

The general first difference form of (2.2) can be specified as follows[5]:

$$\Delta P_t = \mu + \lambda P_{t-1} + \sum_{i=1}^{k} \eta_i \Delta P_{t-i} + \xi_t \qquad \textbf{(2.3)}$$

4 In statistical inference, type II error is referred to as the failure of the test result to reject an incorrect null hypothesis. Unit root test statistics are found less powerful to reject the null hypothesis of unit root when the alternative hypothesis is nearly unit root though not exactly unit root.

5 See Appendix 1 for the derivation.

where Δ is the difference operator, μ is constant, λ = $(\varphi_1 + \varphi_2 + ... + \varphi_K) - 1$, and η_i are coefficients of lagged differences.

In a typical economic time series, φ_1 in (2.1) takes a theoretical value bound between 0 and 1. When φ = 1, the value of P_t becomes just identical to the lagged value P_{t-1}, with the only difference accounted for by the random error term ξ_t. In that case the time series properties of the economic variable resemble that of the random error term and magnitudes of the differences between successive prices, denoted as ΔP_t, become equal to the magnitudes of respective current random error terms, hence the series is considered as a *random walk* process. Being random, these changes are independent of each other and have zero autocorrelation. If agricultural price movements exhibit such time series properties, they might be considered as non-stationary stochastic processes. Under such circumstances neither the autoregressive process $P_{t-1} + \xi_t$ nor the random error term ξ_t in (1) provides a mechanism to speculate about future price levels (P_{t+1}) and the effect of shocks never dies out as it cumulates over time (shock persistence)6. Hence, the best estimate for the producer price at time *t* is the price at time $t-1$ and the best estimate for the producer price that will prevail at time $t+1$ is the price at time t, rather than the prices in the remote past. Literally, assessing whether producer prices follow a non-stationary stochastic process and whether there is shock persistence becomes equivalent to testing a hypothesis whether the magnitude of the lag coefficient φ in autoregressive models such as (2.1) specified for the time series under investigation is equal to or less than unity, or whether λ in (2.3), a model specified in difference forms, is equal to zero in statistical terms. The importance of these unit root tests attracted a considerable amount of empirical research to evaluate the nature of economic time series (Xiao and Phillips, 1998; Patterson, 2000; Sarris, 2000).

3. Price data and models

The analysis of the time series properties of the producer prices of the two food crops is made using real price data observed on monthly basis from 1996M1 to 2000M12. The data are obtained from the Ethiopian Grain Trading Enterprise. The sample

[6] A random walk process is a non-stationary stochastic process resulting from the accumulation of shocks. For a process started at time *t* = 0, $P_1 = P_0 + \xi_1$, and $P_2 = P_1 + \xi_2 = P_0 + \xi_1 + \xi_2$. Consequently, the current observation of P_t in a random walk process becomes $P_0 + \sum_{i=1}^{t} \xi_i$ in which the effect of each shock is accumulated.

period is chosen in such a way that it represents the post agricultural market liberalization period in Ethiopia and that availability of continuous price data and deflator indices is ensured.

First order lag models were fitted for the producer prices of each food crop in their difference forms for testing the unit root hypotheses. The Akaike Information Criterion (AIC) is used as decision criterion on lag order selection. Unrestricted versions of the inferential models are specified as follows, with a constant and with a deterministic time trend variable, in addition to the lagged prices:

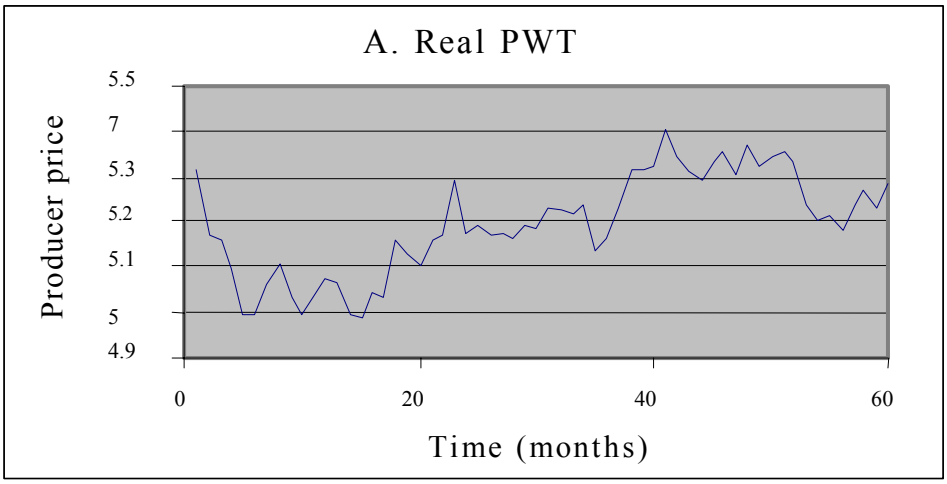
$$\Delta \ln PWT_t = \mu_1 + \lambda_1 \ln PWT_{t-1} + \eta_1 \Delta \ln PWT_{t-1} + \beta_1 T_1 + \xi_t \qquad \textbf{(3.4)}$$

$$\Delta \ln PWW_t = \mu_2 + \lambda_2 \ln PWW_{t-1} + \eta_2 \Delta \ln PWW_{t-1} + \beta_2 T_2 + \xi_t \qquad \textbf{(3.5)}$$

where PWT denotes the real producer price of white teff, PWW denotes the real producer price of white wheat, μ_1 and μ_2 are constants, λ_1, λ_2, η_1, η_2, β_1 and β_2 are coefficients, T_1 and T_2 represent deterministic time trends, and *ln* refers to natural logarithm.

The decision to include a constant and a deterministic time trend variable in each model and to hypothesize that each price series follows a non-stationary stochastic process is based on visual evidence from graphical representations of the respective time series. It can be observed from Figure 1.A that real PWT seems to have a sustained positive deterministic time trend, though not strong. On the other hand, there is a tendency for the successive values to follow the pattern of their immediate past values, which is an indicator of the presence of a unit root (stochastic trend). Slow decay in the autocorrelations of real PWT (Figure 1.B) is in support of the presence of a unit root in the series. This slow decay in the autocorrelations is an indicator of a long lasting impact of shocks on real PWT, which is a property of a series with non-stationary stochastic processes. The observation from Figure 2.A also indicates the presence of a positive, albeit weak, deterministic time trend in the real PWW. However, negatively ragged observations at the center and at the very end of the curve provide evidence for the view that the series is stochastic rather than deterministic. This is further supported by the nature of the autocorrelations observed in Figure 2.B, which decline slowly indicating presence of a unit root in the series.

Figure 1. A and B



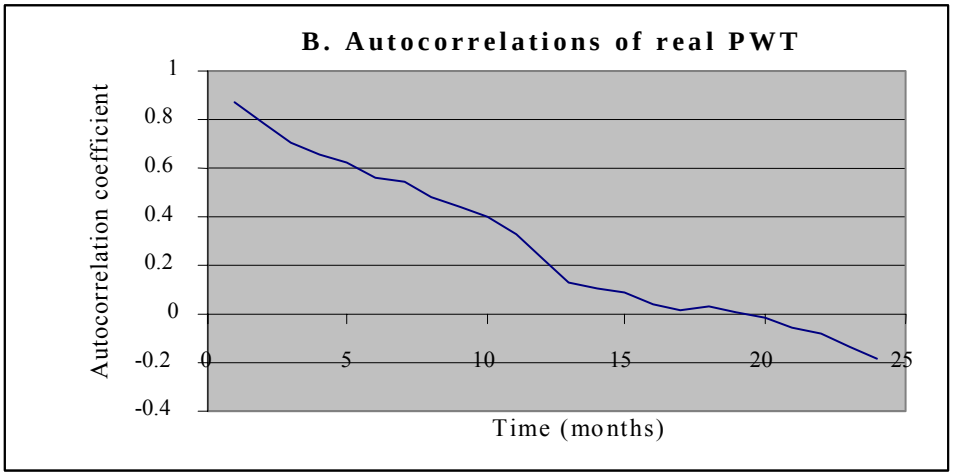
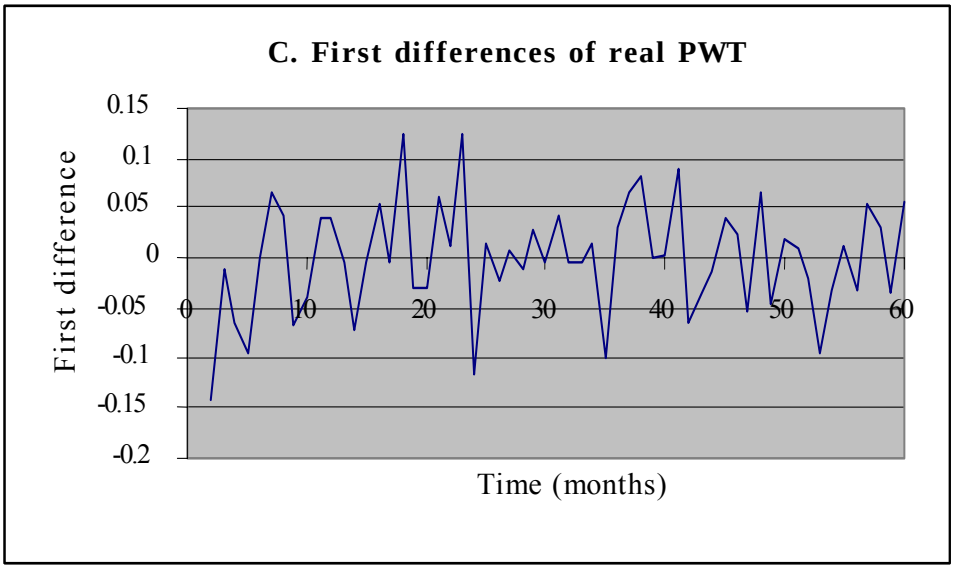


Figure 1. C and D



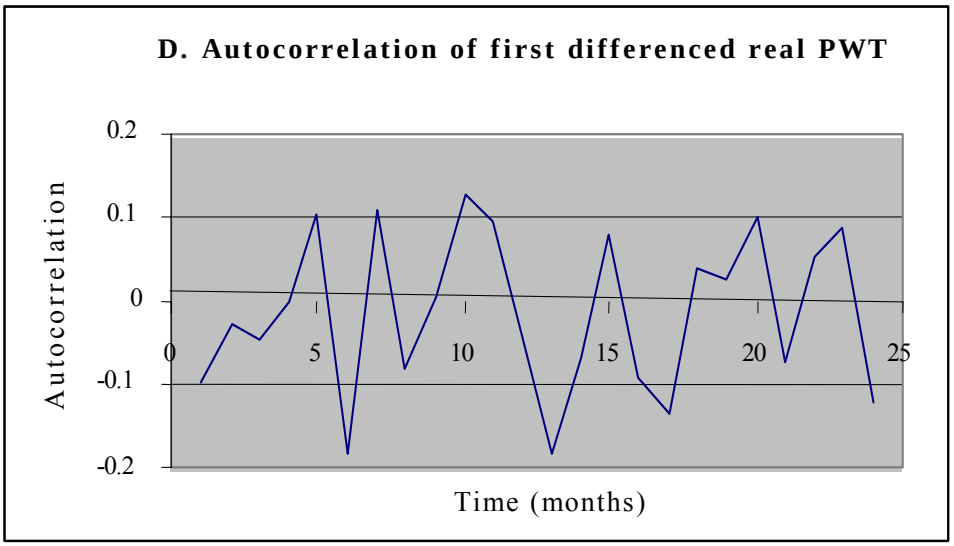
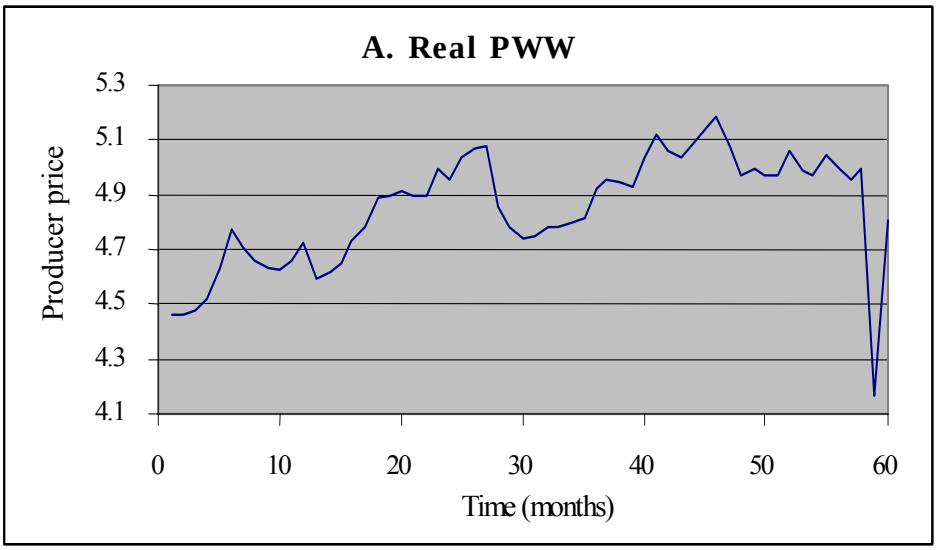


Figure 1

Real Price of White Teff (A), autocorrelations (B and D) and first differences (C) (1996M1 to 2000M12) (Figures in the graphs are natural logarithmic values)

Figure 2. A and B



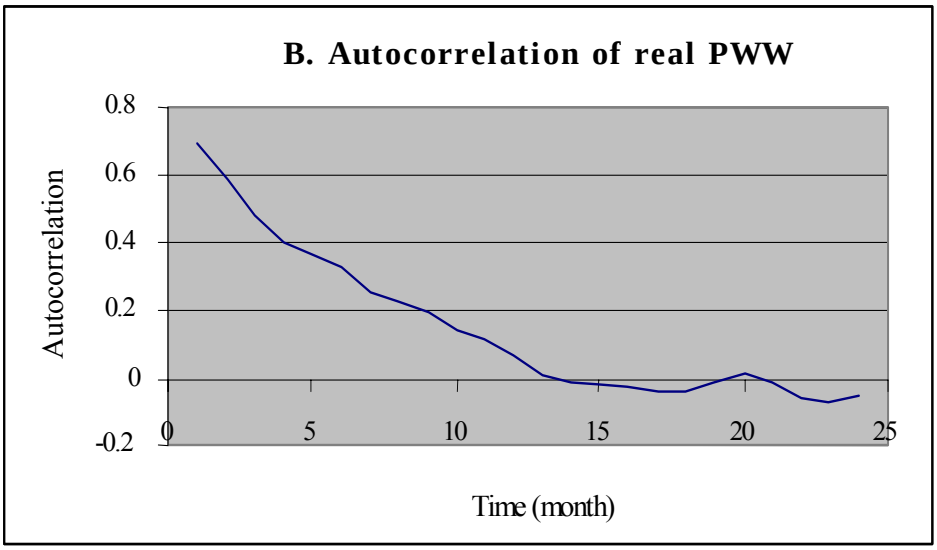
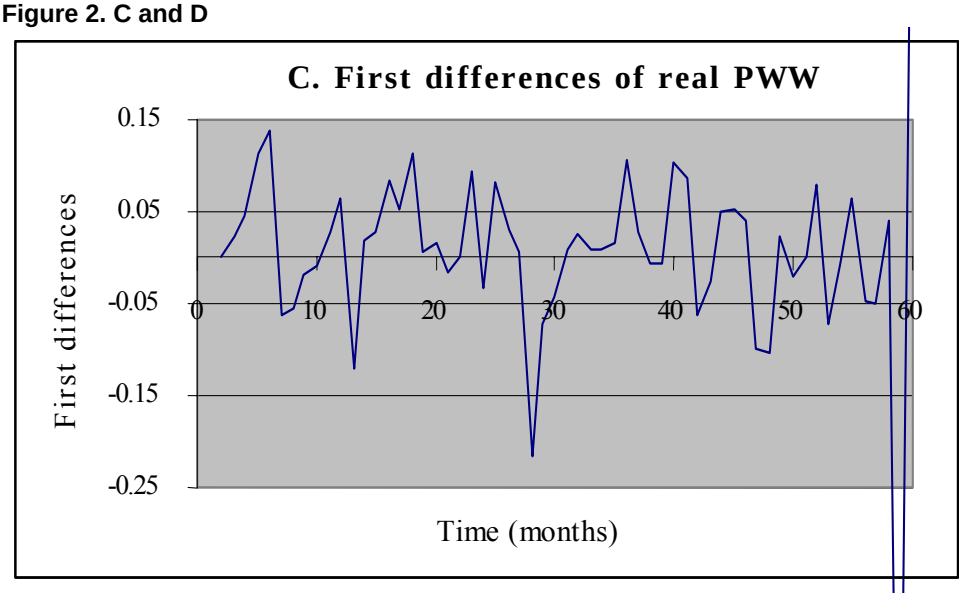


Figure 2. C and D



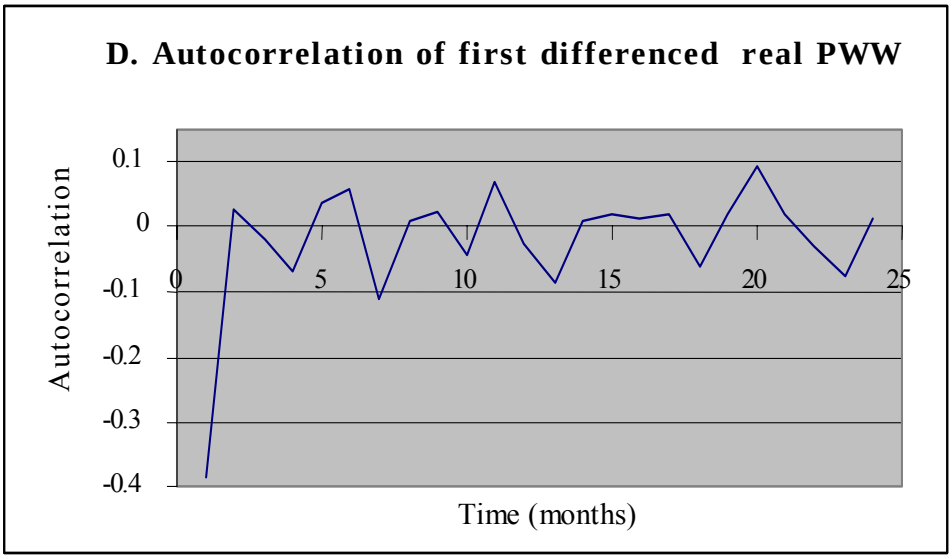


Figure 2
Real Price of White Wheat (A), autocorrelations (B and D) and first differences (C) (1996M1 to 2000M12) (Figures in the graphs are natural logarithmic values).

Generally, the visual evidence from Figure 1.A and Figure 2.A, in support of either a deterministic or a stochastic trend, is inconclusive. The respective autocorrelation figures (Figure 1.B and Figure 2.B), however, indicate presence of unit root in the series in the sense that the autocorrelations decay slowly. On the contrary, graphs for the first differences of real PWT and real PWW seem to have a zero mean, indicating absence of unit root. Relatively speaking, however, it can be seen that the curve in Figure 1.C lacks successive crossing of the expected mean value (zero), because of some positive and some negative accumulations, successively. Though this could cast a doubt about the presence of a unit root in the first differences of real PWT, fast decline in the autocorrelation coefficients of first differences of both series to magnitudes near zero even for the most recent lags (Figure 1.D and Figure 2.D) indicates that first differences do not have unit root.

As discussed above, visual impressions from the graphical representations give indications only about the dominant properties of a time series, without leading to inferential conclusions. As such, the above discussed visual impressions could not replace formal tests for a unit root since they are unable to unambiguously distinguish between near unit root and unit root processes. Formal test procedures for a unit root proceed by specifying and estimating appropriate time series models from which statistical inference is made. For this purpose, three autoregressive models are specified for each producer price series, depending on whether a constant and a deterministic time trend are included. The models are estimated from average monthly real producer price data observed for five successive years (1996M1 to 2000M12), using ordinary least squares estimation techniques. The estimated models are shown in equation (3.6) to (3.11). The marginal significance levels (msl) values show that there is no indication for serial correlation in the error terms at the conventional levels of significance; hence, the models are robust and tentatively adequate for statistical inference. Figures in parenthesis are *t*-ratios and RSS stands for the residual sum of squares. Figures in square brackets are marginal significance levels for serial correlation in the error terms.

Models with a constant and with a deterministic time trend:

$$\Delta \ln PWT_t = 1.50 - 0.30 \ln PWT_{(t-1)} - 0.03 \Delta \ln PWT_{(t-1)} + 0.002T + \xi_t \quad \text{[msl = 0.41]} \quad \textbf{(3.6)}$$

(3.11) (-3.12) (-0.02) (2.68) RSS = 0.13259

$$\Delta \ln PWW_t = 0.89 - 0.18 \ln PWW_{(t-1)} - 0.46 \Delta \ln PWW_{(t-1)} - 0.52T + \xi_t \quad \text{[msl=0.37]} \quad \textbf{(3.7)}$$

(1.21) (-1.12) (-2.17) (-0.52) RSS = 0.96681

Models with a constant but without a deterministic time trend:

$$\Delta \ln PWT_t = 0.52 - 0.10 \ln PWT_{(t-1)} - 0.05 \Delta \ln PWT_{(t-1)} + \xi_t \quad \text{[msl = 0.56]} \quad \textbf{(3.8)}$$

(1.57) (-1.56) (-0.49) RSS = 0.15023

$$\Delta \ln PWW_t = 1.05 - 0.21 \ln PWW_{(t-1)} - 0.42 \Delta \ln PWW_{(t-1)} + \xi_t \quad \text{[msl = 0.37]} \quad \textbf{(3.9)}$$

(2.22) (-2.21) (-2.74) RSS = 0.96832

Models without a constant and without a deterministic time trend:

$$\Delta \ln PWT_t = 0.32 \ln PWT_{(t-1)} - 0.10 \Delta \ln PWT_{(t-1)} + \xi_t \quad \text{[msl=0.51]} \quad \textbf{(3.10)}$$

(0.24) (-0.78) RSS = 0.15692

$$\Delta \ln PWW_t = 0.36 \ln PWW_{(t-1)} - 0.56 \Delta \ln PWW_{(t-1)} + \xi_t \quad \text{[msl = 0.46]} \quad \textbf{(3.11)}$$

(0.10) (-0.34) RSS = 1.0547

4. Testing strategy

For the unit root hypothesis testing, we used a stepwise movement from the most unrestricted versions of the models to the restricted ones. The test statistics used are the augmented Dickey-Fuller unit root test statistics (Dickey and Fuller, 1981), as these are the most commonly used in empirical work (Xiao and Phillips, 1998; Patterson, 2000; Sarris, 2000).

The standard procedure for a unit root test in empirical economic analysis is to start with the most unrestricted model, i.e., the model with a constant and with a deterministic time trend (if the nature of the time series suggests so). Figure 1.A and Figure 2.A indicate presence of a sustained positive deterministic time trend in each of the price series, though not strong. Based on this observation we started our test using the strategy that tests for the null hypothesis of a stochastic trend $(\lambda = 0)$ against the alternative hypothesis of a deterministic time trend $(\beta \neq 0)$ in the unrestricted model of each price series. The constant term is not restricted while testing this hypothesis because it should be there for the trend to be sustained in the direction of the sign of the constant. Therefore, a joint null hypothesis is formulated to test only for ($\lambda = \beta = 0$) against the alternative (λ and/or $\beta \neq 0$) in (3.6) for real PWT and in (3.7) for real PWW. The null hypothesis is that of a stochastic process

with a constant and without a deterministic time trend. The alternative hypothesis can take different forms provided that the null hypothesis is rejected.

At this step of the test procedure we made sure that both the null and the alternative hypotheses are nested in the estimated models (3.6) to (3.9). The joint null hypothesis of a stochastic process ($\lambda = \beta = 0$) in real PWT is nested by (3.6) and the alternative by (3.8). Accordingly, the null hypothesis claims that (3.6) generates producer prices of white teff while the alternative claims that (3.8) generates them. The joint null hypothesis of a stochastic process ($\lambda = \beta = 0$) in real PWW is nested by (3.7) and the alternative by (3.9). The null hypothesis here claims that (3.7) generates producer prices of white wheat and the alternative claims that it is (3.9) that generates producer prices of white wheat. The type of test statistic used to test the above null hypothesis, in each series, is Φ_3, which is a type of F-statistic[7].

Table 1: Autoregressive models, hypotheses, and associated test statistics for unit root test

Model type	Null hypothesis	Alternative hypothesis	Test statistic	
			Type	Calculated value
$\left[\begin{array}{c}\Delta P_t = \mu + \lambda P_{t-1} + \eta \Delta P_{t-1} + \\ \beta T + \xi_t\end{array}\right]$	$\lambda = 0$, $\beta = 0$ Stochastic process without a deterministic time trend.	$\lambda \neq 0$ and/or $\beta \neq 0$	Φ_3	4.95[f] 2.45[w]
	To confirm the test result (i.e., whether the null is truly rejected by Φ_3), test directly for a unit root ($\lambda = 0$ as a null).	$\lambda < 0$	$\hat{\tau}_\beta$	-3.12[f] -1.11[w]
$\Delta P_t = \mu + \lambda P_{t-1} + \eta \Delta P_{t-1} + \xi_t$	$\mu = 0$, $\lambda = 0$ Stochastic process without a constant.	$\mu \neq 0$ and/or $\lambda \neq 0$	Φ_1	2.45[f] 4.91[w]
	To confirm the test result (i.e., whether the null is truly rejected by Φ_1), test directly for a unit root ($\lambda = 0$ as a null).	$\lambda < 0$	$\hat{\tau}_\mu$	-1.56[f] -2.21[w]

3 $\Phi_i = [(RRSS - URSS)/r]/[(URSS/T-K)]$, where *RRSS* = Restricted Residual Sum of Squares, *URSS* = Unrestricted Residual Sum of Squares, *r* = number of parametric restrictions, *T* = number of observations used in estimation, and *K* = number of parameters in the unrestricted model.

$\Delta P_t = \lambda P_{t-1} + \eta \Delta P_{t-1} + \xi_t$	$\lambda = 0$	$\lambda < 0$	$\hat{\tau}$	0.24^f 0.10^w

Note: *f* stands for the values calculated on real producer prices of white teff and *w* stands for the values calculated on real producer prices of white wheat.

5. Results and discussion

The calculated value of Φ_3 is 4.95 for real PWT and 2.45 for real PWW. These values are compared with the Dickey-Fuller (1981) critical values (6.78 and 9.84) at 5% and 1% significance levels, respectively, for a sample size of 50 (the nearest entry to our sample size of 60). Since the calculated values are below the critical values, the null hypothesis of a stochastic process with a constant and without a deterministic time trend is not rejected for real PWT and real PWW.

While this result could lead us to conclude that the two series are consistent with stochastic processes, two facts make it necessary to further proceed with the test in search of further evidence to support the result. One is that the Φ_3 test has a two-sided alternative hypothesis, hence loss of power against the likely departure of the alternative hypothesis from the null. Therefore, it is necessary to use a test statistic with a one-sided alternative hypothesis, in order to seek additional confirmation about the reliability of the results from the Φ_3 test. The other fact is that generally unit root tests in unrestricted models are weak against the alternative hypothesis, possibly because of the inclusion of unnecessary regressors such as a constant and a deterministic time trend. To minimize the chance of type II errors from the Φ_3 test results, we used a test statistic τ_β that tests for a single null hypothesis of a unit root ($\lambda = 0$) against a one-sided alternative hypothesis of a deterministic process ($\lambda < 0$). This test is conducted directly in (3.6) for real PWT and in (3.7) for real PWW. The calculated τ_β test statistic is -3.12 for real PWT and -1.11 for real PWW. These calculated values for the τ_β test statistic are compared with the critical values (-3.49 and -4.14) at 5% and 1% significance levels, respectively, for a sample size of 50. Because the calculated values of τ_β test statistic are lower in absolute value than the critical values, the null hypothesis of a unit root is not rejected for both series. This result gives an additional confirmation to the Φ_3 test result.

To see whether the failure of the first test (Φ_3 test) to reject the null hypothesis of a unit root is because of inclusion of unnecessary deterministic regressors (i.e., deterministic time trend variable), we re-estimated (3.6) and (3.7) without a

deterministic time trend variable as a regressor and obtained (3.8) and (3.9), respectively. The necessity of exclusion of the deterministic time trend variables from the models is also suggested by the fact that the hypothesis ($\beta = 0$) in the joint null of the Φ_3 tests is not rejected. Model (3.8) and model (3.9), specified with a constant but without a time trend variable, are then used to test for a unit root with the joint null hypothesis ($\mu = \lambda = 0$) using the Φ_1 test statistic. This null is adopted in order to see whether the role of the constant term μ is significant in the series. The calculated values of Φ_1 are 2.45 for real PWT and 4.91 for real PWW . These values are compared with the critical values (4.81 and 6.96) at the 5% and 1% significance levels, respectively, for a sample size of 50. While the calculated Φ_1 statistic for real PWW is insignificant only at the 1% significance level, it is insignificant both at the 5% and 1% significance level for real PWT . Hence, the major evidence from the Φ_1 test leads to non-rejection of the null hypothesis of a unit root without a constant for each price series. According to this null hypothesis, each price series is generated by a non-stationary stochastic process without a constant. The finding that the processes are stochastic and have no constant implies that it is equally likely for each of the two series to move downward from the current direction that seems moving upward, as depicted in Figure 1.A and 2.A. This is because there is no minimum (constant) price level that regulates the series from moving into one or the other direction.

For the same reason that the Φ_1 test looses power against the alternative hypothesis (because it has a two-sided alternative), a test statistic τ_μ with a one-sided alternative hypothesis is applied. This test statistic tests directly for a unit root in the models with a constant but without a deterministic time trend ((3.8) and (3.9)). The null hypothesis under this test statistic is of a unit root ($\lambda = 0$) against the alternative hypothesis of a deterministic series ($\lambda < 0$). The calculated values of τ_μ are -1.56 for real PWT and -2.21 for real PWW . When compared with the critical values (-2.92 and -3.57) at the 5% and 1% significance levels, respectively, for a sample size of 50 observations, these values are lower in absolute value and lead to non-rejection of the null hypothesis that each series is consistent with a stochastic process without a constant.

These findings in favor of the null hypotheses under the Φ_1 and τ_μ tests bring the test sequence to its end. However, to see whether the constant term (as unnecessarily included regressor) might have minimized the power of Φ_1 and τ_μ

tests, and because the exclusion of the constant μ is not rejected in the joint null hypothesis ($\mu = \lambda = 0$) under the Φ_1 test, (3.10) and (3.11) are estimated without a constant and without a deterministic time trend. These models could be used to test for the null hypothesis of a unit root ($\lambda = 0$) using the τ test statistic. However, the alternative hypothesis of this null is a deterministic series with zero mean, which does not represent the characteristics of the two price series as there could be no zero mean for producer prices. Therefore, this test is not proceeded with and the entire test procedure ends here with the main finding that each of the two price series follows a non-stationary stochastic process8. According to the test results, (3.10) and (3.11) are the appropriate models for real PWT and real PWW, respectively. These models without a constant and without a deterministic time trend are chosen as suggested by the non-rejection of the null hypotheses under Φ_3 and Φ_1 tests in that the Φ_3 test results suggest exclusion of the deterministic time trend term and the Φ_1 test results suggest exclusion of the constant term.

6. Conclusions and implications

Occasionally low and unstable producer prices increase farmers' uncertainties. Through biasing farmers' expectations and production decisions, such phenomena are known to be at the back of the declining use of improved techniques for food crop production in Ethiopia in recent years. Price expectations based only on the past price scenarios of a series lead to biased and non-optimal production decisions. If producers are preoccupied with occasionally low prices observed in the past, their successive production decisions are at risk of being unnecessarily adaptive to these price signals, with negative consequences on the food self-sufficiency and food security status of the farm households and the country.

This study tried to investigate the true price dynamics of two staples in Ethiopia in order to know if actual price behaviors could explain the declining use of improved production techniques for food crop production in the smallholder agriculture of Ethiopia. This is approached in terms of testing unit root hypotheses for producer price data observed from 1996M1 to 2000M12. Different univariate autoregressive models were specified and estimated for each price time series depending on

8 Each producer price series is also tested for a possible single structural break due to the Ethio-Eritrea border conflict during the sample period (T_b = May 1998), using the Innovative Outlier Augmented Dickey-Fuller (IOADF) test of Perron (1989). The test results for each series do not reject the null hypothesis of unit root against the alternative of trend stationary series with a single structural break. The $\tilde{\tau}_A$ statistics for producer price of white teff and white wheat are -3.26 and 0.91, respectively, while the critical values are -3.76 at the 5% and -3.46 at 10% significance level for $\lambda =$ 0.50.

whether or not a constant and a deterministic time trend are included. Consistency of the results from these different tests, in the direction of the null hypotheses of a unit root, reinforced the prior impression from the visual evidences that the two series are consistent with non-stationary stochastic processes. This view was typically evident from the slow decays in the autocorrelations of levels (Figure 1.B and Figure 2.B) and from the frequent crossings of the autocorrelations of differences on the zero mean (Figure 1.D and Figure 2.D).

When product prices follow a non-stationary stochastic process, it is most likely that the direction of their movement through time persists, yet with variations due to unpredictable random factors. As a consequence of such unpredictable random factors in such series, the best expectation farmers could have about the future price level is the immediate past price level. This is because, through exhibiting a random walk behavior, the price level is known to have a high probability of persistence in a particular direction. Hence, farmers tend to adapt their price expectations to the immediate past price levels, the scenario which they know to persist and are able to predict. Nevertheless, the resulting production decisions that depend only on the past price levels are most likely to be biased and not fully informed for they lack information on the current and future phenomena (informationally inefficient practice). In this regard, the results show the need for market information provision to farmers if the policies meant for increasing food production are to be successful. This is because the bias from the stochastic properties of their prices could cause the farmers to overlook the importance of incorporating recent developments and information in their production decisions. Partly, farmers may opt for adaptive choices in making production decisions simply because they lack appropriate information about the recent and prospective market situations to make rational instead of adaptive choices. Therefore, we suggest government commitment to provide timely information on the price movements and other market phenomena like weather and the evolution of input prices that are known to influence producer prices. By doing so, it is possible to help farmers making optimal and informationally efficient production decisions that incorporate the past, current, and future market outlook.

The finding of a non-stationary stochastic process in producer prices provides useful information that needs to be considered in making production and policy decisions. First, the stochastic behavior of producer prices implies that the seemingly increasing tendencies in the prices have random behavior, with the possibility of direction reversal at any time. This suggests that the sequential changes (positive or negative) are not with fixed but random magnitude and direction, though the chance to persist in the particular direction is high. As a result, there is the problem of price unpredictability based on previous observations. In their autoregressive form, (10) and (11) allow back reference that is limited only to the prices of the last two months.

This very limited predictive structure informs that the occasionally low prices like those that occurred in 1997 and 2000 should not influence farmers' production decisions without time limit. Instead, given appropriate market information, the only best estimate of a future price level of each food crop is the price level prevailing during the time of such decision-making. After all, considerable advantages could have been taken from the rising moments of producer prices during most of the periods from 1996M1 to 2000M12 as seen from Figure 1.A and 2.A had the bias and reference of farmers back to the preceding few bad price scenarios been avoided. It is difficult to know the movement of each price series *a priori* and to extrapolate them into the future. As such, decision-making based on the bad experience of the situation of 1997 and 2000 and derailing from optimal investment in crop production are irrational. This is evident from the experiences that farmers faced since the harvesting season of the 2005/2006 production year during which food crop prices spike and persist at historically high levels.

Second, for agricultural and food policy makers the results from this study inform that particular events of price increase or decrease should not be regarded as bases for a long-term policy and strategy making purpose, such as for devising long-term price stabilization intervention schemes. This is because such price phenomena are subject to stochastic processes to be firmly relied upon. Instead, we suggest an approach that is responsive to price shocks only when deemed necessary.

Third, the finding of a stochastic process is also an indicator of persistence of price shocks unless offset by another counteractive phenomenon. Price movements due to shocks are sustained in the direction of the departure from the long-run average, with no tendency to return to their previous level in the near future (for example, the positive price trend since the harvest period of the 2005/2006 production year). As these shocks may also arise from economic policies that are not intentionally directed to prices, but with implications on prices, policy makers should assess their policy decisions *ex-ante* in a far-sighted and wider perspective. In this regard the result obtained corroborates that of Dercon (2004) that concludes about the persistent effect of shock factors such as rainfall and famine in Ethiopia.

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Appendix 1: Derivation of augmented Dickey-Fuller model

According to Fuller (1976), a second order autoregressive process such as $P_t = \mu + \varphi_1 P_{t-1} + \varphi_2 P_{t-2} + \xi_t$ can also be written as

$$P_t = \mu + (\varphi_1 + \varphi 2)P_{t-1} - (\varphi_2)(P_{t-1} - P_{t-2}) + \xi_t \tag{1.1}$$

By subtracting P_{t-1} from both sides, the autoregressive process in (1.1) can be specified in a first difference form as follows:

$$\Delta P_t = \mu + \lambda P_{t-1} + \eta_1 \Delta P_{t-1} + \xi_t \tag{1.2}$$

where $\lambda = (\varphi_1 + \varphi_2)$ and $\eta_1 = -\varphi_2$. Accordingly, the general first difference form for a *k* order autoregressive process takes the form of

$$\Delta P_t = \mu + \lambda P_{t-1} + \sum_{i=1}^{k} \eta_i \Delta P_{t-i} + \xi_t \tag{1.3}$$

where Δ is the difference operator, λ = $(\varphi_1 + \varphi_2 + ... + \varphi_K) - 1$, η_i are coefficients of lagged differences $(\eta_1 = -(\varphi_2 + \varphi_3 + ... + \varphi_k)$, $\eta_2 = -(\varphi_3 + ... + \varphi_k)$, …, and $\eta_{k-1} = -(\varphi_k))$.

WHAT DO FARMERS FINANCIALLY LOSE IF THEY FAIL TO USE IMPROVED SEEDS? SOME ECONOMETRIC RESULTS FOR WHEAT AND IMPLICATIONS FOR AGRICULTURAL EXTENSION POLICY IN ETHIOPIA[1]

Edilegnaw Wale[2]

Abstract

Before making any recommendation for the use of improved seeds, policy makers have to ensure that the improved seeds are superior to the local ones. To generate information on the financial viability of improved seeds, this paper computes the gross margin that farmers lose when they fail to use these inputs. Using the switching regression method, it then examines the contextual factors that affect the income foregone if farmers fail to use improved seeds.

The study is based on the fifth round of the Ethiopian rural household survey data taking wheat as a case. The estimated foregone gross margin ranges from 277 to 886 Birr per hectare and the total gross margin foregone at the national level ranges from 295 million to 946 million Birr per year. On the whole, the results suggest that, even though failure to use improved seeds involves foregoing financial benefits, it varies across farmers and farming systems. Not all farmers forego equal financial benefits.

The regression results show that the gross margin foregone increases with labour use, fertilizer use, farmers' experience with the extension package, wheat marketing, rainfall suitability, and wheat price index. On the contrary, it decreases with plot quality, education, input price index, oxen ownership, and chemical use. The results imply that improved seeds will have better income generating capacity when accompanied by other complementary services. Agricultural extension policy should establish targeting principles based on the comparative advantage of the respective seeds. On the whole, blanket recommendation of improved seeds for all farmers and farming systems across the board has to be re-visited.

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1. Introduction

Seeds are the basic inputs in crop production. To improve agricultural production and productivity in developing countries, adoption of improved seeds is believed to have a key role to play. However, because of the incompatibility of farmers' socioeconomic and agro-ecological environment to the production and marketing of improved seeds, productivity can not be enhanced by simple replacement of the local seeds by the improved ones3. In some contexts, the improved seeds may not be superior to the local ones.

Farmers' local seeds are the breeding basis for developing improved seeds and responding to future potential shocks that may affect agricultural production. In addition, indigenous seeds possess valuable traits such as disease resistance, adaptability to harsh and local conditions, potential without modern inputs such as fertilizer, yield stability and so on. For smallholder farmers, managing a portfolio of local seeds enables them to survive in marginal areas (Edilegnaw, 2004).

Given the seed types available to them (Smale *et al.*, 1998), farmers will choose to grow the seed (s) that is (are) most attractive to them in terms of income or other attributes of value (such as tolerance to environmental stress, early maturity, *etc.*) important to them. This is because farmers' seed selection, maintenance, and storage is a function of their household objectives (Barkley and Porter, 1996; Dercon, 1996). The Ethiopian peasants are operating in highly varied micro-environments differing in characteristics such as topography, soil type, water, temperature, and fertility (Tesfaye and Efrem, 1998). Seed choice is, therefore, far complex than just maximizing household income. Given the diverse ecological conditions of the country, there can not be 'one-size-fits-all' strategy that will trigger sustainable development (Mulat, 2003).

As compared to the availability of a huge adoption literature, studies that deal with the impact of agricultural extension and improved seeds (Gavian and Gemechu, 1996; Beyene *et al.*, 2000; and Mulat and Bekele, 2003) are very scarce. This emphasis is pre-occupied with the presumption that the new seeds are all the time superior to the old ones. But, are we sure that the improved seeds are superior (to the local ones) for all farmers and farming systems? Do the improved seeds fetch better prices? What is it that non-users of improved seeds or users of farmers' seed (s) are losing? What factors promote the positive impact of improved seeds on farmers' incomes? These are questions hardly addressed in the Ethiopian context.

[3] The incompatibility could arise because farmers' working environment (markets, land quality, environmental stress and so on) may not be suitable to the production and marketing of the improved seeds or the improved seeds do not fit to farmers' preferences, potentials, concerns and constraints (Edilegnaw *et al.*, 2005). If the technology does not fit to farmers' conditions, it will have to be shelved after

What needs to be done is not to cover all farmers' fields with either the improved or local seeds. The solution is neither planting improved seeds every where nor covering all farmers' plots with farmers' seeds. Taking the former option would be unacceptable due, among others, to crop biodiversity loss (Edilegnaw, 2004). Taking the latter option is wasting resources committed for getting the improved seeds and lower productivity as the local varieties are already failing to produce enough to feed the growing population. In a nutshell, the target for agricultural extension policy makers should, therefore, be locating the comparative advantage of the respective seeds.

When it comes to agricultural technologies, often blanket recommendations are made disregarding the heterogeneity of farmers and farming systems (Asmerom and Abler, 1994; Mulat and Bekele, 2003). That either has resulted for failure of farmers to take up the technologies and / or marginal impact even if they use the technologies. According to a study in South East Asia (Fujiska, 1994), the six reasons for farmers' failure to adopt agricultural technologies are that farmers do not face the problem targeted by the innovation, farmers' practice is equal to or better than the innovation, the innovation does not work, extension fails, the innovation costs too much, and other social and contextual factors. If at all some farmers take up the technologies partly or wholly bypassing these hurdles, the impact on their livelihoods will remain to be trivial.

For more productive use of technologies, their dissemination has to target farmers and farming systems where they can work better (Edilegnaw, 2003). The limited capacity of the government also necessitates targeted interventions. The premises of this paper is that generating information on the loss that non-users of improved seeds face will serve as an input to this end.

To shade some light on the financial viability of improved seeds, the paper estimates the financial loss (in terms of gross margin per hectare) that farmers face when they fail to take up improved seeds of wheat and further examines the contextual factors affecting the magnitude of this loss.

In terms of policy, such an investigation is timely and of utmost importance to agricultural development for various purposes. It serves policy to target technologies to farmers and farming systems where they have better comparative advantage. It justifies the investment made on seed development and dissemination, enables policy optimize the use of improved seeds, helps identify the best mechanisms of reducing the foregone financial net-benefit, and maximises the impact of farm technologies on farmers' incomes. More over, it informs agricultural researchers on the marginal utility (in terms of financial net-benefits) of the seeds they are developing

a lot of resources are wasted OR it will not work even if it is used.

and informs extension policy makers on the complementary inputs and market institutions required to enhance the profitability of technologies.
The remaining part of this paper is structured as follows. Section 2 further elaborates the research agenda. Section 3 presents the theory underlying the methods of data analysis and the econometric methods adopted. Section 4 takes up the data generation process and description. Econometric results are presented and discussed in section 5. Finally, conclusions and policy implications are drawn.

2. Defining the research agenda in the Ethiopian context

2.1 Setting the scene

Nowadays, farmers are using improved seeds and fertilizer delivered (on credit basis) by the Ministry of Agriculture and Rural Development. However, they are not benefiting as they should due to various structural and institutional factors. There is a fundamental disconnect between the issues that African research and extension services tend to address and the resources and problems faced by farmers (Snapp *et. al.*, 2003).

Despite the potential benefits (in terms of income) of using improved seeds, many farmers are using their own seeds year after year for risk, tolerance to environmental stress, disease resistance, taste and related reasons (Nkonya *et al.,* 1997; Yapa and Mayfield, 1978). They continue to rely on local seeds and traditional farming practices (Mulat and Bekele, 2003) the reasons of which are well documented in the agricultural technology adoption literature.

One of the major motivations for the use of improved seeds is to increase incomes and achieve better yield response to modern inputs. However, there may not be desperate need to use improved seeds to improve productivity (Brush, 1991) since improved seeds may not have clear income advantage over farmers' seeds (Perales *et al.*, 1998). A traditional variety that is better adapted to local agro-climatic conditions may be more successful than its modern counterpart on a plot of low fertility or on a plot with no means of irrigation (Meng, *et al* 1998). Before moving into the promotion of agricultural technologies of any sort, one has to ensure their viability and superiority contextually. To contribute to this task, this paper analyzes the foregone gross margin for farmers who didn't use improved wheat varieties.

2.2 Theoretical factors affecting the financial benefit foregone

Choice and use of any seed, be it local or improved, involves trade-offs and opportunity costs (in terms of net-return, insurance value, responsiveness to modern inputs such as fertilizer, disease and pest resistance, marketability and the likes). While choosing certain combinations of seeds, farmers forego other attributes from the non-selected seed (s). In using local seeds, farmers, rural communities, and governments face *opportunity costs* (von Braun and Virchow, 1997). In this paper, the positive difference between the gross margin from improved seeds and the gross margin that a similar farmer gets from farmers' seeds is taken as the foregone financial net-benefit (opportunity cost) resulting from non-use of improved seeds. This is the variable taken as a response variable in the regression analysis.

This variable is assumed to be a function of factors affecting resource allocation and resource use efficiency. Accordingly, the explanatory variables to be considered in the regression analysis include household-related factors (such as schooling, farming experience and oxen ownership), level of use of inputs by the household (fertilizer, labor, and chemicals), agro-ecological factors (such as rainfall and plot quality), access and institutional factors (such as experience in the extension package and access to public goods), and input and output prices (price indices)[4].

The financial net-benefit foregone varies from farm to farm subject to the suitability of farmers' working environment to the production and marketing of improved and local seeds. The more favorable the environment is to the production and marketing of improved seeds (compared to farmers' seeds), the higher will be the financial net-benefit foregone. For instance, the financial net-benefit foregone increases as agriculture becomes more intensified and commercialized (Smale *et al.*, 1998). Inputs and local conditions affecting both seeds equally do not affect the foregone net-benefit.

Correcting for potential econometric problems like self-selection (See Sub-Section 3.1 for more complete discussion), the financial net-benefit foregone can be defined as:

$$NB_{FOREGONE} = GMPH_{IV} - GMPH_{FV} \qquad \textbf{(2.1)}$$

where $NB_{FOREGONE}$, $GMPH_{IV}$, and $GMPH_{FV}$ refer to the foregone net-benefit, gross margin per hectare of the improved seeds, and gross margin per hectare of the farmers' seeds, respectively.

[4] Input and output prices are important determinants of gross margin foregone because the gross margin is an increasing function of output prices and decreasing function of input prices.

3. Methods of data analysis

3.1 The choice of methods of data analysis

Due to non-random distribution of the non-seed factors and unobserved variables, selection bias is the most important econometric problem that needs to be addressed in our empirical analysis. Sample selection bias may arise in practice for two reasons (Heckman, 1979). First, there may be self-selection by the individuals and secondly sample selection decisions by analysts. In our case, the first is due to farmers' own self-selection in such a way that each farmer takes the seed (s) that have comparative advantage to his (her) working environment. Accordingly, farm households who have a better potential to use improved seeds will be joining the use of improved seeds and thus will benefit more from it than would a randomly selected farmer. The second type of self-selection could arise due to the purposive selection of the so called 'high potential areas or farmers' by the Agricultural Extension Department, Ministry of Agriculture and Rural Development.

Selection bias could potentially arise due to selection on the observables or un-observables. Better educated farmers, better quality land, and better farm management practices could be skewed towards the users of improved seeds. This is selection on the observables. The gross margins achieved by farmers using improved seeds or farmers' seeds are, accordingly, affected differently by the explanatory variables. Regarding selection on the un-observables, the essence of the problem is that users of improved seeds and users of farmers' seeds are not the same with respect to variables that are relegated to the error term. Given that gross margins for users of improved and farmers' seeds are observed conditional on different unobservable factors, there will be a self-selectivity problem in the observed data (Huang *et al.*, 1991). Both facets of the selection problem will result in biased OLS estimates.

Disregarding self-selection, a gross margin per hectare equation that takes into account the value of using improved seeds could be set using the equation:

$$GM_i = \beta' x_i + \delta IV_i + \varepsilon_i \qquad \textbf{(3.1)}$$

where GM_i is the gross margin for the ith farmer; x_i's are the independent variables; and IV_i is a dummy variable indicating whether or not the farmer has used improved seeds. This simple OLS regression is implying that the two groups of farmers have the same potential to earn gross margin irrespective of their seed choice. However,

the coefficient δ does not measure the value of improved seeds if the typical farmer who chooses to use improved seeds would have relatively high gross margin irrespective of the type of seed used (Greene, 2000). Of course, OLS estimate of δ will over-estimate or under-estimate the impact depending on the nature (positive or negative) of self-selection. Thus, the simple gross margin difference is not the result only of use of improved seeds; there are also other household and environment-related factors that affect the financial benefits of the seeds which are not randomly distributed among users of improved and farmers' seeds.

Having justified the non-plausibility of the OLS regression (given by equation 2.1), the other option one can think of is to estimate separate OLS equations for each group. Splitting the data-set into two, a Chow test was run to test whether coefficients differ across by type of seed use status. The test rejects the hypothesis that the two regressions are the same. The equations differ not only in the constant but also in each coefficient. This approach, therefore, does not solve the problem either.
As a result of this problem, this paper has opted for a regression approach that differentiates each coefficient for the two groups. Sections 3.2 and 3.3 below present the econometric methods of data analysis that address the selection problem.

3.2 Homogenous treatment effects models

To see the extent to which the results are sensitive to the choice of the method, the paper uses a variety of econometric methods to estimate average foregone financial benefits in terms of gross margin.

3.2.1 Matching

Matching is an evaluation method based on the intuitively appealing idea of contrasting the outcomes of users of improved seeds (denoted y_{1i}) with the outcomes of 'comparable' users of farmers' seeds (denoted y_{0i}). Using logit or probit models in the first step, matching uses the predicted value of the first step estimation for finding a counterpart for each farmer using improved seeds from among those farmers using local seeds (Rosenbaum and Rubin, 1983). It homogenizes the two groups so that the differences ($\Delta = y_{1i} - y_{0i}$) in outcomes between the two groups can be attributed to use of improved seeds. In this sense, matching is addressing selection on the observables because it matches each user with a corresponding non-user (using the observable regressors) in such a way that each pair is made the same except by the type of seed used.

3.2.2 Instrumental variable and treatment regression models

Unlike the instrumental variable regression which estimates linear probability model in the first stage (Baltagi, 1999), the treatment regression considers the dummy for the use of improved seeds (z_j) as dichotomous by fitting a probit equation model. The reason to use treatment regression is the belief that the random shocks which affect a farmer's gross margin also affect whether or not that farmer uses improved seeds. Before running these 2-stage regression methods, the endogeneity of one suspected variable, namely, '*impexep*' (experience in growing improved seeds) has been tested. It is found that endogeneity does not exist for this variable.

3.3 Switching regression model

All the above methods generate an average figure for the financial net-benefit foregone. The more interesting question could be: 'Who foregoes higher financial net-benefit and who pays lower?' 'Why?'or 'What factors determine the size of the benefit foregone?' Addressing these questions requires estimating gross margin equations for both groups of farmers in such a way that the coefficients can be compared and self-selection can be addressed.

If the use of improved seeds does have not only an intercept effect but also a slope effect (*i.e.* the coefficients differ according to seed use status as well), then a switching regression model is the appropriate model to use (Goldfeld and Quandt, 1973; Quandt, 1988). More over, a switching regression model can correct the possible selection bais problem (Freeman *et. al*, 1998). Thus, the switching regression model has been used for the compelling reason that the impact does not just show-up as an intercept effect *per se*. This model allows full set of interactions between seed use status and the *x*'s.

One of the potential uses of switching regression models is to evaluate the benefits of social programs (Maddala, 1983). In the context of Ethiopian agriculture, this model has, among others, been used by Beyene and others (2000) to study the impact of agricultural extension on farm productivity.

Let us consider the usual linear regression problem:

$$y_i = x_i \beta_i + e_i \qquad \textbf{(3.2)}$$

Taking this basic equation, we can split it into two regimes and the gross margins generated by the two regimes can be given as (Maddala, 1983):

$$y_{1i} = \sum_{j=1}^{k} \beta_{1j} X_{ji} + u_{1i} \quad \text{(Regime 1)} \tag{3.3}$$

$$y_{0i} = \sum_{j=1}^{k} \beta_{0j} X_{ji} + u_{0i} \quad \text{(Regime 0)} \tag{3.4}$$

$$C^{*} = \gamma_{j} Z_{ji} + u_{i} \tag{3.5}$$

where the errors, u_{1i} and u_{0i}, are assumed to be distributed normally and independently, with mean zero and constant variance, σ^2. The γ_j's are unknown coefficients to be estimated and Z_{ji}'s determine in which regime the ith observation is generated. The X_{ji}'s refer to the explanatory variables described in Table 1. C^* is the criterion or choice function that itself is explained and it determines the regime (Quandt, 1988) *i.e.* regime 1 holds when C = 1 and regime 0 holds when C = 0. The size and sign of the gross margin difference in the two regimes ($\hat{y}_{1i}$ - $\hat{y}_{0i}$) is the indicator for the financial net-benefit foregone *i.e.*

$$GM_{foregone} = \underbrace{E\left(y_{1i} \middle| C_i = 1\right)}_{\text{Users of improved seeds GM}} - \underbrace{E(y_{0i} \mid C_i = 1)}_{\text{Users of local seeds GM had they been like users of improved seeds}} \tag{3.6}$$

If gross margin foregone is zero, users of traditional seeds have nothing to regret as far as income is concerned. Positive and negative values indicate the gross margin foregone for non-use and use of improved seeds, respectively.

4. Data generation and description

4.1 Data generation process

Wheat is taken as an example considering its national importance. It is one of the most important crops for Ethiopia ranking fourth in total crop area and production (Gavian and Gemechu, 1996). The country is the largest wheat producer in Sub-Saharan Africa second only to South Africa.

The data are extracted from the fifth round of the 1999/2000 Ethiopian rural household survey data collected by the Economics Department, Addis Ababa University (AAU) in collaboration with the USAID. The data come from 1681 farm households of four large regions in the country (Oromiya – 625 households, Amhara – 466 households, SNNP5- 440 households, and Tigrai – 150 households).

[5] Southern Nations, Nationalities, and Peoples Regional State.

From among the 671 plots only 634 of them which were not inter-cropped are considered so as not to mix gross margins of other crops with wheat. Part of the data that deal with 402 wheat-growing farmers (352 users of farmers' seeds and 50 users of improved seeds) have been extracted. Even though the analysis is only for wheat, these farmers are growing other crops too. The 50 farmers are exclusively using improved wheat varieties.

Naturally, computing gross margins is a partial cost-benefit analysis exercise since it considers only variable costs in the calculation. However, complete valuation of costs and benefits is neither desirable nor relevant for the purpose at hand as long as inputs statistically different between users and non-users are valued and computed *i.e.* if a given variable input is of equal size for users of improved and local seeds, its impact on the foregone gross margin will cancel out. The cost of land is disregarded since the gross margins are on per hectare basis.

To compute the gross margin per hectare for each household, the costs of fertilizer (DAP and UREA), labor, seeds (improved and local), and herbicides have been subtracted from gross value of wheat. The value of non-marketed wheat (stored and consumed) has been imputed using the prevailing market price at the time of the interview.

Input and output prices are the other most important factors affecting the foregone financial net-benefits. To study the effect of prices on the gross margin foregone, input and output price indices are computed. Output price indices are computed as the ratio of the price of output that the ith household faces to the overall average price. To construct the input price index, for *n* inputs used in producing wheat, the weighted input price index is computed in two steps. First, the individual input price indices (Ψ_{ij}) are computed for each household using the same procedure as output price indices. Following that, the ratios of the ith input cost to total cost (η_{ij}) are computed for each household to be used as weights in the input price index computation. For each household, the ratio tells the contribution of the ith input in the total cost structure of the household to produce wheat. Thus, the input price indices (κ_{ij}) will be:

$$\kappa_{ij} = \sum_{i=1}^{n} \psi_{ij} \eta_{ij} \qquad \textbf{(4.1)}$$

where *j* indexes inputs and *i* indexes households.

4.2 Data description

The following table reports descriptive statistics for the variables used latter in the regression.

The variables *Age*, *Schooling*, *Exteexpr*, *RFdistri*, *Whetinde*, *Sold*, and *Inpuindx* are household level variables which hold for all plots. The rest are plot level variables which hold for wheat. The response variable in the two regimes, *Gmperha*, is the wheat gross margin per hectare for users of improved wheat seeds (regime 1) and users of local seeds (Regime 0). It is on per hectare basis and most of the explanatory variables are on per hectare basis. That is why land size is not part of the regressors. Plot quality and rainfall distribution are meant to capture agro-ecological differences across farmers.

Table 1: Descriptive statistics of the variables used in the regression

Variable	Description	Mean (SD) – users of improved seeds (50)	Mean (SD) – users of farmers' seeds (352)
Age6	Age of the HH head (Years)	44.84 (11.9)	51.21 (15.6)
Schooling	The highest grade the farmer has achieved at the time of the interview	2.14 (1.4)	1.78 (1.2)
Exteexpr	Experience in the extension package (years)	1.5 (1.9)	0.30 (1.1)
RFdistri	Rainfall distribution (1 – bad, 2-medium, 3-good)	2.2 (0.6)	1.85 (0.6)
Plotqulx	Plot quality (3 – good, 2- medium, 1-bad)	2.42 (0.7)	2.51 (0.6)
Chemical	1 if chemical is used and 0 other wise (dummy)	0.48 (0.5)	0.42 (0.5)
Fertph	Fertilizer on the wheat plot hectare (quintals per hectare)	1.41 (0.8)	0.83 (0.7)
Oxenph	Number of oxen per hectare of land holding	4.76 (5.2)	5.11 (5.03)
Whetinde	Wheat price index	1.01 (0.2)	0.99 (0.3)
Sold	1 if wheat is sold and 0 otherwise (dummy)	0.58 (0.5)	0.39 (0.5)
Laborph	Labor used on the wheat plot (Man-days per hectare)	192.88 (249.6)	81.07 (77.2)
Inpuindx	Input price index	0.97 (0.1)	1.02 (0.2)
Gmperha	Gross margin per hectare	1731.1 (1280.4)	1015.7 (1119.3)

[6] Experience in using improved varieties, instead of age, can better capture the difference but there was no information on this variable.

Source: Computed based on the fifth round of the Ethiopian rural household survey data, AAU / USAID

All the farmers included in the econometric analysis have a single plot allocated for wheat on which either local or improved seeds are grown. There were three farmers with multiple wheat plots but only the larger plot and its quality are considered to simplify the analysis. The results reported in Table 4 are, therefore, for 402 farmers / plots. Farmers are classified into users and non-users at the farm / farmer level, not at the district level.

5. Econometric results and discussions

5.1 Estimates of foregone financial net-benefits

The table below shows the average financial net-benefit foregone for wheat which is generated from different homogeneous treatment statistical procedures discussed in Section 3.2.

Table 2: Average gross-margin foregone for not using improved seeds

Method	Gross margin foregone in Birr per hectare
Matching	276.5
Treatment regression	687.02
Instrumental variable regression	885.9
Over-all mean difference[1]	715.4
Mean difference[2]	299
Simple OLS[3]	435.4

Source: See Table 1

Notes: [1]This mean difference is the average difference based on the gross margin figures reported in Table 1.

[2]In this case, we are only considering users of farmers' and improved seeds (different farmers) on plots of the same quality.

[3]We are considering seed use as an exogenous variable.

Obviously, the simpler methods (over-all mean difference, mean difference and simple OLS) do not solve the basic econometric problems like endogeniety and self-selection. The purpose of reporting all of them is to show the extent to which the results are sensitive to the violation of the different econometric problems. All the results of Table 2 assume that improved variety use has only intercept effect.

All in all, the data show that users of improved seeds are applying inputs (such as fertilizer and labor) more intensively than the users of farmers' seeds. Depending on the method of analysis used, the average financial benefit foregone for not using improved seeds of wheat ranges from 277 to 886 Birr per hectare. On average, the results imply

that improved seeds are financially viable and failure to use them involves foregoing financial benefits. This is in line with a study in West Shewa which has shown significant improvement in farm level maize productivity and profitability among the extension package participants as compared to non-participants (Beyene *et al.*, 2000). According to Negussie and Mulat (2003), improved seeds had significant impact on farm productivity. However, all previous studies do not confirm positive impacts. For instance, according to Mulat and Bekele (2003), the contribution of extension to yield is not significant.

To explore implications of the results reported above at the national level, the national level estimates of land use for wheat production are used. For instance, according to FDRE (2003), for the 2001/02 cropping season, wheat was planted on about 1.1 million hectares of land. Of this, only 1.99 percent of the land was planted with improved seeds. Using these estimates, the total gross margin the country has foregone as a result of not using improved seeds of wheat can be estimated to range from 295.3 million Birr to 946.2 million Birr per year7. If improved seeds are subsidized, the financial benefit foregone will be lower by the size of the subsidy.

Even though improved seeds are financially better than the farmers' seeds, all users of improved seeds are not equally enjoying the benefits of improved seeds and neither are all non-users foregoing equal financial net-benefit. There are users of farmers' seeds who have earned a gross margin greater than the average of the users of improved seeds. Failure to use improved seeds does not always involve foregoing financial benefits. Neither does loss in gross margin using farmers' seeds mean that higher financial benefits are sacrificed. According to the data, from 50 users of improved seeds, 12 have negative gross margins. Out of the 352 users of farmers' seeds, 131 farmers have attained gross margins greater than the average of the users. Computing the foregone financial net-benefit for farmers of nine Districts reveals some important results on how the benefits foregone and the gross margins vary across localities.

Based on the above simple descriptive results, four groups of localities can be identified. First, there are Districts earning negative gross margin and foregoing higher financial benefit (eg. Koro Degaga). It implies that had they used improved seeds, they would have either lost less or they would have attained a positive gross margin. These are the Districts for which using improved seeds could make a big difference. Second, there are Districts enjoying positive gross margin and foregoing lower to higher financial benefits (eg. Shashemene and Haressaw). These are the localities for which targeting for better adoption of improved seeds is essential depending on the magnitude of the foregone net-benefit. Third, there are Districts

[7] All the potential financial benefit of the improved seeds could not be realized due to capacity limitations and non-suitability of all plots and farming systems to improved seeds.

getting positive gross margin with no foregone net-benefit involved because, on average, the gross margins of the non-users was higher than the users (eg. Yetmen). These farmers were getting the best result from the farmers' seeds and there is no regret for failure of extension to introduce improved seeds. Fourth, there can be Districts earning negative gross margin with no benefits foregone. This is possible because if these farmers were to use the improved seeds, they would still have lost even more as the investment made on the complementary inputs will be lost.

The results are by and large context-specific. Lower average gross margin from the farmers' seeds (in Haressaw, Durame Azedebos, and Shumsha Lalibela Districts) was associated with higher foregone financial benefit. Higher gross margin from the farmers' seeds (in Debre Berhan, Debre Zeit, Shashemene and Eteya) was associated with lower foregone financial benefit. All in all, these results imply that using improved seeds is not a *panacea* for all farmers.

Table 3: The estimated foregone financial benefits and the average gross margins across Districts

District	Number of wheat plots	Average gross margin foregone (Birr)	Average gross margin per hectare for non-users (Birr)
Debre Berhan	158	217.41	914.59
Eteya	117	197.00	934.99
Shashemene	82	120.16	1011.84
Debrezeit	77	152.53	979.47
Haressaw	31	1052.72	79.28
Koro Degaga	22	1248.31	-116.31
Yetmen	19	-1226.26	2358.26
Durame	15	812.93	319.07
Adele Tike	11	1028.83	103.17

Source: See table 1.

5.1 Factors influencing magnitudes of foregone financial net-benefits

The computations made above reveal that the financial net-benefits foregone vary across farmers and farming systems. The regression analysis that follows explains this variation for wheat.

If any of the variables is insignificant in both regimes (like *Oxenph* and *Fertph*), it is not relevant to explain the foregone gross margin. If it is not significant in either of the regimes, it takes a value zero in the regime where it is insignificant. If the coefficients

of a given regressor are significant in both regimes, they are compared in the two regimes to decide its impact on the gross margin foregone (Regime 1 minus Regime 0). The gross margin difference between the users of improved and local seeds is our definition of the foregone gross margin. Hence, if the coefficient in Regime 1 less the corresponding coefficient in Regime 0 is positive (negative), that particular coefficient is affecting the gross margin foregone positively (negatively).

According to the results above, labor use per hectare, fertilizer use per hectare, farmers' experience with the extension package, quantity of wheat sold, rainfall suitability, and wheat price index are the most important factors increasing the foregone gross margin. On the contrary, age of the household head, education level of the household head, land quality, input price index, oxen ownership per hectare of land holding, and chemical use on the plot are found to have the opposite effect.

Table 4: Full information maximum likelihood estimates of a switching regression model

Variable	Coefficient	Variable	Coefficient
Regime 1 – Users of improved seeds		**Regime 0 – Users of farmers' seeds**	
Constant	-770.7 (-1.3)	Constant	-699.6 (-0.42)
LABORPH	1.3*** (2.6)	LABORPH	-1.2 (-0.98)
AGE	1.4 (0.3)	AGE	30.6** (2.20)
SOLD	1048.7*** (7.6)	SOLD	297.9 (0.75)
EXTEEXPR	112.0*** (2.8)		
INPUINDX	-847.8** (-2.2)	INPUINDX	588.3 (0.46)
SCHOLING	248.7*** (4.7)	SCOLDUMY	260.0** (2.00)
PLOTQULX	-110.5 (-1.1)	PLOTQULX	398.2** (1.98)
RFDISTRI	194.5** (1.9)	RFDISTRI	-368.1 (-1.56)
OXENPH	.983 (0.08)	OXENPH	41.9 (1.11)
WHETINDE	1727.6*** (8.9)	WHETINDE	1341.9* (1.66)
CHEMICAL	-124.9 (-0.9)	CHEMICAL	368.6 (0.97)
FERTPH	-71.8 (-1.00)	FERTPH	-518.2*** (-2.6)
Sigma(1)	971.9 (26.9)	Sigma(0)	1272.4 (7.8)
Dependent variable GMPERHA	Number of observations 402		
The sample separation variable is use of improved variety (DUMMY)			

Source: See Table 1.
Notes: ***-Significant at 1%; **- Significant at 5%; and *- Significant at 10%. Values in parentheses are the ratio of the coefficient to the estimated asymptotic standard error. The coefficient for *Exteexpr* in Regime 0 is missing due to lack of enough observation on users of local seeds with some experience in using agricultural extension service.

Fertilizer and labor use per hectare increase the opportunity cost of not using improved seeds of wheat implying that farmers who can apply these inputs easily

have comparative advantage to use improved seeds more productively. Farmers' decision to use fertilizer more intensively with improved seeds (while 94% of the users of improved seeds are applying fertilizer, 76% of the users of farmers' seeds are applying fertilizer) is, therefore, rational. Farmers having better experience with the improved seeds and those who are marketing their produce get better benefit from the improved seeds. When the rainfall and output prices are more favorable, the improved seeds have better comparative advantage.

Education and age of the household head reduce the financial benefit foregone enabling the users of farmers' seeds earn better gross margin. When schooling by the household head increases, the foregone net-return decreases because those who are better educated can produce more from farmers' seeds compared to the average user. Therefore, other factors held constant, better education can reduce the benefit foregone enabling local seed users to benefit more. The effect of plot quality on the net-benefit foregone is also negative implying that better quality plots can reduce the gross margin difference and make the farmers' seeds more advantageous. Oxen ownership also reduces the gross margin difference implying that farmers' capacity to undertake agricultural practices on time enables them to reduce the foregone gross margin.

The negative impact of input prices on gross margin is more pronounced for farmers growing improved seeds reflecting their capital intensity. Better output prices increase the benefit foregone because better prices benefit more the users of improved seeds as the wealthy farmers (who are able to store and sell when prices are better) are the ones predominantly using the improved seeds. The result of a previous study in Arsi Zone has indicated that the greatest improvement in the returns to the higher yielding packages came from increases in grain prices, not from decreases in input prices (Gavian and Gemechu, 1996). Given that wheat is relatively a rich man's crop, the prospect for getting a better price is very high if farmers can postpone selling their products right after harvest.

The benefit foregone is a negative function of favorable natural factors like rainfall. Accordingly, if the rainfall distribution suits the production season, farmers who are planting their seeds are foregoing less financial benefits.

6. Conclusions and implications for agricultural extension

Before taking up the conclusions derived from the results, some cautionary notes and directions for further research are in order. One of the shortcomings is that improved seeds and farmers' seeds are grouped into two as if all seeds in each group are

synonymous. Because the data used in this paper do not capture input-output information based on type of seed used, seed-based analysis is not pursued.

Secondly, it has to be noted that achieving higher gross margin is not the only reason for which improved seeds are developed. Wheat breeders have had goals far wider than direct net return increases (Brennan, 1984). Food taste, early maturity, feed value, and tolerance to environmental stress are other traits often targeted. Despite their importance, these attributes are not considered due, simply, to the difficulties involved in their valuation which will take the paper beyond its scope. The third problem that forces us to cautiously interpret the results is that non-users of improved seeds are over-represented in the sample used for this analysis. Last but not least, the data are of cross-section nature representing only the 1999 / 2000 cropping season.

6.1 Conclusions

In recent times, the Ethiopian government is trying to address problems of low agricultural productivity, poverty, and resource degradation through technology-driven agricultural extension programs. However, before scaling up the dissemination of agricultural technologies to wider areas, evaluating their financial, technical and economic viability can't be over-emphasized. To contribute to this daunting task and draw policy lessons for agricultural extension, this paper has empirically examined the financial net-benefit foregone when farmers fail to use improved seeds of wheat. Having this motivation, the paper has generated information on the financial benefit that wheat growing farmers forego if they fail to use improved seeds.

Based on the descriptive results, four groups of farmers have been identified. First, there are Districts earning negative gross margin and foregoing higher financial benefit. Had these farmers used improved seeds, they would have either lost less or they would have attained a positive gross margin. These are the localities for which adoption of improved seeds could make a big difference. Second, there are Districts enjoying positive gross margin and foregoing lower to higher financial benefits. These are the localities for which targeting for better adoption of improved seeds is essential depending on the magnitude of the foregone net-benefit. Third, there are Districts getting positive gross margin with no foregone net-benefit involved because, on average, the gross margins of the non-users were higher than of the users. These farmers were getting the best result from the farmers' seeds and there is no regret for failure of extension to introduce improved seeds. Finally, there can be Districts earning negative gross margin with no benefits foregone.

Depending on the method of analysis used, the average financial benefit foregone for not using improved seeds of wheat ranges from 277 to 886 Birr per hectare. Despite the variations across farmers and farming systems, the results imply that, on the

whole, improved seeds are financially viable and failure to use them involves foregoing financial benefits. However, the results have also shown that higher average gross margin from the farmers' seeds does not necessarily mean that there is no foregone net-benefit. Neither does loss in gross margin from the farmers' seeds necessarily mean absence of foregone financial benefit.

The estimates suggest that all users are not equally enjoying the benefits of improved varieties and neither are all non-users foregoing equal gross margins. Using the estimates of foregone gross margin and the 2001/02 cropping season CSA statistics, it has been shown that the total gross margin the country has foregone as a result of not using improved seeds of wheat ranges from 295.3 million to 946.2 million Birr per year. If improved seeds have been subsidized, the financial benefit foregone will be far lower.

The regression results show that labour use per hectare, fertilizer use per hectare, farmers' experience with the extension package, quantity of wheat sold, rainfall suitability, and wheat price index are the most important factors increasing the foregone gross margin. On the contrary, age of the household head, education level of the household head, land quality, input price index, oxen ownership per hectare of land holding, and chemical use on the plot decrease the foregone gross margin.

Farmers who can apply labor, and oxen easily have better benefited from the use of improved seeds. Improved seeds have better comparative advantage if farmers can sell their products. The results show that farmers' seeds have better comparative advantages with better quality plots. Better educated farmers do not necessarily have comparative advantage in using improved seeds. Similarly, when schooling by the household head increases, the net-return foregone decreases.

6.2 Implications for agricultural extension

The current agricultural extension system in Ethiopia is criticised from various angles. Here, the paper would like to list the most relevant ones for this paper and show how the results can help address them. It is technology-driven failing to account for agro-ecological, cultural, and socioeconomic diversity of farmers' working environment. The existing extension disregards the potentials and comparative advantages of each farming system. Its criterion of success is the number of farmers involved in the program, not the impact of extension on farmers' productivity and incomes. It never asks the question 'What do farmers lose if they fail to take part in the extension package?' It focuses on activities rather than on outcomes. Extension is mainly catering the needs of the better-off and more commercialized farmers[8].

8 More details on the features, challenges, and impacts of Ethiopia's agricultural extension can be found in a recent publication by the Ethiopian Economic Association (EEA/EEPRI, 2006).

The results of the paper re-enforce the need for revisiting the extension program and highlight the directions for improvement to address the preceding shortcomings. The results have shown that availability of improved seeds alone is not enough to make these technologies profitable. Agricultural development is not just a question of disseminating improved seeds. It needs market development and ensuring the availability of other complementary inputs that improve the comparative advantage of using improved seeds.

The results imply that improved seeds have comparative advantage when accompanied by other complementary services such as irrigation, credit, input supply, market and storage infrastructure. If they have to be productively and profitably used, government has to, therefore, invest on those services. So far, Ethiopian smallholders have not been able to fully benefit from modern technologies such as improved seeds due, mainly, to lack of other complementary services. For instance, unless farmers get better prices for their produce, they will be using more inputs, incurring more costs, producing more, selling at low price, and losing more. This is especially the case when there is drought and natural disaster during which there will be recurrent food insecurity and hunger.

Mostly, it is argued that as long as the subsistence farmers have no opportunity to get hold of improved seeds, they do not face opportunity costs. But access factors are just policy variables that can be improved to realize the comparative advantage. Moreover, from income distribution point of view, the first argument will impoverish the poor and marginalize them. As a result, Lipton and Longhurst's (1989) story of new seeds and poor people will prevail. Once access-related policy variables are dealt with, recommendation of improved seeds should be made based on their comparative advantage considering the prevalence of variables promoting the comparative advantage. Targeting principles should be established based on the comparative advantage of the respective seeds.

Hence, blanket recommendation of improved seeds for all farmers and farming systems across the board is a waste of resources because in some farmers' working environment the local seeds may even work better. In some farmers' working environment, the farmers' seeds can even perform better. Identification of farming systems and farm households for targeted technology adoption optimizes the benefits of using both sets of seeds. All the results re-enforce the need for targeted intervention to improve the benefits from improved seeds. Adoption of improved seeds is not some thing that policy makers can favor for all farmers and farming systems across the board. It all depends on which technology can work better under which conditions.

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