The Efficiency of Public Spending in Agriculture in Ethiopia: The Macro and Micro-econometric Frontier

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IAES Working Paper Serious NO. A11/2011

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IAES Working Paper

Abstract

Acknowledgment: **This paper is based on a background paper prepared for IFPRI Ethiopian office. . The copy right of the final paper after soliciting comments through this WP belongs to IFPRI. We acknowledge and grateful for the grant from IFPRI for working on this paper**

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I. Introduction

Public Spending Reviews: the macro-micro balance

The literature on public spending efficiency on agriculture in Ethiopia is very thin and studies focusing on public spending on agriculture and the returns to public investment on the sector are fewer and far between. This section provides an overview of studies in the recent literature that have illuminated on the subject. Since the purpose of the present review is to reflect on what previous studies on the subject have covered and to discuss what the present study offers to the body of knowledge on the area under discussion, we do not attempt to present a review of studies in continental Africa, or other developing countries on the same topic.

One of the earlier studies focusing on agriculture and priorities in spending in Ethiopia is Block[1] (1999). Block (1999), by employing a four sector simulation model, calculates the macroeconomic growth multipliers resulting from income shocks to agriculture, modern-industry, traditional industry, and services. The above, in return, were used to evaluate the distributional implications of the growth in the respective sectors. Block's (1999) model produced growth multipliers: *1.54, 1.8, 1.34 and 1.22* for agriculture, services, modern industry and traditional industry, respectively. Although the above results show that inter-sector linkages are uneven, the study notes, "Income shocks to agriculture are clearly the most progressive choice o highlight agricultural development in growth strategies for Ethiopia" [251]. Even though the service sector offers a marginally higher indirect benefit ($0.80) to an income shock ($1.00), the greatest impact on poverty reduction is one to be had by agriculture offering indirect benefits to the tune of $0.54. In addition, Block (1999) notes that agriculture and services share the largest proportions of the net impact of income shocks. The study expounds on sector priorities and what they offer in terms of poverty reduction, but does not discuss the modalities of spending in agriculture to bring about growth, where spending in agriculture should go. Hence, although the study is useful in understanding sector priorities in spending to growth and distribution, it offers little in terms of our focus area (i.e. efficiency in agricultural spending). Diao et al (2007) recent study supports this finding.

Agenor *et. al.*[2] (2005), on the other hand, employs an elaborate macroeconomic framework to investigate the relationship between aid, public investment, growth, and poverty. Although the theme of the study is too broad to be of great significance to our study, its application to Ethiopian data with special emphasis on social-sector spending is of much import to our present project. Furthermore, Agenor *et. al.* (2005), attaches the macroeconomic framework to data from household surveys to analyze the impact of policy shocks on poverty. The study evaluates the effect of the trade-off between government consumption and public investment on economic growth and poverty reduction. The model uses 2002 as a base period and makes arbitrary assumptions for exogenous variables over the period 2003-2015[3]. The model makes allowances to make public infrastructure an engine of growth due to its "direct effect on the productivity of private inputs and its complementarity effect on private investment" [38]. The simulation results show that since public investment and public consumption offset each other in the short term the dividends from higher public investment will be miniscule. However, as supply side effects start to unfold, in the intermediate run, the relocation of public resources have positive output effects. In the long run, Agenor *et. al.* (2005) contends, fiscal balance improves, and external debt-to-GDP and debt service-exports ratios fall and hence dependence on external sources of finance grows weaker. The

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[1] Block, Steven A., (1999), Agriculture and economic growth in Ethiopia: growth multipliers from a four-sector simulation model, *Agricultural Economics*, 20 (1999) 241-252.

[2] Agenor, Pierre-Richard, Nihal Bayraktar, and Aynaoui, Karim El, (2005), Roads Out of Poverty? Assessing the Links between Aid, Public Investment, Growth, and Poverty Reduction. World Bank Policy Research Working Paper No. 3490.

[3] For more detail on the assumptions see Agenor *et. al. (2005): 33-35*

simulation exercise does not include agriculture, but can be extended to include the sector with relative ease. However, similar to Block (1999), the study exclusively focuses on the growth effects of reallocation of public resources, and assumes away potential institutional reorganizations that may be essential for effectively utilizing additional public spending. Furthermore it is essential to note that the above can only be remedied with an involved inter-sectoral focus similar to the one proposed in our analytical framework.

In the same vein, Tewodaj *et. al.*[4] (2007) employs a three tired approach to estimate the relative returns of public investments to rural welfare. The first stage specifies a household consumption equation in such a way that the effect of public services on household consumption is captured. The second stage employs a variation of the distributed lag model to estimate the effects of public expenditure in pro-poor services, while the final stage incorporates results from the first two sections to evaluate the marginal effects of increases in public expenditure in various sectors on household welfare. The results note that household expenditure impacts of per capita public expenditure in agriculture have been consistently low across regions. The largest returns to public investment in agriculture, comparatively speaking, seem to have taken place in urbanized regions. The authors attribute the above to external factors that influence "public intervention in agriculture": market proximity, geographical location (as is reflected in the returns to public investment in agriculture in Dire Dawa and Harari). The study noted that the absence of regionally disaggregated data on the subsectors of agriculture precluded a more involved analysis. The results of the study were also reflected in a previous study by Tewodaj *et. al.* [5](2006). The two studies use a framework that slightly resembles the analytical framework proposed in our present study. The difference between the first two studies and the present study is the focus microeconomic techniques were afforded in the first two, while the latter employs a comprehensive approach incorporating a compendium of macro (inter-sectoral allocation of resources) and micro tools (welfare and productivity outcomes of spending on agriculture).

Another study of significant relevance in regards with our current project is World Bank[6] (2008). The report evaluates public expenditure data on agriculture and rural development for the period 1996-2005. Agriculture and rural development were defined broadly to include fourteen sectors that are aggregated into four: Sector Oversight, Productivity, Vulnerability and Food Security, and Infrastructure [Note that the review only includes external assistance that is directly incorporated in the budget and therefore it does not look at food security programs financed by bilateral donors and large infrastructure projects. Furthermore, the review does not examine social spending on education and health that are important to agriculture and rural development.] The report examines expenditure data to explain why despite expenditure levels that are in keeping with development priorities, agriculture in Ethiopia remains, in overall assessment, "low-input, low-value, subsistence oriented, and subject to climate shocks" [1]. The report finds that, even if, the public sector has a major role to play in delivering public goods (research in agriculture and extension services), the potential for private sector participation remains to be explored including the option of public provision and private sector management of projects. Furthermore, increased private sector participation requires that the government provides the necessary regulatory environment including provision of grades and standards, food safety, bio-safety, and environmental protection. The report also notes that although there is upward trend in total public expenditure in agriculture and rural development, expenditure volatility within the sector is widespread. The report also stresses on the importance of: building capacity at the regional and Woreda level to guarantee that interventions are aligned with local needs, review of vulnerability and food security spending in the context of national objectives given the geographical focus of the program on low-growth areas. The study, further, notes that the need for program

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4 Tewodaj Mogues, Gazahegn Ayele, and Zelekawork Paulos (2007), The Bang for the Birr: Public Expenditures and Rural Welfare in Ethiopia, IFPRI Discussion Paper 00702, Development Strategy and Governance Division.

5 Tewodaj Mogues, Gazahegn Ayele, Zelekawork Paulos and Shenggen Fan (2006), How effective is public spending? Public investment composition and rural welfare in Ethiopia.

6 World Bank (2008), Ethiopia Agriculture and Rural Development Public Expenditure Review 1997/98-2005/06, Report No. 41902.

design capacity, streamlining of budgetary procedures at local levels, and formal monitoring of the impact of agricultural and rural development programs is essential.

II. Efficiency of Public Spending in Agriculture: A Macro and Sectoral Perspective

2.1 Introduction

It is worth to began the issue of inter-sectoral relation in the context of efficiency of public spending in Agriculture by looking first the sectoral growth rates and their contribution to GDP growths. It has to be noted from the outset, however, that GDP growth rates in ~Ethiopian is fundamentally determined by what happens in the agricultural sector which itself is again determined by vagaries of nature and other external shocks (see Alemayehu 2008). During the period 1996/97- 2005/06, real GDP on the average grew by about 4.8 percent while per capital income grew by around 2.2 percent (calculated from WB WDI, 2006). As shown in Table 1.2, two episodes of negative growth rates in real GDP were recorded. The growth rate in agriculture was quite erratic exhibiting significant swings. With its high share of GDP (an average of around 48 percent during the last decade), it shaped the growth of the overall economy. Notwithstanding the recent high growth rates in the agricultural sector, the average growth rate during the period 1996/97 – 2005/06 stood at only 3.8 percent. In contrast to the agricultural sector, the growth rates of industry and service sectors were more stable and exhibit higher average growth rate of 6.2 percent and 6 percent, respectively, during the same period.

In terms of the contribution each sector to the overall growth of the economy (see Table 1.2), the contribution of the agricultural sector during the period of 1996/97 – 2005/06 appears to be small. Out of the observed 4.8 percent average growth of GDP, the agricultural sector's contribution to growth was around 34 percent while the non-agricultural sectors account for the remaining 66 percent. The latter compares to a sub-Saharan average of 81 percent for non-agricultural sector contribution to growth (WB WDI, 2006). Within the non-agricultural sector, the service sector was dominant, accounting for about 50 percent of the GDP growth

Table 1: Sectoral Contribution to National GDP Growth

	Growth Rates				Source of GDP Growth		
Year	Agriculture	Industry	Services	GDP	Agriculture	Industry	Services
1996/97	2.5%	3.9%	3.0%	2.9%	1.4%	0.5%	1.1%
1997/98	-10.6%	5.2%	2.2%	-4.2%	-5.6%	0.6%	0.8%
1998/99	3.6%	5.5%	10.5%	6.5%	1.8%	0.7%	4.0%
1999/00	3.2%	5.4%	9.6%	6.0%	1.5%	0.7%	3.8%
2000/01	10.4%	5.1%	3.8%	7.1%	4.9%	0.6%	1.6%
2001/02	-2.1%	8.3%	1.7%	0.7%	-1.0%	1.0%	0.7%
2002/03	-11.4%	3.0%	4.5%	-3.2%	-5.4%	0.4%	1.8%
2003/04	17.3%	10.0%	7.3%	12.0%	7.4%	1.4%	3.1%
2004/05	13.4%	8.1%	8.4%	10.6%	6.0%	1.1%	3.4%
2005/06	11.2%	7.4%	9.2%	9.9%	5.2%	1.0%	3.7%
1st 5 Year Average	1.8%	5.0%	5.9%	3.6%			
2nd 5 Year Average	5.7%	7.4%	6.2%	6.0%			
10 year Average	3.8%	6.2%	6.0%	4.8%	1.6%	0.8%	2.4%
Relative contribution to GDP Growth (1996/97-05/06 average)					33.7%	16.8%	49.5%

Source: Computations based on MOFED data

Further disaggregation of the achieved national growth into the contributions of the urban and rural economies[7] showed that the growth in the Industrial and service sector (urban economy) explains around 60% of the observed national growth while the agricultural (rural economy) explains the rest, 40%. The comparable figure for the sub-Saharan Africa non-agriculture/urban growth share is around 70% for the period of 1995-2003 (calculated from WB, ADI, 2006). It is interesting to note however that with its 48% share of GDP, agriculture is still the dominant sector. However, its performance and hence its contribution to growth had not been satisfactory. For instance, during the last decade, the contribution of agriculture to growth had been only around 35%. Though more than half of the country's growth had been generated outside of the agricultural sector, what is happening in the agricultural sector still could erode the contribution of the other sectors given that almost half of the GDP comes out of this sector. In addition, the relatively high variability in agricultural output and its growth[8] would make this sector an important determinant that shapes the overall economic growth performance.

2.2 The Conceptual Framework

One of the weaknesses that we have identified in the previous study about efficiency of public spending on Agriculture through the budget process in Ethiopia (Alemayehu and Dawit, 2009a) relates to the failure to take the inter-sectoral relation on board in the design of spending in agriculture. This is partly constrained by lack of a quantitative study about that linkages. In this section we have attempted to do so using macro, sectoral as well as SAM based data and analysis.

[7] Growth in GDP $= \frac{GDP_t - GDP_{t-1}}{GDP_{t-1}!} = \frac{\Delta GDP_{Agr} + \Delta GDP_{nonAgr}}{GDP_{t-1}} + \cdots$Note that $\frac{\Delta GDP_{Agr}}{GDP_{t-1}}$ is the contribution of Agriculture to national growth.

[8] The standard deviations of the agricultural and non agricultural growth rates are 0.094 and 0.028, respectively.

Using sectoral value added (industry, services and agriculture) and public spending in each of the three sectors, we have attempted to address the issue of inter-sect oral linkages using a Vector Autoregressive (VAR) and vector Error /Equilibrium Correction (ECM/EqCM) model approach outlined below. This is complemented by a Social Accounting Matrix (SAM) based analysis where we used the recent SAM build in the context of ESSP2 for the purpose.

The VAR approach follows Sims' (1980) formulation. We have specified sectoral value added and public spending in each sector in the VAR system. VAR allows for cross variable dynamics when the theoretical basis for causality is blurred as is the case in Ethiopia's inter-sectoral relations. The VAR model is, thus, important when we are not sure about the endogenous-exogenous classifications (ie., the theoretical relationships) of the variables. In this method all the variables are treated as endogenous.This approach has a number of advantages. First it eases the difficulty of fitting particular theoretical frameworks for specifying inter-sectoral linkages which usually is a contestable issue. The second advantage relates to issue of capturing the perceived, but not well specified, relationships among each sector or what is referred before as inter-sectoral linkages. Finally, VAR is an important framework for testing long-run sectoral relationship using the co-integration techniques as well as for modeling of the dynamics of the sector as well as forecasting sectoral output evolution. This VAR (and EqCM) model, following Fiess and Verner (2001), could be given by equations [1] and [2].

Following Johansen (1988, 1991) and Fiess and Verner (2001), we may consider a VAR model for all sectors (given by vector 'X') which could be given by equation [1].

$$X_t = A_1 X_{t-1} + \cdots + A_k X_{t-k} + \phi D_1 + \varepsilon_t \ (t = 1, \dots T) \qquad [1]$$

Where: X refers to a vector of sectors: Agriculture, Industry, Services and Public spending in each sector; A, estimated coefficient matrix, D a vector of constants and relevant dummy variables and ε a white noise error term.

In general, an economic time series is a non-stationary process, and VAR systems like equation [3] can be expressed in the first-difference form. If we use$\Delta = 1 - L$, where L is the lag operator, we can rewrite equation [3] as

$$\Delta X_t = \Gamma_1 \Delta X_{t-1} + \cdots + \Gamma_{k-1} \Delta X_{t-k-1} + \Pi X_{t-k} + \varepsilon_t \qquad [2]$$

Where: $\Gamma_i = -(\mathrm{I} - A_1 - \cdots A_i)(i = 1, \dots k-1) and\ \Pi = -(\mathrm{I} - A_1 - \cdots A_k)$

Model equation [2] is tantamount to modelling a traditional first-difference VAR model except for the term ΠX_{t-k}. The Johansen co-integration test procedure is based on an examination of matrix Π, which contains information about a long-run relationship. The analysis of the long-run relationship in the model is based on examining the rank of this matrix. If this matrix has a full rank, the vector process X_t is stationary. If the rank equals zero, the matrix is a null matrix and equation [2] remains a traditional VAR where the variables are not cointegrated and hence have no long-run solution. The third and most interesting possibility is when $0 < \text{rank}(\Pi) = r < p$. This implies there are $p \times r$ matrices of α and β such that $\Pi = \alpha\beta'$. The cointegration vector β has the property that $\beta' X_t$ is stationary even though X_t itself is non-stationary. The Johansen procedure helps to determine and identify this (these) cointegrating vector (s) from which we will infer about long run relationships between sectors (See Alemayehu *et al* 2009 for detail).

This co-integration analysis will be complemented by formulation of an impulse response function for the VAR in equation [2]. Impulse response analysis is a method of assessing the interaction among the variables in the VAR. It can be used either to assess the dynamic behavior of the variables (among sectors in our case) or to investigate the policy impact, such as public spending across sectors, on the variables that constitute the VAR. The impulse response function can easily be derived by reparameterizing (and normalizing the moving average representation by the standard deviation, referred as Cholesky normalization) of the VAR model in [2]. The result could be given as equation [3] (see Alemayehu *et al* 2009),

$$X_t = \sum_j \beta_{ij} \epsilon_{xt-j} \qquad [3]$$

Where: X_t is the vector of sectoral output and β and ε the vector of parameters and innovations respectively. The β coefficients in equation [3] are referred as impulse multipliers.

By introducing innovation, ε , which represents public spending in the various sectors, in the function given by [3], we will show the implication of spending in different sectors on the agricultural sector, taking the inter-sectoral linkages onboard. Capturing this interconnection assists policy makers in several ways. First, given the limited number of policy instruments available, it is possible that a single instrument can be used to address multiple targets. So, there is a possibility of picking optimal mix of policy instruments[9]. The second advantage relates the complementary nature of the analysis to a fixed effect SAM based analysis carried out below and recent SAM based analysis by Diao et al (2007) by offering the dynamic that could be implied by such inter-sectoral relation. Finally, it is hoped that , this quantitative evaluation of public spending in agriculture will complemented the qualitative study of: (a) how the choice of inter-sectoral resource allocation at macro level, and (b) public spending planning at sectoral level (ie, at the Ministry of Agriculture, and local/ *woreda* level) is made (Alemayehu and Dawit, 2009b).

[9] Our analysis in this study will primarily be based on examination of the allocation of public spending across various sectors. However, it is also possible to examine the implication of scaling up spending in the agricultural sector. Such possible scaling up however need to be accompanied by a stable macroeconomic environment. If this is not the case, not only any success in the agricultural sector will be comprised but also the poor may suffer from the resulting macro instability as that of inflation. Examining scaling up of spending on agriculture requires to complement this analysis by the use of a macroeconomic model such as The MoFED model. Alemayehu *et al* (2006) have successfully used this feature of the model to carry out MDGs need assessment for the Government of Ethiopia and UNDP. This may not be carried out in this study, however, since issue of scaling up is not investigated.

2.3 The Result

2.3.1 VAR Based Regression Analysis

We have managed to collect data of sectoral value added, for Agriculture, industry and services sectors, as well as public spending in each of this sector for the year 1967 to 2007. Thus, we managed to have 40 years of data points. We have began our VAR based modeling by first examining the time series properties of the variable under analysis.

Table Data and Description of Variables (1965/66 – 2007/08)

Variable	Description (all in natural logarithm)
a	Value added in agriculture
ind	Value added in industry
ser	Value added in services
ps_a	Public spending in agriculture
ps_ind	Public spending in industry
ps_ser	Public spending in services

Note: L (or Log) given before the symbol of the variables indicates the natural logarithm of the variable in question

In determining the number of cointegrating relationships the lag length used is 2. The lag-order selection test shows that two period lag could be selected as the reasonable lag structure using AC, SC , HQ as well as LR criterion for this. Structural break dummy and a constant are also included in the model. The structural break dummy is intended to capture the effect of the shift in many macro variables observed since 1990/91.

The Johansen procedure test results in one cointegration vector with two lags in the system as given by Table 1. Both trace and maximum eigen value tests fail to reject the null of zero cointegrating equation in the system and given in Table 1.

Table 1: Johansen Cointegration Test for Inter Sectoral Relations and Public Spending by Sector

Hypothesized no of CEs	Eigen value	Trace test*		Max Eigen value test	
		Trace Statistics	Critical level at 5% level of significance**	Max-Eigen* Statistics	Critical level at 5% level of significance**
None#	0.79	130.59	95.75	64.41	40.08
At most 1	0.47	66.18	69.82	26.15	33.88
At most 2	0.35	40.03	47.86	18.24	27.58

*Both Trace test and Max-Eigen value test indicates 1 cointegrating eqn(at the 0.05 level

**MacKinnon-Haug-Michelis (1999) test

Following the co-integration test the co-integration vector (the long-run relations ship between the three sectors and public spending in each of these sectors) is given by the following equation of the model (all variables are in logarithm):

$$ECM_{11} = \log(\mathrm{A}) + \underbrace{0.19\log(IND)}_{[0.42]} - \underbrace{1.22\log(SER)}_{[-2.04]**} \ldots + \underbrace{0.36\log(PS\_A)}_{[2.66]*} + \underbrace{0.18\log(PS\_IND)}_{[1.30]} - \underbrace{0.47log(PS\_SER)}_{[-3.14]*}$$

$$\Rightarrow \log(A) = - \underbrace{0.19\log(IND)}_{[0.42]} + \underbrace{1.22\log(SER)}_{[2.04]**} \ldots - \underbrace{0.36\log(PS\_A)}_{[-2.66]*} - \underbrace{0.18\log(PS\_IND)}_{[-1.30]} + \underbrace{0.47log(PS\_SER)}_{[3.14]*}$$

Diagnostic tests were conducted to test the adequacy of the model. The model satisfies almost all diagnostic tests (residual based tests). The estimated cointegration equation also produces a sound impulse response (reported below) -complement the results obtained above.

As can be read from the CI equation above activity in the industrial sector had the intuitively unexpected negative coefficient with the agricultural sector, although it is not statistically significant. On the other hand the service sector is found to have strong statistically significant positive relationship with agriculture in the long run. Hence a 1% change in services will be accompanied by 01.22 % change in agriculture. Similar positive coefficient is found for public spending in the service sectors – thus underscoring investing in the non-agricultural sector as part the agricultural development strategy.

The finding about the impact of public spending in the agricultural and the industrial sector on agriculture is also interesting. The results shows that, the effect of public spending in agriculture and public spending in industry are found to have a negative effect, although the latter is not statistically significant. Public spending in Agriculture is, however, found to have statistically significant negative relations to valued-added in agriculture. Although this latter results seems not to be intuitive, it is not that surprising given our micro finding below as well as efficiency of public spending in agriculture form our qualitative study (see Alemayehu and Dawit, 2009b) where growth in spending in Agriculture is associated with stagnation in the agricultural sector.

Although our objective in this section is to see the long run sectoral relation and spending in each sectors form macro and sectoral perspective, we have offered below an dynamic error correction model and an impulse response analysis using the error-correction model based on the co-integration analysis above (see Table 2).

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Table 2: Parsimonious Error [Equilibrium] Correction Model (Dependent Variable: Δ(LA)

1965/66 – 2007/08

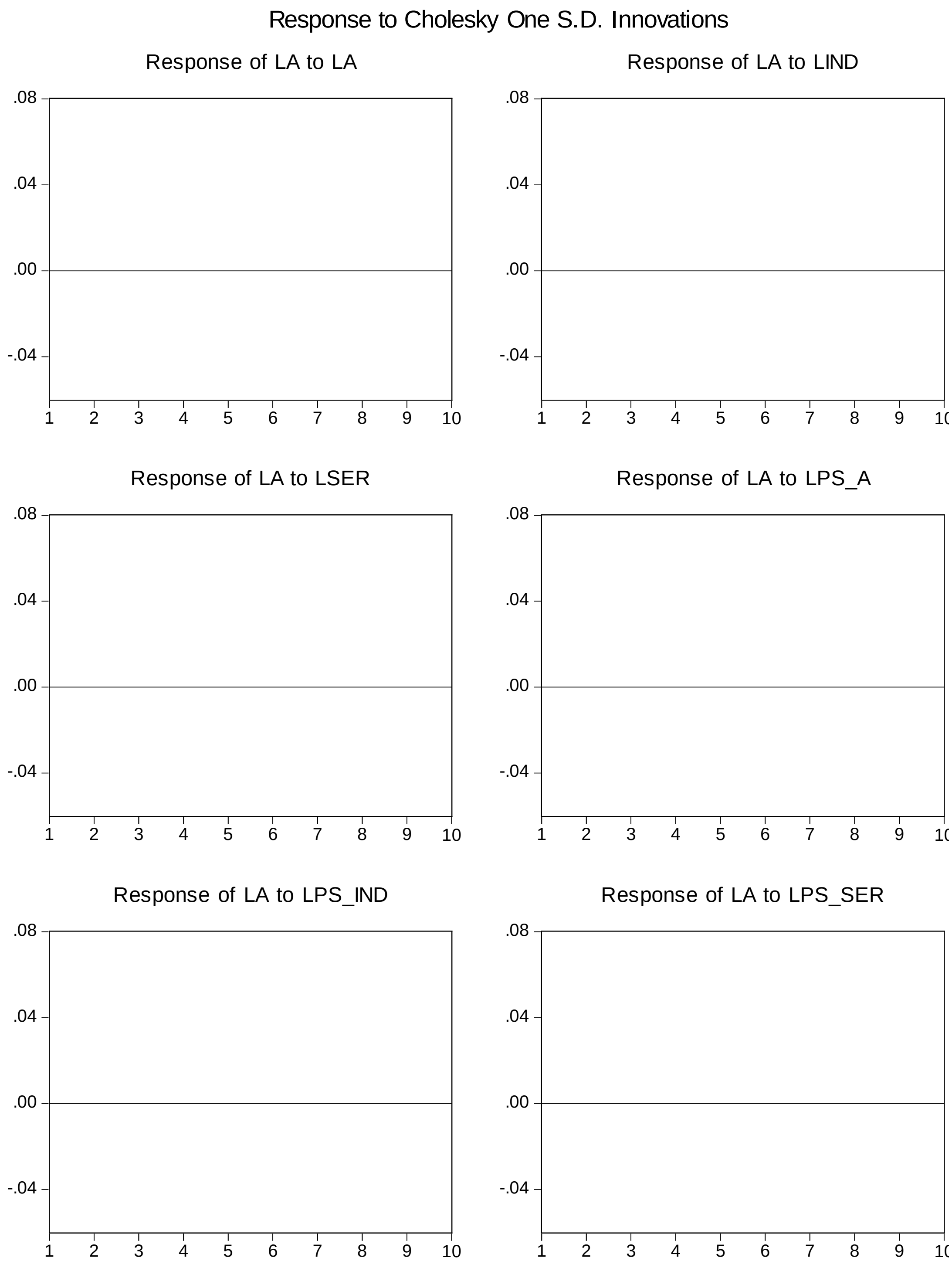
Variable	Coefficient	t-Statistic	Prob.
Δ(LA(-1))	0.17	1.09	0.00
Δ (LIND(-1))	-0.02	-0.09	0.95
Δ (LSER(-1))	-0.11	-0.49	0.10
Δ (LPS_A(-1))	-0.19	-3.52*	0.10
Δ (LPS_IND(-1))	0.05	0.85	0.95
Δ (LPS_SER(-1)	-0.44	-2.48*	0.99
ECM(-1)	-0.56	-4.24*	0.00
Constant	0.06	2.30*	0.00

R^2=0.62
Adjusted R^2=0.41
Log likelihood =277.85

It is interesting to note that from EqCM/ECM above (Table 2) that inter sectoral relation and public spending in Agriculture are either statistically insignificant or are counter intuitive with numerical values that are not significant (has less potency), perhaps indicating the importance of this relationship only in the long run.. This short run result is fairly consistent with the previous section long-run result.

Having the VAR model and the EqCM that followed, we have done an impulse-response analysis to see the implication of injection or a shock in one sector (say in the Service and the Industrial sector) or in different categories of public spending (say public spending in the service sector) on the value-added in agriculture sector. This is shown by Figures 1 below. We have presented here the response of Agriculture value added to various innovations. A similar analysis could be carried for the rest of the sectors..

Figure 1: Impulse Response Analysis


Response to Cholesky One S.D. Innovations
Response of LA to LA
Response of LA to LIND
Response of LA to LSER
Response of LA to LPS_A
Response of LA to LPS_IND
Response of LA to LPS_SER

The impulse response in Figure 1 shows that taking into account the inter-sectoral value-added and inter-sectoral public spending interaction in a dynamic set-up, growth in public spending in the the agricultural, the service and industrial sector will bring an initial decline in value added in agriculture which will pick-up positively only that which comes from the service sector . On the other hand a positive change in the industrial and the service sector r lead to immediate rise in value-added in agriculture that, the potency of that from the service sector being larger.

The main conclusion that is emerging from the above exercise could be summarized as follows:

a) The first important point to note is that there is a measurable interaction among sectoral value-added (in Agriculture, industry and services) as well us public spending destined for each of these sectors. This need to be taken on board when planning of spending in the agricultural sector is made.
b) The second major finding is that the agricultural sector growth could enormously benefit from growth both in the industrial and service sectors with strong elasticity, specially from the latter.
c) Third public spending in services r has a positive and significant effect both in the long run as well as in a dynamic set up.
d) Finally, our finding that public spending in agriculture having negative effect on the sector's value added strengthen our earlier finding using the qualitative study that there is a problem of spending without proper planning. Yet spending at least in service sectors have positive effect on agriculture– this also strengthen our point about lack of inter-sector synergy focus on planning in our qualitative data based study (see Alemayehu and Dawit, 2009b).

We have substantiated further the finding above using recent economy wide SAM based models which are briefly outlined in the next sub-section.

2.3.2 An IO and SAM Based Analysis Results: Agriculture and Non-Agricultural Linkages

In this sub-section we will highlight the about inter-sector linkages using the result of two recent economy-wide SAM based model for years 1995 and 2001/02. The debate about the role of agriculture and industry as the basis for development strategy and hence by implication the focus on either Industry and services (urban) or Agriculture (rural economy) is a highly contested issue in Ethiopia. It also informed the political discourse in the country where the opposition invariably arguing against the government strategy of Agricultural Development Led Industrialization (ADLI). The perception about the role of agriculture as a source of weak multiplier, compared to industries, is partly attributed to the confusion in using either Social Accounting Matrix (SAM) or Input-Output (IO) analysis for empirical validation of each of the claims. In general when IO based multiplier analysis is used the urban (industrial) economy shows to be relatively more important than the agricultural sector. On the other hand, as noted by Sadolet and de Janvery (1995), once a SAM based multiplier is used, owing to demand effect, agriculture doesn't fare any worse than industry (Figure 3 below shows this for Ethiopia).

The first and until recently the only SAM in the country was the 1987 SAM which is constructed by a group of Ethiopian experts at MOFED and experts from the Food Studies Group of the University of Oxford. The 1987 SAM was meant an input for the construction of a CGE model which never realized. Since it was constructed for the purpose of understanding grain market in Ethiopia, it focused on the agricultural sector. Other sectors are consolidated to obtain consistency. The 1987 SAM is a 61 by 61 matrix. It contains 25 production activities, 26 commodities, 4 factors of production and 6 institutions. The agriculture sector is divided into three main cereals (*teff*, wheat and maize) that constitute 13% of GDP and 'Other agricultural activities' comprise about 25% of the GDP. Industry and services constituted about 41.5 % of the GDP, while trade accounted for 20.3 % of the GDP. The latter are pre-dominantly an urban economic activities.

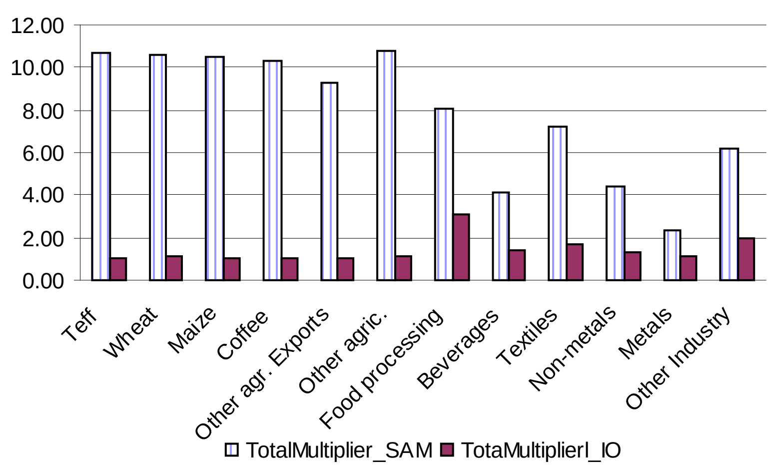
Tadle (2000) modified and consolidated the 1987 SAM in his MSc thesis submitted to the Department of Economics of AAU in 2000. He (1) consolidated the commodity and activity accounts into one 'activity' account, (2) disaggregated the agricultural sector to consider 'exports' explicitly; similarly, he disaggregated the industrial sector into six sub-sectors and the service sector into three, (3) the factors of accounts are consolidate to two, (4) the stock accounts is replaced by the capital account, (5) the tax account is merged with the government sector; and (6) the SAM is updated to the year1995. This has led to the modified and consolidated SAM with a size of 23 by 23 (one of rows/columns being an adjustment factor account). .This SAM is used to inform the sub-section [A] below. This is complemented by yet by another recent similar SAM based analysis done by IFPRI that used recent 2001/02 SAM (see Diao et al 2007) in sub-section [B] below.

A] The 1995 SAM-based Multiplier Analysis

A SAM based multiplier matrix computed based on the 1995 SAM noted above (i.e., the Leontife inverse) shows the following results. Each cell of a particular column of this matrix shows the impact of a unit change on that account on endogenous variables (given across rows) and its column total shows the total effect., total multiplier. The average total multiplier for all 23 sectors in this SAM is 8.3 units. Of this 'total activities', which for convenience are divided into agricultural (2.14) and industrial sectors (0.57), has an average multiplier of 2.7 per sector. Thus, the industrial sector's multiplier effect on the whole economy is on average about four times smaller (see Alemayehu and Daniel 2009).

Similarly, the total multiplier effect of the agricultural sector (62) is twice that of the industrial sector (32)[10]. If we examine each column in detail, the top eight sectors, with a total multiplier value of over 10 are: labour (10), *Teff* (10.7), wheat (10.7), maize (10.5), coffee (10.3) and 'other agriculture' (10.8), National Bank (10.6) and 'Other financial services' (10.7). In the industrial sector, the highest multiplier comes from the food processing sector (8.08), followed by textiles (7.20), 'other industries' (6.22), non-metals (4.45), beverage (4.15) and metals (2.3). These figures suggest that, given this static framework, from macro and inter-sect oral interaction perspective, focusing on agriculture is justifiable. Moreover, within industrial sector food process and textiles industries do worth the attention of the government. This needs to be taken cautiously, however. This is because the SAM framework is not only static but also a demand driven one.

Figure 1: Total Multipliers using the 1995 SAM and IO Tables for Ethiopia



The horizontal axis shows the activity columns of the 1995 SAM and I-O tables. Figure 1 makes it clear that the multiplier effects of the agricultural sector is very strong when a SAM based model is used. This is because agriculture, through its demand effect, has strong multiplier effect on the economy.

To get some clue about sectoral priorities from macroeconomic interaction perspective, Alemayehu and Daniel (2009) have computed the backward and forward linkages for thirteen of the 23 accounts shown in the 1995 SAM. Twelve of these accounts are sub-sectors of the industrial and agricultural sectors, the 13th account being the 'non-financial services'.

10 This ranking is, however, reversed (agriculture being 6.4 and industry 10.5) when an input-output, rather than, SAM, based multiplier is used (see below).

The backward (BWL) and forward (FWL) linkages are computed as the column and row totals, respectively, of the multiplier matrix for each of the thirteen accounts. The total multiplier effect of a sector (or an account) is not simply the sum of the two linkages since the theoretical basis of the two differs: backward linkages are based on demand-led growth theory while forward linkages are informed by supply-led growth (see Sadolet and de Janvery (1995). The method used to compute the total linkage effects is what is called the *extraction method* (see Cella 1984). In this method the level of output of the 20 endogenous accounts is computed for a given multiplier and the three exogenous accounts (government, external sector and capital). Then, the row and column of the sub-sector for which we want to compute the total linkage effect, except its diagonal element, is filled with zero. A new multiplier for this new matrix is computed and used to compute the endogenous account values for the same level of exogenous accounts' values used before. The resulting output differential (deviation) is reported as percentage of the base run. The result shows the backward, forward, and total linkage effects for each sector (See Alemayehu and Daniel 2009)r. Since we have discussed the backward linkages (column total) above, we will focus on the forward and total linkages below.

The total 1995 SAM based multiplier shows that the backward multiplier has an average (over the thirteen accounts) value of 7.8 compared to forward multiplier of 10.8. However, this average conceals the fact that the agricultural sector has relatively higher forward linkages (over twice the forward linkages). On the other hand, the industrial sector shows relatively higher backward linkages. This pattern remained unchanged when the multiplier is computed for the activity sub-matrix, although the magnitude of the backward and forward multiplier has declined (to an average figure of 2.8 for backward and 6.3 for forward linkages). The agricultural sector has an average BWL and FWL multipliers of 2.3 and 4.3, respectively. The corresponding figures for the industrial sector are 0.7 and 1.9, respectively.

This result also shows that the total (BWL and FWL) multiplier computed using the 'extractive' method described above. This is done for cereals (*Teff,* Wheat and Maize) our indicator of the agricultural sector/the rural economy; as well as for the industrial sector and its sub-components/ the urban economy. The average deviation from the base run for all the thirteen sectors when we exclude 'cereal' and 'industry' categories from the SAM is about 24 % for cereals and 41 % for industries. It is interesting to note that excluding the industrial sector from the SAM results in greater reduction, about 11 % reduction in the production of the agricultural sector than similar effects of agriculture on industry which is about 3%. Thus, notwithstanding its small size, the industrial sector, and hence the urban economy has relatively high total linkage effect in the economy. This is especially true of textile, non-metal and food processing industries. It should also be noted that this would have been much more if service sectors are added to the industrial sector. The analysis in this section shows that the SAM framework can offer a perspective on what the likely constraints of output growth might be, if not its predictability. Although the framework is static and assumes output is demand constrained, it is helpful to pinpoint at the linkage between the industrial and agricultural sectors. From the foregoing discussion we note that:

a) the multiplier effect of agriculture sector (rural economy) is better than the industrial sector (urban economy) once the analysis is carried in a SAM analytical framework; however, when an IO is used the industrial (urban economy) becomes more important
b) Identification of sources of growth from the perspective of macroeconomic and sectoral interaction reveals that agricultural growth is dependent on the total multiplier effect of the industrial sector. In particular, food processing, textile and non-metal industries have the highest linkages and worth the attention of policy makers. Since almost all such industries are located in urban areas, focusing on urban economy is a vital component for a success in agricultural-led growth.

B] The 2001/02 SAM- based Analysis

The second recent economy-wide SAM based work which has a focus on the agricultural sector is that of Diao et al (2007) at IFPRI. We have briefly summarized relevant results of this study for our point here – the impotence of inter-sector linkages for Agricultural growth. The data used for the analysis is extracted from the 2001/02 Ethiopian SAM. This SAM is a 63x63 matrix and contains an account for each of twenty production activities, five factors of production, twenty-five commodities, transactions costs, three household groupings, three enterprise types, recurrent government, three types of public investment, savings/investments of institutions other than the government, and the rest of the world. Under the assumption of semi-constrained supply response the 2001/02 SAM based model result shows that , a 1 Birr increase in maize output under traditional agricultural production will generate 1.97 Birr rise in total GDP. The analogous change in GDP are 2.18 Birr for teff, 3.45 Birr for coffee, 1.40 Birr for textiles, and 1.16 Birr for other manufactures. In short, almost all sectors generate large linkages. But those induced by agricultural activities are larger, primarily because of larger initial value added (income) and consequently larger second round of consumer spending on local goods and services. In general, growth in agriculture produces stronger linkages than growth in non-agriculture. This is in line with the 1995 SAM based analysis noted above. The potential benefits of stimulating growth in agricultural production (albeit differentiated by products) are thus substantial. Nevertheless, the size of this potential as well as the extent of its realisation depends on a parallel expansion in non-agricultural sectors. Estimates obtained by varying the set of non-agricultural sectors assumed to be supply unconstrained show this dependence clearly. (Diao et al 2007:14-15)

The growth impact of staple crop, agricultural, export crop and non-agricultural led growth can be read from Table 3. It can be read from the Table 3, among other things, the GDP and Agricultural GDP growth is the heist for Agricultural-led growth compared to Non-agricultural-led growth, although the magnitude is not that big.

Table 3: Simulation Results About Agriculture and Non-Agricultural Sector Induced Growth using the 2001/02 SAM

Growth Rate	Base-run	Staple crop led growth	Export crop led growth	Agricutlure led growth	Nonagriculture led growth
GDP growth rate	4.5	5.5	5.5	5.5	5.5
Ag GDP growth rate	3.7	4.1	5.7	4.5	4.2
NAg GDP growth rate	5.3	6.8	5.4	6.4	6.7
Total staple crop and livestock growth rate	3.1	4.9	3.0	4.3	3.2
Cereal output growth rate	2.9	4.5	2.9	4.2	3.0
Livestock output growth rate	4.1	6.4	4.0	5.2	4.2
Total export crop growth rate	3.1	2.7	15.6	7.7	3.0
Nontraditional export crop growth rate	4.0	3.7	15.0	8.0	4.0
Nontraditional exports growth rate	8.0	4.8	31.2	18.3	6.4

Source: Diao et al (2007)

To make the impacts more clearly comparable the Diao et al (2007) study used growth multipliers. The multipliers are defined as the total increase in real GDP divided by the increase in the shocked sector's total output, both measured at the initial (base-year) level of prices. The resulting multipliers derived using an economy wide and endogenous price models are in general relatively smaller than the standard fixed-price multipliers. The simulation results show that the staple sector's growth multipliers are consistently greater than one and increase overtime. These results imply that one unit increase in staple production will generate more than one unit of increase in total GDP. Moreover, such growth linkages become stronger over time. On the other hand, the linkages from agricultural export sector to total GDP is strong only in the initial five years, while the linkages become weaker overtime, and the growth multipliers fall to below one by 2015. (Diao et al 2007:22)

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Growth in agriculture significantly stimulates the non-agricultural sector's growth. Measured by total non-agricultural GDP, the annual growth rises to 6.42 percent, instead of 5.26 percent in the base-run. The additional 1.2 percentage points of non-agricultural annual growth are thus induced by the growth in agriculture. Calculated GDP growth multipliers are 1.05 – 1.13 in the first five years and increase to 1.29 by

2015 in this scenario. Strong demand linkages explain why faster agricultural growth, especially of food production, has such strong growth linkage effect on the non-agricultural sector. This has two implications for the overall growth in the economy. First, it implies that it is unlikely to have any broad-based growth without agriculture.. Second, it implies that rural demand is the dominant factor to provide enough market opportunities for both industrial products and services produced in the economy. Although the effects are less one, a unit injection in the non-agricultural sector has also a positive less than unit effect on the agricultural sector (Diao et al 2007:24-25).

III. Efficiency of Public Spending in Agriculture: A Micro Perspective

In this section we will present two approaches that utilize survey data and a host of micro-econometric techniques to investigate the efficiency of public spending in Agriculture. The following section discusses the conceptual framework and the nature of the data employed in the analysis, before delving deeper into a presentation of the results from the two approaches

3.1 The Conceptual Framework

3.1.1 Microeconomic tools in public spending efficiency analysis

The most popular taxonomy of the methods classifies them into two broad categories: *parametric* or *non-parametric*, and *deterministic* or *stochastic*. The parametric approach imposes functional forms for the relationship between inputs, outputs and the deviation term capturing the distance between observed outputs and the efficiency frontier using econometric methods, while the latter (none-parametric) determines the frontier directly from the data in lieu of making assumptions on functional forms and therefore employs mathematical programming techniques. On the other hand, the deterministic approach in the second pairing considers all deviations from the frontier as being indicative of inefficiency while the latter (i.e., stochastic) characterizes deviations as a combination of inefficiency and random shocks.

The development of modern public sector spending efficiency analysis has not gravitated towards a particular model. A review of the methodology by Herrera and Pang (2004) notes that half of the six recent studies on the area have employed either input oriented FDH[11] [Gupta and Verhoeven (2001)], single-input-single-out put FDH (*Free Disposable Hull*) [Afonso et. al. (2003)], or DEA (*Data Envelopment Analysis*) and FDH [Afonso and St Aubyn (2004)]. The other three [Evans and Tandon (2000), Jarasuriya and Woodon (2002) and Greene (2003)] have employed parametric techniques. The World Bank's PRMED (Economic Policy and Debt Department) website detailing some of the Bank's research projects in the area also shows the focus of the methodology with growing emphasis being accorded to FDH and DEA [*non-parametric approaches*], and the stochastic frontier model [*a parametric approach*]. Gupta and Verhoeven (2001) argue that the analysis of public spending efficiency has taken different forms over the past four decades. The study notes that the focal points of analysis have ranged from qualitative studies investigating ways of enhancing efficiency in practical application to quantitative studies focusing on inputs of government spending but not outputs, vice-versa. Various studies have incorporated both inputs and outputs in their analysis.

[11] Note FDH and DEA are non-parametric approaches.

Even though we have outlined in (Alemayehu and Dawit (2009a)) that our focus will be on the three dominant approaches in the literature *FDH, DEA* and the *stochastic frontier models*, we only deal with the latter approach, as the latter is best suited to our data. In the next section we provide a discussion of the stochastic frontier model and its application. Although we will not be discussing the FDH, or DEA approaches in this paper, earlier versions of it have experimented with FDH using data for the Belg season.

Stochastic Frontier model:

Aigner, Lovell and Schmidt's (1977) normal-half-normal model is credited as being the first progress made in stochastic frontier modeling. Although the compound disturbance term is asymmetrically distributed, most choices of the distribution of the disturbance term are well behaved.

$$f_v(V_i) = N(0, \sigma_v^2) = \frac{1}{\sigma_v}\varphi\left(\frac{v_i}{\sigma_v}\right), -\infty < v_i < \infty$$

and

$$u_i = |U_i|, where\ f_u(U_i) = N[0, \sigma_u^2] = \frac{1}{\sigma_u}\varphi\left(\frac{U_i}{\sigma_u}\right), -\infty < U_i < \infty$$

where $\varphi(.)$ denotes the standard normal density. The resulting density for U_i is

$$f_u(U_i) = \frac{1}{\Phi(0)}\left(\frac{1}{\sigma_u}\right)\varphi\left(\frac{U_i}{\sigma_u}\right), \qquad 0 < U_i < \infty,$$

Where $\Phi(.)$ is the standard normal cumulative density function (CDF). The symmetrically distributed v_i is usually to be assumed to be normal, which we will denote $f_v(V_i) = N(0, \sigma_v^2)$. The distribution of the compound random variable $\varepsilon_u = v_i - u_i$ has been derived by Weinstein (1964) and is discussed in Aigner, Lovell, and Schmidt (1977).[12] The end result, maintaining the form above, is

$$f_s(\varepsilon_i) = \frac{2}{\sqrt{2\pi(\sigma_u^2 + \sigma_v^2)}}\left[\Phi\left(\frac{-\varepsilon_u\left({}^{\sigma_u}/{\sigma_v}\right)}{\sqrt{\sigma_u^2 + \sigma_v^2}}\right)\right] exp\left(\frac{-\varepsilon_i^2}{2(\sigma_u^2 + \sigma_v^2)}\right)$$

A convenient parameterization which also produces a useful interpretation is $\sigma^2 = (\sigma_u^2 + \sigma_v^2)$ and $\lambda = \frac{\sigma_u}{\sigma_v}$.[13] Then,

$$f_\varepsilon(\varepsilon_i) = \frac{2}{\sigma\sqrt{2\pi}}\varphi\left(\frac{\varepsilon_i}{\sigma}\right)\left[\Phi\left(\frac{-\varepsilon_i\lambda}{\sigma}\right)\right]$$

This density is skewed in the negative direction.

[12] The derivation appears in many other sources, for example, Pitt and Lee (1984), Greene (1990), and Kumbhakar and Lovell (2000).

[13] An alternative parameterization that is convenient for some other forms of the model is $\gamma = \frac{\sigma_u^2}{\sigma^2}$. Consult Battese and Corra (1977), Battese (1992), Coelli (1991) and Greene (2000, Chapter 28).

With the assumption of a half-normal distribution, we have $E[u] = \sigma_u\sqrt{\frac{2}{\pi}}$ and $var[u_i] = \sigma_u^2\left[\frac{(\pi-2)}{\pi}\right]$. A, rather, common misapprehension in applications is to treat σ_u^2 as the variance of u_i. The above overstates the variance by a factor of nearly 3! (Green (2005)-31). Since σ_u is not the standard deviation of u_i it gives a somewhat misleading picture of the amount of inefficiency that the estimates suggest is present in the data. Although λ is indicative of this aspect of the model, it is primarily a convenient normalization, not necessarily a directly interpretable parameter of the distribution. It might seem that the variance ratio $\frac{\sigma_u^2}{\sigma^2}$ would be a useful indicator of the influence of the inefficiency component in the overall variance. The variance of the truncated normal random variable u_i is $var(U_i|U_i > 0) = \sigma_u^2\left[\frac{(\pi-2)}{\pi}\right]$, not σ_u^2. In the decomposition of the total variance into two components, the contribution of u_i is

$$\frac{var[u]}{var[\varepsilon]} = \frac{\left[(\pi-2)/\pi\right]\sigma_u^2}{\left[(\pi-2)/\pi\right]\sigma_u^2 + \sigma_v^2}$$

Details on estimation of the half-normal model may, also, be found in Aigner, Lovell, and Schmidt (1977) and in Greene (2003a). The parameter λ is the inefficiency component of the model. The simple regression model results if λ equals zero. The implication would be that every DMU operates on its frontier. This does not imply, however, that one can 'test' for inefficiency by the usual means, because the polar value, λ = 0, is on the boundary of the parameter space, not in its interior. Standard tests, such as the LM test are likely to be problematic.

The log-likelihood function for the normal - half normal stochastic frontier model is

$$lnL(\alpha, \beta, \sigma, \lambda) = -Nln\sigma - constant + \sum_{i=1}^{N}\left\{ln\Phi\left[\frac{-\varepsilon_i\lambda}{\sigma}\right] - \frac{1}{2}\left[\frac{\varepsilon_i}{\sigma}\right]^2\right\}$$

where

$\varepsilon_i = lny_i - \alpha - \boldsymbol{\beta^T X_i}, \lambda = \sigma_u/\sigma_v, \sigma^2 = \sigma_u^2 + \sigma_v^2$

$\Phi[.]$ represents the standard normal CDF

The log likelihood function is quite straightforward to maximize, and has been integrated into several contemporary commercial computer packages, including Frontier4 (Coelli (1996)), LIMDEP (Greene (2000)), Stata (Stata (2005)) and TSP (TSP International (2005)). (See, also, Greene (2003) for discussion of maximizing this log likelihood.). We will be using this approach in this study.

3.1.2 Demand for publicly provided agricultural services

The second dimension in analyzing the efficiency of public spending is the demand for publicly provided agricultural services. In other words, public spending which is the supply of agricultural services may not be effective if there is no demand for it from the users. Different studies have gone about analyzing the issue in different ways. Herrera and Pang (2005) that incorporates a variable capturing the ratio of public to private financing of service provision in its non-parametric analysis of the efficiency of public spending and finds that higher ratios of public to private financing of service provision in education and health is associated with lower efficiency scores. Due to lack of data on public-private ratios of spending in agriculture we employ a variation of the model detailed in Collier *et al* (2002). Collier *et. al.* (2002) analyzes the effects of quality and density on usage of health care. We will apply a similar framework to analyze the marginal effectiveness of public expenditure on agricultural services (infrastructure, extension services).

The next few paragraphs will be devoted to reconstructing Collier *et al* 's (2002) framework and apply it to analyze the demand for agricultural services in Ethiopia. The above framework is essential in examining our working hypothesis: even if there is a stream of supply of agricultural services as part of public spending on productivity, its effectiveness may be limited by the low demand for it by farm households.

We begin with the objective function of government in regards with agriculture: the maximization of agricultural output subject to the budget constrain and the behavior of a utility maximizing representative farm household. Instruments at the disposal of government include the quality of agricultural services and the density (supply or quantity) of services and infrastructural facilities. The representative farm household has a utility function with the value of agricultural yield (A_y) and consumption excluding own-farm produce (C).

$$U = U(A_y, C)$$

Time is spent either in providing labor (l) or in soliciting the services of extension workers (t_{sA}). The demand for publicly provided agricultural services is represented by D_A.

$$L = l + t_{sA} D_A$$

The full income budget constraint is hence given by:

$$w \cdot L = C + A_{sc} \cdot D_A + w \cdot t_{sA} \cdot D_A$$

'w' represents the real wage rate while, A_{sc} represents the cost of publicly provided agricultural services.

Agricultural yield is determined by a parsimonious production function including the demand for publicly provided agricultural services (D_A), and the quality of the services (Q).

$$A_y = A_y(C, D_A, Q)$$

Collier *et al* (2002) treats all functions as deterministic, but notes that, although, the stochastic element cannot be denied, it will not affect the integrity of the model.

The household is supposed to choose the levels of D_A and L to solve the optimization problem:

$$max\, U(A_y, C)$$

Subject to: $L = l + t_{sA} D_A$

$$w \cdot L = C + A_{sc} \cdot D_A + w \cdot t_{sA} \cdot D_A$$

$$A_y = A_y(C, D_A, Q)$$

The maximization problem yields demand functions for agricultural yield and the demand for publicly provided agricultural services

$$A_y = a_y(A_{sc}, w, Q)$$
$$D_A = a_y(A_{sc}, w, Q)$$

Similar to collier and Dercon (2002) we are primarily concerned in the partial derivatives of the demad functions, particularly $\partial D_A/\partial Q$.

Government's allocation of resourcees between recurrent and capital expenditure is supposed to generate a combination of good quality and affordable public provision of agricultural services.

$$G = rQ - cA_{sc}$$

Where G is government budget; 'r' is the unit price of improvement in quality and 'c' is the unit price of reduction in the cost of publicly provided agricultural services

The government maximizes the A_y subject to the constraints:

$$G = rQ - cA_{sc}$$
$$A_y = a_y(A_{sc}, w, Q)$$
$$D_A = a_y(A_{sc}, w, Q)$$

Our main interest in this study is on two measures: the marginal effect of expenditure on quality improvement, and the effect of increases in expenditure on the provision of publicly funded agricultural services.

The first measure can be represented as [Note that $E_q$represents public expenditure on the quality of service provision]:

$$\frac{dD_A}{dE_q} = \frac{dQ}{dE_q} \cdot \frac{dD_A}{dQ}$$

The second measure, on the other hand, is represented by the following expressison below [Note that E_f represents public expenditure on service provision, while N represents expansion in publicly provided agricultural services].

$$\frac{dD_A}{dE_f} = \frac{dN}{dE_f} \cdot \frac{dA_{sc}}{dN} \cdot \frac{dD_A}{dA_{sc}}$$

The demand analysis[14], similar to the efficiency frontier analysis employs a variation of the half-normal stochastic frontier model (presented in the previous section).

[14] The limitations of parametric vis-à-vis non-parametric techniques is discussed in Alemayehu and Dawit (2009a)

$$lnL(\alpha,\beta,\sigma,\lambda) = -Nln\sigma - constant + \sum_{i=1}^{N}\left\{ln\Phi\left[\frac{-\varepsilon_i\lambda}{\sigma}\right] - \frac{1}{2}\left[\frac{\varepsilon_i}{\sigma}\right]^2\right\}$$

Where

$$\varepsilon_i = lny_i - \alpha - \boldsymbol{\beta}^{\boldsymbol{T}}\boldsymbol{X}_{\boldsymbol{i}}, \lambda = \sigma_u/\sigma_v, \sigma^2 = \sigma_u^2 + \sigma_v^2$$

$\Phi[.]$ represents the standard normal CDF

The following section discusses in detail the data requirements for the analysis.

3.2 Data and Empirical Results

3.2.1 Data

The dataset for the micro-econometric module of the study was developed by the World Bank in collaboration with the Ethiopian Economic Policy Research Institute (EEPRI/EEA) in the years 2004 and 2006. There are indications that developers of the dataset, more appropriately referred to as 'Land Policy Study in Ethiopia, may have grappled with unresolved household identification problems in the datasets for the two years. However, the second installment has managed to match around 2300 households. We have opted to use the most recent version of the data-series. Another justification for the use of cross-sections instead of panels is that an involved investigation of dynamics may not be necessary at this point, although the use of panels could be helpful in controlling for household heterogeneity in the adoption and use of public services. The most recent study has developed a sampling methodology that illuminates on an important characteristic feature of extension services in the country: commodity orientation. Hence, the sampling procedure entwines purposive and random selection procedures. The former signifies the stratification of Woreda units by potential agricultural commodities. The twin sample selection criterion, in addition, is meant to address the bias of extension services in favor of major cereal crops.

The study covers a total of 92 Woreda units across the country, drawn from 9 regional states, and distributed over 43 administrative zones, (see Map 1 in Annex I). The Woreda units were randomly selected from among units listed as having potential in the production of a certain agricultural commodity. In addition, the sampling procedure covers differences in agro-ecology, moisture regimes, length of crop growing period, market opportunity and the availability of supporting institutions.

The sampling procedure accommodates differential levels of access to markets and communication centers, and access to technologies and institutions. [More on sampling procedures and instruments can be obtained from the project's Manual for methods of sample selection and sample size].

Table 1: Number of zones and households sampled per region

	Selected zones		Selected farm households	
Region	Number	Percent	Number	Percent
Tigray	4	9.1	350	7.6
Afar	2	4.5	200	4.4
Amhara	8	18.2	994	21.6
Oromia	13	29.5	1891	41.2
Somalie	1	2.3	100	2.2
Benshangul Gumuz	2	4.5	100	2.2
SNNPRs	11	25.0	852	18.6
Dire Dawa	1	2.3	50	1.1
Harari	1	4.5	50	1.1
Total	43	100	4587	100

Source: EEPRI/EEA-World Bank project documents on sample design.

However, our main focus, throughout the module will be on the production of major cereal crops (Barley, Corn, Teff and Wheat) and hence, all households in the dataset involved in the production of major cereal crops are used-around 2142 households spatially distributed over four regional states and over 50 woreda units (see Annex II). The sampling procedure of the study is also reflected in the distribution of Woreda units in cereal crop production. We, then, proceeded to extract information relating to: household identification, input purchases, extension package, and crop production and input use.

3.2.2 Result:

A] The Efficiency Frontier Approach-The Case of multiple inputs and One output (SFM)

Variable descriptions and assumptions

Scrutiny of [reported] data on regional revenue indicates that the capacity of regional states to raise sufficient revenue has not substantially improved over the years. Hence a large bulk of the regional budget is made up of federal block grants that are determined based on a number of criterions. Population differences and the level of underdevelopment of regional states represent two of the variables with prominent weights in the composite regional block grant allocation formula. The above implies that the level of expenditure and economic development of regional states may not be strongly linked and therefore would not produce anything that resembles the Balassa-Samuelson effect. The latter contends that price levels (goods and factor outputs) in wealthier countries tend to be higher than levels in poor countries.

However, we have kept the assumption that as economic activity increases the sum total of government consumption and investment tends to follow the trend. Hence, the elasticity of demand for publicly provided services is greater than one. However, the above hypothesis commonly referred to as Wagner's hypothesis [Herrerra and Pang (2005): 8][15] is invoked, more appropriately, in a panel data setting.

Efficiency frontier analysis routinely assume that there is a level of homogeneity in the number of, and quality of production inputs utilized across spatially distributed decision making units (DMUs). The above implies that omissions in important factors of production will yield efficiency rankings that favor the DMU that uses more of the omitted input. In addition, disparity in the quality of inputs utilized will, also yield efficiency scores biased in favor of DMUs using better quality inputs. Studies have indicated that factor heterogeneity is not a problem if it is distributed spatially and hence there are limited spatial differences in the average quality of a factor. Although most cross-country studies are plagued with this limitation, there is little concern in our case that there is a systematic relationship between spatial differences in the average quality of inputs. Herrerra and Pang (2005): 8 notes that the significant correlation between public spending and per-capita GDP implies a systematic relationship between the quality of factor inputs (spending in this case), and level of development. The above is not readily apparent in our case, as cross-regional disparities in the level of development do not cause higher budgetary allocation in favor of regions with bountiful production.

We were unsparing in our selection of factor inputs in the production of cereal crops (see Annex IV, Table 1A). Multiple-input-single output efficiency scores were developed for a joint production of major cereal crops (Barley, Maize, Wheat, and Teff) using:

Outputs: *Value index* (Birr)

Inputs: *Woreda spending in agriculture* (estimated using regional expenditures on capital and recurrent spending and applying unit shares across Woreda units in regional states.), *Land* (hectares)*, family labor* (Number of man days), *seeds* (KGs), *fertilizers* (KGs), *manure* (KGs), *herbicides/fungicides* (Liters/KGs), and *Oxen-days* (Traction days)

One of the limitations, shared by studies using efficiency frontier approaches is the combination of monetary and non-monetary factors of production. On a different note, the focus on small holder agriculture has meant the exclusion of private spending as an input. However, data constraints also limit its application.

The conceptual basis of the adoption of a joint production model is apparent. The latter approach to economic interactions stresses the necessary relationships between various inputs and, corresponding outputs. In addition, the absence of small holder specialization in the production of cereal crops implies that it may be conceptually incomplete to consider production processes that utilize similar inputs.

The input-oriented efficiency scores for the joint production decision model show varying levels of correlation (computed using Spearman's rank correlation test) suggesting that they may not be robust to the use of other output variables [see Annex III]. However, our set of output variables is limited to one and therefore the change in efficiency rankings that may result from the use of an alternative output variable is not of significant concern in this study.

In addition, the low standard deviation of the efficiency scores for the joint production model may signify widely observed inefficiency levels in the production of cereal crops. Despite above average spending in agriculture, there is noticeable inefficiency in the production of cereal crops. An alternative explanation for the minimal

[15] Santiago Herrera and Gaobo Pang (2005), Efficiency of public spending in developing countries; an efficiency frontier approach, World Bank, Washington.

variation in efficiency scores could be sample design that sorts Woreda units by their potential in the production of a particular commodity.

Table 2: Multiple-input single output: Efficiency levels

More efficient					
	Achefer	Boloso Sorie	Hitosa	Silti	
	Ada Berga	Bule	Horo	Shinasha Dinsho	
	Ada'a Lome	Dangla	Insarona wayu	Sodo zuria	
	Adaba	Debre Brehan	Kersa	Tiyo	
	Akaki	Dedo	Kobbo	Welmera	
	Alaba	Dejen	Kuni	Misha	
	Alamata	Dessie Zuria	Merawi		
	Alem Gena	Dugda Bora	Metu		
	Bacho	Enemay	Raya Azebo		
	Badawocho	Gonder Zuria	Shashemene		
	Bahir Dar	Gumer			
Less efficient					
	Dedo	Bacho	Enda Mekhonil	Achefer	Alemaya
	Dejen	Bule	Adaba	Alaba	Gerar Jarso
	Hawzien	Metu	Aleta Wondo	Angacha	Baso Liben
	Merawi	Wegera	Badawocho	Begi	Sodo zuria
	Tiyo	Gimbichu	Dangla	Dessie Zuria	Misha
	Gimbi	Horo	Enemay	Ada Berga	Legambo
	Hitosa	Raya Azebo	Adwa	Alamata	Ambo
	Silti	Welmera	Aaro	Awassa	Bako Tibe
	Yirgachefe	Goma	Bahir Dar	Boloso Sorie	Deder
	Gumer	Insarona wayu	Debre Brehan	Dugda Bora	Gonder Zuria
	Kobbo	Shashemene	Fedis	Ada'a Lome	Kersa
	Shinasha Dinsho	Wuchalen jedu	Akaki	Alem Gena	Awlalo
				Kuni	Habru
					Soro

Efficiency Comparisons across decision making units (DMUs)

The analytical framework provided as a prelude to the micro-econometric module discusses, in depth, recent developments in statistical methods that have been developed to assuage empirical problems associated with the estimation of the efficiency frontier (see Alemayehu and Dawit, 2009a). It also outlines the subsequent steps involved in investigating the statistical relationships between "formulated efficiency scores and 'environmental variables' that are associated with public spending and the performance of agriculture across DMUs (Woreda units and regional states) and, perhaps, more importantly at the national level. A brief rerun of the discussion in the analytical framework is presented here to conserve cogency.

We have noted that since the dependent variable (stochastic frontier efficiency scores) is continuous and distributed over a limited interval (0, 1) *Tobit* is the most suitable regression model to analyze the relationship of stochastic frontier efficiency scores with selected "environmental variables" that are deemed to determine cross-DMU differences in efficiency (farm households). Moreover, we have noted that some of the environmental variables discussed in Herrera and Pang (2004), and studies considered to be precursors to it, may also be applicable in the case of agriculture. We have used the following in our model here.

a) Variations in efficiency are also expected to depend on rainfall and soil quality. Soil quality has historically been associated with soil productivity. It is determined by complex interactions of physical (texture, water-holding capacity, soil-depth), chemical (acidity, cation-exchange capacity [CES]), and biological (organic matter content, microorganism activity) variables -Jaenicke and Lengnik (1999): 881.

The average level of rainfall is also associated with food and fiber productivity. We used mean deviation of rainfall and soil quality ,measured on the scale (0-1], where higher numeric values are associated with higher levels of soil quality.

b) Many studies have stumbled upon the question 'does more government involvement (in the shape of spending relative to GDP) yield efficiency gains?' While these studies might have sought to find the effect of the additional dollar spent by the public sector on an outcome variable of their concern, the results are mixed. A significant proportion of public spending in agriculture in Ethiopia is regional spending (more than 80%) and hence our public expenditure parameter in this study is the Woreda budget.

c) Another variable that is strongly associated with efficiency is the composition of spending. Tanzi (2004) notes that the composition of public spending largely determines whether there has been an administrative hijacking of budgeted resources. We use the share of recurrent spending in total Woreda expenditure to proxy for the size of spending on administrative oversight in total expenditure in agriculture.

d) Tanzi (2004) contends that the clustering of households is associated with lesser costs in the provision of services. Hence we introduce population-density at the Woreda level to proxy for impacts resembling the 'clustering-cost of services' effect in the context of rural development.

e) It is generally expected that skewed income distribution would be correlated with other social indicators and hence may impact, negatively, on outcomes related to production in agriculture. However, due to limitations on the availability of data on 'poverty-gap' at our sample Woredas level we have dropped the poverty variable.

f) Although in the general scheme of things the inclusion of per-capita GDP is meant to control for the 'Balassa-Samuelson effect' (the level of underdevelopment determines the size of relative wages and prices) its application in our case may not be relevant. As noted earlier, the level of underdevelopment of regional states is an important determinant of block grant transfers and hence, transfers that favor the, relatively, less developed reduce the relationship between spending and relative prices

g) Efficiency in input usage could also be influenced by the source of funds (external versus domestic). The absence of the burden of taxation may limit the efficiency of input use. The volatility of external financing could also provide a source of inefficiency. However, a bulk of external assistance is channeled through the federal government and may not be distributed over the DMUs of concern. Hence the use of external aid as a proportion of fiscal revenue may not be readily comprehensible. Even if the external-domestic distinction applied to the block grant transfers and funds out of the Woreda treasury, respectively, the capacity of regional states or Woreda units in raising their own revenue is very limited and hence the variable loses its value as an important indicator.

Having this general characteristics of the model and data we used the Tobit model specified as,

$$y_i^* = x_i\beta + u_i \qquad \text{\{EQ.1\}}$$

$$y_i = 1(y_i \geq y_0)y_i^*$$

x_i represents the matrix representing the list a, b, c, and d, above.

The Tobit estimation involves the maximization of EQ.1

$$L = \prod_{i=1}^{n} \Pr(y_i^* < y_0)^{(1-D)}\{\Pr(y_i^* \geq y_0) f(y_i^* | y_i^* \geq y_0)\}^D \qquad \text{\{EQ.2\}}$$

Results of the Stochastic Frontier Model and Tobit estimation for the joint production decision (Barley, Maize, Wheat and Teff) are presented as Table1A, Table1B, respectively, below.

Table 1A: stochastic frontier normal (half-normal) model

```
Stoc. frontier normal/half-normal model              Number of obs    =       2142
                                                     Wald chi2(7)     =    1037.22
Log likelihood =   -3115.445                         Prob > chi2      =     0.0000
```

lnValue_In~x	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lnWoredaAg~d	-.2047673	.0428296	-4.78	0.000	-.2887117	-.1208228
lnLand_size	.2843466	.0244196	11.64	0.000	.2364852	.3322081
lnfamily_l~r	.627895	.0537944	11.67	0.000	.5224599	.7333301
lnfertilizer	.0820738	.0481323	1.71	0.088	-.0122639	.1764114
lnSeed	.116567	.0118492	9.84	0.000	.0933429	.139791
lnManure_	-.0828014	.0314585	-2.63	0.008	-.1444589	-.0211439
lnOxen_day	.2241167	.0503826	4.45	0.000	.1253687	.3228647
_cons	9.791838	.1865274	52.50	0.000	9.426251	10.15742
/lnsig2v	-.7100242	.0555017	-12.79	0.000	-.8188056	-.6012428
/lnsig2u	.535628	.058736	9.12	0.000	.4205076	.6507484
sigma_v	.701165	.0194579			.6640467	.740358
sigma_u	1.307104	.038387			1.233991	1.384549
sigma2	2.200153	.0924818			2.018892	2.381414
lambda	1.864189	.0496913			1.766796	1.961582

```
Likelihood-ratio test of sigma_u=0: chibar2(01) = 2.3e+02Prob>=chibar2 = 0.000
```

Table 1B: Tobit Model for joint production

```
Tobit regression                                     Number of obs    =       2101
                                                     F(   5,    2096) =       4.08
                                                     Prob > F         =     0.0011
Log pseudolikelihood =   928.54746                   Pseudo R2        =    -0.0118
```

efficiency	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
Rain_dev	-.0000291	.0000107	-2.73	0.006	-.0000501	-8.16e-06
Soil_quality	.0090359	.0145652	0.62	0.535	-.0195279	.0375996
Woreda_bud~t	.0061929	.0030856	2.01	0.045	.0001418	.0122439
Woreda_recur	-.0626255	.0228362	-2.74	0.006	-.1074095	-.0178415
Pop_density	.0000292	.0000316	0.92	0.356	-.0000328	.0000911
_cons	.4516245	.0164683	27.42	0.000	.4193286	.4839204
/sigma	.155217	.0030281			.1492786	.1611554

```
  Obs. summary:          1  left-censored observation  at efficiency<=.0013639
                      2099     uncensored observations
                         1 right-censored observation  at efficiency>=.92988819
```

Table 1A basically shows the stochastic frontier model while Table 1B refers to the Tobit model for joint production which is based on Table 1A. Thus, the discussion below will be based on the result given in Table 1B. Some of the findings from these estimation results are summarized in the rest of this section. The results summarize the effects of the variables in the order they appear in the description of the variables provided earlier in the section (see variable definition in Annex II).

Beginning with rainfall, deviations from average levels of rainfall are expected to be negatively related to efficiency in production. Accordingly, Table 1B shows that deviation of rainfall from its average is associated with lower levels of efficiency. However, the impact of the variable appears to be numerically small, albeit statistical significance at conventional levels. Soil quality, on the other hand, is found to be of the right sign, but a statistically insignificant predictor of differences in efficiency levels across households.

Table 1B also shows that unlike (Filmer and Pritchett, 1999)[16] the impact of the public spending variable (Woreda budget in our case) is quite small, with a coefficient that is typically both numerically small, but statistically significant at conventional levels. Table 1B shows that a percentage increase in the Woreda budget is associated with efficiency gains of around 0.6%. The above indicates that the level of public spending at the Woreda level plays a part in explaining efficiency disparities in the production of major cereal crops. However, it is important to note that the relationship between expenditure and benefit is not straightforward. If additional resources allocated at these administrative units are absorbed mostly by higher salaries and the higher salaries are not accompanied by higher productivity of the public employees, the higher public spending can be unproductive and produce little additional benefits to farm households.

Unlike in Herrera and Pang (2005): 33-35, the efficiency returns to cereal crop producers from a reduction in the share of Woreda level recurrent expenditure in agriculture is substantial. The variable is numerically large and significant at conventional levels. The results show that a 1% reduction in the share of recurrent spending, results in efficiency gains of 6% in the production of cereal crops. The above attests to the negative marginal returns from recurrent spending, due to the weight of the component in the Woreda agriculture budget. The results point to an administrative hijacking of budgeted resources. Unlike in the health or education sectors where actual spending goes the salaries of the public employees in exchange for outputs in the form of better health, or more literacy, how much of the actual size of the workforce in agriculture is associated with public service delivery is not well documented.

The 'clustering-cost of services' effect mirrored by the inclusion of the population density variable is both statistically insignificant and numerically small. The conceptual basis for the inclusion of the variable was that denser rural agriculture is associated with lower cost of services and hence induces participation in efficiency enhancing public services. However, the above is not reflected in the results.

B] The Demand for publicly provided services in agriculture: A focus on extension programs

Variable descriptions and assumptions

The second dimension in the analysis of efficiency in public spending: the demand approach was developed in line with Collier *et. al.* (2002) that derives demand and production functions by solving an optimization problem involving a utility maximizing representative farm household. Collier *et. al.* (2002) produces the derivatives of interest by appending government allocation decisions that aim at the quality and affordability of public services

[16] Filmer, D., Pritchett, L., 1999. The impact of public spending on health: does money matter? *Social Science & Medicine* 49, 1309–1323

(namely the response of demand to spending that aims at the improvement and expansion of public services, respectively.) The demand analysis utilizes the same dataset as the non-parametric efficiency analysis and focuses on aggregate cereal crop production involving 2142 households. The analysis follows multiple stages that are discussed, concurrently, below.

The analysis requires that a production function be fitted on the dataset. We have used a parametric analysis in the previous section to determine the relationship between efficiency in production in agriculture and components of public expenditure, sector oriented and more. In the subsequent section we experiment with the same parametric variation of frontier analysis to investigate the relationship between the quality of public services in agriculture and their impact on participation in extension services (in general) and credit services (in particular) for cereal crop production.

Results of the Stochastic Frontier Model for the joint production decision model (Barley, Maize, Wheat and Teff) are presented in Table1A. The above exercise helps to generate a total factor productivity variable which will be used in the subsequent regression model. The variables of concern, as highlighted in the analytical framework, are factors that are considered to be important determinants of participation in an extension service. A detailed description of the variables is provided below.

The determinants of demand for public services are *the quality of publicly provided agricultural services, the real market wage rate, and the cost of publicly provided services in agriculture.*

Thus, the participation variables which is the dependent variable assumed to take the following values:

Participation in an extension program

0=No, 1=Yes; and

Participation in a credit program

0=Never, 1=Once, 2=More than once, and 3=Every-year

Regarding the independent variables, there is, currently, no data providing rankings for extension services across regional states or Woreda units. Had there been any, it would have depended, largely, on expenditure in the quality of services and, therefore, would have been an endogenous determinant of participation in extension services and needs to be instrumented for. Instead we use variables generated by the Land Policy Survey series that routinely inquire about the extent of problems encountered during extension services. We have selected two value determinants that reflect the input-provision orientation of extension services. These variables are labeled Quality (Extension)-improved seeds, and Quality (Extension)-Fertilizers, and provide information on the quality of extension services related to improved seeds and fertilizers, respectively. There may be concerns as to the exogeneity of the two variables as regards the dependent variable. However, first time participation in extension programs are determined by a set of determinants of which quality is largely excluded. First time participation is, in no particular order, dependent on *successful awareness creation programs, the experiences of other farmers with extension packages, and the need for access to inputs due to consistently low harvest.* In addition, our concern will be, largely (but not limited to), the relationship between the second half of the frequency of participation and how it is impacted on by quality in services. Moreover, the quality variables have been striped-off their endogeneity since quality ratings represent responses to spending on the quality of services. However, the relationship cannot be readily signed as expenditure on quality could be positive, ineffectual, or with regressive effects depending on its orientation. Hence our concern will not be on the quantification of the response of 'participation' to expenditure on quality, but, rather, on its response to disparities in the quality of extension services. As presented below, the quality variables are composite indices that weigh the effect of several variables.

Quality (Extension)-Improved seeds [The variable assumes ratings]:

1="NO PROBLEM", 2 =MODERATE PROBLEM", and 3 ="SEVER PROBLEM"

The ratings are composite indices summarizing indicators for: *the availability of improved seeds on time, whether the seeds are of the correct variety, susceptibility to diseases, susceptibility to pests, the quality of grains, the quality of germination, and the quality of adaptation to the locality*

Quality (Extension)-Fertilizers [The variable assumes ratings]:

1 "NO PROBLEM", 2 "MODERATE PROBLEM", and 3 "SEVER PROBLEM"

The ratings are composite indices summarizing indicators for: *the availability of fertilizers on time, affordability, credit repayment schedule (tight vs. slack), proximity of distribution*

Efficiency scores (efficiency) captures variation in efficiency across households. Similar to the set of public service quality ratings the relationship between efficiency and participation cannot be readily signed. One would, naturally, expect that positive levels of the cost of participation would leave efficient farmers thinking that their efforts would be best served by not participating in extension programs. However, farm households with better commercial orientation might see extension services as plausible avenues for the expansion of output, and hence income.

Due to the absence of properly functioning labor markets in rural Ethiopia, determining real off-farm wage rates is practically impossible. Hence, we use a variable of the household head's educational attainment to proxy for real wages. Although, it may be an imprecise proxy (due to the limited cross-section of off-farm employment opportunities), it has been widely observed that it is a significant determinant of off-farm wage (de Janvry and Sadoulet (2001), Ruben and Van den berg (2001), and Ferreira and Lanjouw (2001) [17] are cases in point.)

The clustering-cost of services proxy is also included to evaluate the impact of costs of participation and the levels of the latter. The sign of the above is expected to be positive. However, a negative coefficient could signify that there is congestion.

[17] de Janvry , Alain and Elisabeth Sadoulet (2001) Income Strategies Among Rural Households in Mexico: The Role of Off-farm Activities, *World Development,* 29(3): 467-480

Ruben, Ruerd and Marrit Van den berg (2001) Nonfarm Employment and Poverty Alleviation of Rural Farm Households in Honduras, *World Development,* 29(3):549-560

Ferreira, Francisco H. G. and Peter Lanjouw (2001) Rural Nonfarm Activities and Poverty in the Brazilian Northeast, *World Development,* 29(3): 509-528

In addition, agro-climatic influences are controlled for by the introduction of the mean deviation of rainfall and the soil quality variables discussed in the previous section. We expect the coefficients of both variables to be negative in small holder agriculture.

A Tobit model is used to is used to investigate the relationship between variations in levels of participation (in extension services) and the dependent variables (most importantly the quality of services), while an ordered choice model (Probit) is used to determine the relationship between variations in levels of participation (credit program) and the dependent variables (most importantly the quality of services). The following section presents some of the stylized results [summarized in Table 2A and 2B]. Marginal effects accompanying probit regressions are presented in Annex V, Table 2C. The results summarize the effects of the variables in the order they appear in the description of the variables provided earlier in the section.

Demand for Agricultural services: Tobit Regression Result

Table 2B shows that a 1% quality improvement in extension services involving improved seeds and fertilizers translates into a 3% and 0.8% higher, respectively, probabilities in predicted participation in extension services. The coefficients are numerically small, but statistically significant at conventional levels. The effect of spending on the quality of extension services can be quantified using reasonable estimates of the elasticity of quality improvements to the quality of spending. The result shows that quality improvements in extension services can improve, albeit marginally, participation in extension services. Similar studies have shown that farmer's proclivity to participate in such services depend on the frequency of contact with extension workers-Foti et. al. (2009). Other studies show that subjective perceptions of technology characteristics affect adoption decisions and hence an understanding of farmer's perceptions should pave the way for decisions of introducing new farming technologies in an area-Sinja et. al. (2004). These studies share the conviction that the quality of extension services offer returns in terms of higher likelihoods of participation.

Table 2A: Tobit regressions-demand for extension

```
Tobit regression                                  Number of obs   =       1133
                                                  F(   7,   1126) =      47.39
                                                  Prob > F        =     0.0000
Log pseudolikelihood = -1045.5792                 Pseudo R2       =     0.1108
```

Extension_~i	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
School_years	.0272322	.0138863	1.96	0.050	-.0000138	.0544782
efficiency	-.4012401	.1710917	-2.35	0.019	-.7369346	-.0655456
Pop_density	-.000989	.0002362	-4.19	0.000	-.0014524	-.0005257
Rain_dev	-.0003867	.0000767	-5.04	0.000	-.0005372	-.0002362
Soil_quality	-.5882333	.1207807	-4.87	0.000	-.8252139	-.3512527
Quality_se~s	-.2532704	.0222617	-11.38	0.000	-.2969495	-.2095913
Quality_Fe~r	-.072053	.0321249	-2.24	0.025	-.1350843	-.0090217
_cons	1.715254	.153288	11.19	0.000	1.414491	2.016016
/sigma	.8179841	.0225981			.7736448	.8623233

```
  Obs. summary:        589  left-censored observations at Extension_~i<=0
                       544     uncensored observations
                         0 right-censored observations
```

Quality (Extension)-seeds
The variable assumes ratings:
1="NO PROBLEM"
2 =MODERATE PROBLEM"
3 ="SEVER PROBLEM"
The ratings are composite indices summarizing indicators for: *the availability of improved seeds on time, whether the seeds are of the correct variety, susceptibility to diseases, susceptibility to pests, the quality of grains, the quality of germination, and the quality of adaptation to the locality*

Quality (Extension)-Fertilizers
The variable assumes values:
1 "NO PROBLEM"
2 "MODERATE PROBLEM"
3 "SEVER PROBLEM"
The ratings are composite indices summarizing indicators for: *the availability of fertilizers on time, affordability, credit repayment schedule (tight vs. slack), proximity of distribution*

Table 2B: Marginal Effects-Extension participation

```
Marginal effects after tobit
      y  = E(Extension_Parti|0<Extension_Parti<1) (predict, e(0, 1))
         =  .45420225
```

variable	dy/dx	Std. Err.	z	P>|z|	[95%	C.I.]	X
School~s	.0031769	.00163	1.95	0.051	-.000019	.006373	5.04395
effici~y	-.046808	.02011	-2.33	0.020	-.086217	-.007399	.466918
Pop_de~y	-.0001154	.00003	-4.07	0.000	-.000171	-.00006	225.312
Rain_dev	-.0000451	.00001	-4.91	0.000	-.000063	-.000027	36.6739
Soil_q~y	-.0686223	.01461	-4.70	0.000	-.097256	-.039989	.724242
Qualit~s	-.0295461	.00306	-9.66	0.000	-.035541	-.023551	2.83369
Qualit~r	-.0084056	.00379	-2.22	0.027	-.015842	-.000969	2.40282

The results in Table 2B also show that variations in efficiency play a role in inducing participation. The former shows that a 1% lower level of efficiency raises the probability of participating in extension services 4.7%. The above seems to endorse Mosher's notion of the evolutionary role of the extension agent. Mosher (1966) notes that at early stages of commercialization, characterized by "traditional farming and social values that discourage departure from the traditional pattern" there are substantial differences in practices between the most and least productive farmers. The introduction of the extension agent in such a setting would create a subculture in which a few poor, but potentially venturesome farmers, and the former would act as "temporary substitutes for the force that social values would exert once the community accepts the view that progress is possible and desirable." Hence, with commercialization, Mosher (1966) contends, the initial role of the extension agent-"an encouraging companion who knows of the potential for more productive farming for more famers would change".

The story is not significantly different for the off-farm income proxy. Table 3 shows that variations in schooling may play only a marginal role in inducing participation. The former shows that a 1% increase in the highest level of grade completed raises the probability of participating in extension services by a mere 0.3%. Recent empirical lessons claim that participation by farmers in extension and research is dictated, largely, by the realization of low income farmers of the "socio-economic and agro-ecological conditions are diverse, complex and risk-prone"-Farrington (1997). Farrington notes that unidirectional technology transfers that are based on research station trials have been found to be ineffectual. Berhanu et. al. (2006) shows that the Ethiopian extension system is characterized by a top-down, non-participatory approach, primarily supply driven, low capacity of experts and development agents, and high turn-over of extension staff and shortage of operational budget and facilities. In the light of the above evidence the result seems to be plausible.

The clustering-effect also appears to be weak in inducing participation in extension services (Table 2B). On the other hand, the strength of the impacts of the agro-ecological variables is also divided. As rainfall moves to its mean level, the probability of participation in extension services increases (albeit very marginally). The above shows that rainfall complements productivity enhancing inputs. The latter has been extensively discussed in the literature-Yanggen et. al. (1998). Lamb (1996): 8 shows that increases in the mean level of rainfall raises the demand for fertilizers. Soil quality, contrastingly, shows that only the use of marginally productive land induces participation in extension services. The impact of the latter is significant, as a 1% reduction in soil quality leads to a 6.9% increase in the probability of participation in extension services.

a.

Demand for credit: Probit regression result

Similar to the Tobit regressions, Table 3B shows that a 1% quality improvement in extension services involving improved seeds and fertilizers translate into 2.3% and 1.3% higher probabilities, respectively, that households would participate in credit programs more than once. Similarly, the probability of annual participation in credit programs is 2.8% and 1.6% more probable with quality improvements in extension services involving improved seeds and fertilizers, respectively. Hence, an across the board improvement in the quality of extension services yields positive changes in the demand for publicly provided services.

Table 3B, unlike in the tobit regressions, shows also that variations in efficiency and average levels of schooling may be poor predictors of participation in a credit program.

Table 3B also shows that the results for the agro-ecological variables is similar to the once in the tobit regressions. A marginal deterioration in soil quality is associated with 8-10% higher probabilities of participation in credit programs (more than once, and every year, respectively). The results for rainfall do not improve significantly, as the impact coefficients are numerically low, albeit, their statistical significance at conventional levels. The result for the proxy of cost in services (population density) does not deviate, notably, from the tobit counterpart.

Table 3A: Probit regression-demand for credit

Ordered probit regression

	Number of obs	=	**1133**
	LR chi2(7)	=	**140.73**
	Prob > chi2	=	**0.0000**
Log likelihood = **-1166.6223**	Pseudo R2	=	**0.0569**

Credit_Parti	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
School_years	-.0102454	.018071	-0.57	0.571	-.0456638	.0251731
efficiency	.1694509	.2332101	0.73	0.467	-.2876324	.6265343
Pop_density	-.0013237	.0002989	-4.43	0.000	-.0019096	-.0007378
Rain_dev	-.0003035	.0001028	-2.95	0.003	-.0005049	-.000102
Soil_quality	-.6802358	.158047	-4.30	0.000	-.9900024	-.3704693
Quality_se~s	-.1899551	.0298487	-6.36	0.000	-.2484575	-.1314528
Quality_Fe~r	-.1116799	.0392859	-2.84	0.004	-.1886788	-.034681
/cut1	-1.289702	.2199946			-1.720884	-.8585208
/cut2	-.6905649	.2185946			-1.119002	-.2621273
/cut3	-.1585858	.2190984			-.5880108	.2708391

Table 3B: Marginal Effects: Participation only once, more than twice and Annually.

```
. mfx compute, predict(outcome(1))

Marginal effects after oprobit
      y  = Pr(Credit_Parti==1) (predict, outcome(1))
         =  .19877193
```

variable	dy/dx	Std. Err.	z	P>|z|	[95%	C.I.]	X
School~s	-.0011682	.00206	-0.57	0.571	-.005212	.002876	5.04395
effici~y	.0193214	.02664	0.73	0.468	-.032893	.071536	.466918
Pop_de~y	-.0001509	.00004	-4.09	0.000	-.000223	-.000079	225.312
Rain_dev	-.0000346	.00001	-2.84	0.004	-.000058	-.000011	36.6739
Soil_q~y	-.0775629	.01931	-4.02	0.000	-.115405	-.039721	.724242
Qualit~s	-.0216594	.00389	-5.56	0.000	-.029292	-.014027	2.83369
Qualit~r	-.0127341	.00463	-2.75	0.006	-.021813	-.003655	2.40282

```
. mfx compute, predict(outcome(2))

Marginal effects after oprobit
      y  = Pr(Credit_Parti==2) (predict, outcome(2))
         =  .10913737
```

variable	dy/dx	Std. Err.	z	P>|z|	[95%	C.I.]	X
School~s	-.0012633	.00223	-0.57	0.571	-.005636	.00311	5.04395
effici~y	.0208935	.02882	0.72	0.469	-.035601	.077388	.466918
Pop_de~y	-.0001632	.00004	-4.20	0.000	-.000239	-.000087	225.312
Rain_dev	-.0000374	.00001	-2.90	0.004	-.000063	-.000012	36.6739
Soil_q~y	-.0838738	.02071	-4.05	0.000	-.124457	-.043291	.724242
Qualit~s	-.0234217	.00414	-5.66	0.000	-.031529	-.015315	2.83369
Qualit~r	-.0137703	.00496	-2.78	0.005	-.023486	-.004055	2.40282

```
. mfx compute, predict(outcome(3))

Marginal effects after oprobit
      y  = Pr(Credit_Parti==3) (predict, outcome(3))
         =  .07742275
```

variable	dy/dx	Std. Err.	z	P>|z|	[95%	C.I.]	X
School~s	-.0014858	.00262	-0.57	0.571	-.006624	.003652	5.04395
effici~y	.0245742	.03385	0.73	0.468	-.041763	.090911	.466918
Pop_de~y	-.000192	.00004	-4.31	0.000	-.000279	-.000105	225.312
Rain_dev	-.000044	.00002	-2.91	0.004	-.000074	-.000014	36.6739
Soil_q~y	-.0986495	.02351	-4.20	0.000	-.144725	-.052574	.724242
Qualit~s	-.0275478	.00463	-5.95	0.000	-.036624	-.018472	2.83369
Qualit~r	-.0161961	.00576	-2.81	0.005	-.027493	-.0049	2.40282

IV. Conclusions

In this study we have attempted to deploy both macro and microeconomic tools that are helpful to learn about efficiency of public spending in agriculture. The main conclusion that is emerging from the exercise could be summarized as follows:

First, from a macro perspective, we noted that there is a measurable interaction among sectoral value-added (in Agriculture, industry and services) as well us public spending destined for each of these sectors. This need to be taken on board when planning of spending in the agricultural sector is made.

The second major finding again from macro perspective is that the agricultural sector growth could enormously benefit from the growth of both the industrial and service sectors with strong elasticity and multiplier effect.

Third, public spending in services and the industrial sector has a positive and significant effect both in the long run as well as in a dynamic set up.

Fourth, our finding that public spending in agriculture having negative effect on the sectoral value added seems to strengthen our earlier finding using the qualitative study that there is a problem of spending without proper planning for that spending is not planned as part of the overall economy. Yet spending in the industrial and service sectors have positive effect on agriculture– this also strengthen our point about lack of inter-sector synergy focus on planning in our qualitative data based study (see Alemayehu and Dawit, 2009b).

The analysis using SAM and IO framework, that complements the above finding, does also offer a perspective on what the likely constraints of output growth might be and the inter sectoral linkages worth examining. From that exercise we noted that that: First, the multiplier effect of agriculture sector (rural economy) is better than the industrial sector (urban economy) once the analysis is carried in a SAM analytical framework; however, when an IO is used the industrial (urban economy) becomes more important. Second, identification of sources of growth from the perspective of macroeconomic and sectoral interaction reveals that agricultural growth is dependent on the total multiplier effect of the non-agricultural sectors. In particular, food processing, textile and non-metal industries have the highest linkages and worth the attention of policy makers. Since almost all such industries are located in urban areas, focusing on urban economy is a vital component for a success in agricultural-led growth.

Coming to our microeconmetric based analysis of the study, both parts of the micro-econometric module (on efficiency of spending and on demand for agricultural services) offer some interesting results. The first section used a popular parametric technique to determine the relationship between components of spending and input-oriented, efficiency scores. The results have indicated that total regional spending plays a part in explaining efficiency differences across households. Although some of the studies referenced in the section indicate that the influence of public spending in explaining differences in efficiency across decision making units has been less than satisfactory, in the greater scheme of things one would, naturally, expect to find that spending on non-agriculture sectors would have spill-over effects that would contribute to efficiency differences in cereal crop production (proxy for agriculture), this study finds that it is the case.

The results, also, have important implications for the nature and composition of public spending in agriculture and the need to reformulate it. We have noted that the negative marginal returns from recurrent spending in agriculture signify that the threshold level of recurrent spending, in some cases, may have missed its stop a long way back and hence bloated administrative structures may have led to efficiency losses. We have stressed on the need to backpedal away from a budget composed prominently of recurrent spending and an improvement in the quality of capital spending. With decentralization of authority high on the agenda the above may well be easier said than done. However, this may suggest to the need to reconsider the optimal level of decentralization, given the current capacity and resource. We have also highlighted on the need to encourage private sector participation in the provision of services, and operation and maintenance (O&M) and limit the government's sphere of influence to where it could be of efficient use.

The second approach investigated the role of improvements in the quality of services that are direct results of spending on the quality of extension and credit services on the demand for extension services. We note that off-farm income, and variations in efficiency determine the demand for participation in government supplied agricultural services, but are not robust to the changes in the dependent variable (extension services, in general, vis-à-vis credit services that constitute subsets of the former). However, the impact of the two may be puny compared to the effect of improvements in the quality of services. The results consistently show that quality improvements influence the chances for participation in publicly provided services.

The methods of analysis employed in the study could be expanded to present a more symmetrical view of the problem investigated (varied parametric and non-parametric techniques). In addition to methodological issues, we note that an efficient analysis of efficiency in spending could do with better quality of data. Future directions for efficiency analysis in spending in agriculture would also benefit from longitudinal data analysis and hence departure from a static examination of the topic and a closer look at the dynamics of efficiency in spending.

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Annex I

Impulse Response for the Agricultural Sector

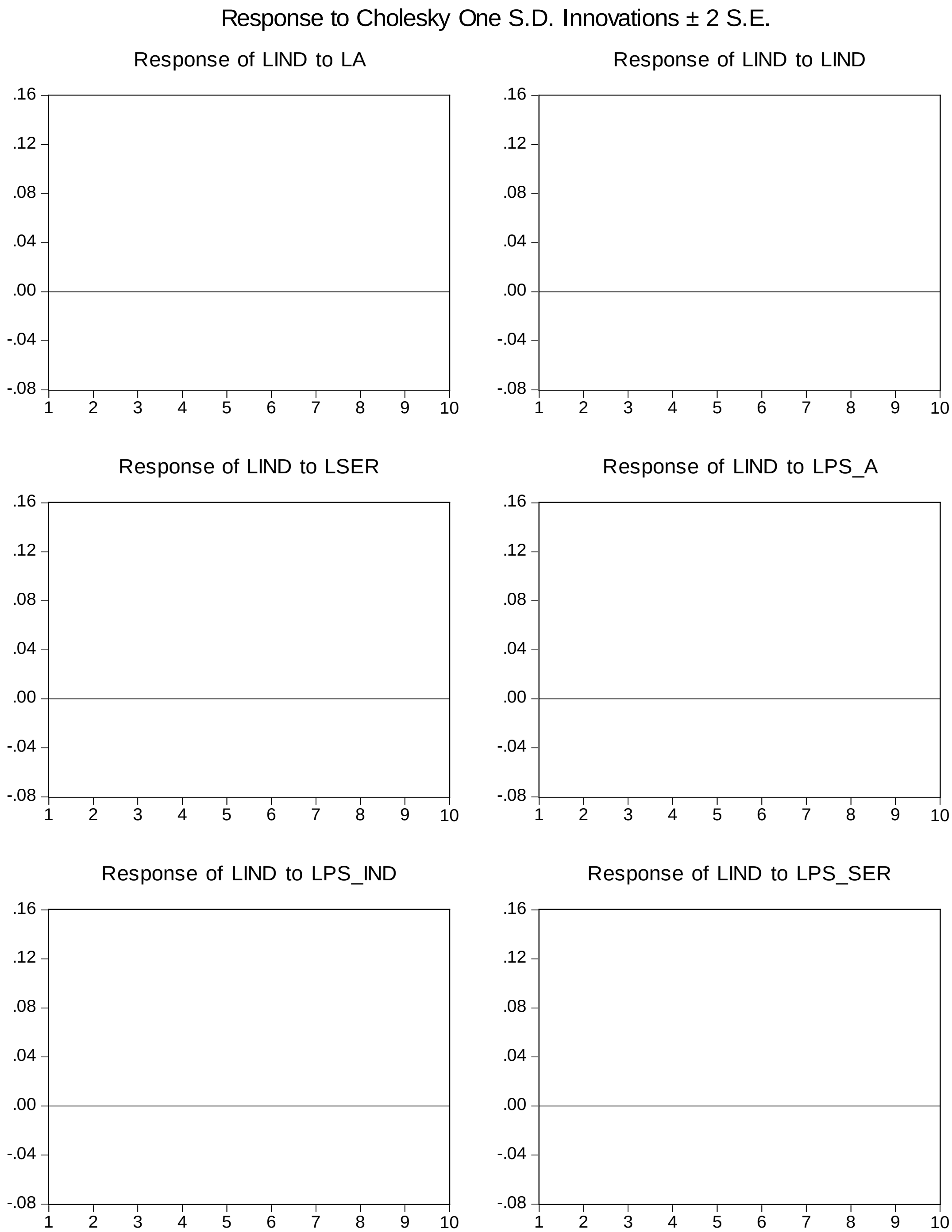

Figure 1: The distribution of sample Woreda units

Annex II

Table 1: List of Woreda units in the sample

		Regional states			
Woreda name	Tigray	Amhara	Oromiya	SNNPR	Total
Achefer	0	39	0	0	39
Ada Berga	0	0	40	0	40
Ada'a Lome	0	0	37	0	37
Adaba	0	0	39	0	39
Adwa	37	0	0	0	37
Akaki	0	0	40	0	40
Alaba	2	0	0	40	42
Alamata	31	0	0	0	31
Alem Gena	0	0	40	0	40
Aleta Wondo	1	0	0	31	32
Amaro	0	0	6	0	6
Ambo	0	0	40	0	40
Angacha	0	0	0	1	1
Awassa (incl. Wendogenet)	1	0	0	37	38
Bacho	0	0	40	0	40
Badawocho	0	0	0	36	36
Bahir Dar	0	38	0	0	38
Bako Tibe	0	1	0	0	1
Baso Liben	0	0	1	0	1
Begi	0	0	39	0	39
Bolosso Sorie	0	0	0	39	39
Bule	0	0	0	29	29
Dangla	0	39	1	0	40
Debre Brehan Zuria	0	41	0	0	41
Deder	0	0	40	0	40
Dedo	0	0	39	0	39
Dejen	0	41	0	0	41
Dessie Zuria	0	35	0	0	35
Diredawa-Zuria	0	0	34	0	34
Dugda Bora	36	0	2	0	38
Enda Mekhoni	0	36	0	0	36
Enemay	0	0	38	0	38
Fedis	0	0	37	0	37

Gimbi	0	0	37	0	37
		Regional states			
Woreda name	Tigray	Amhara	Oromia	SNNPR	Total
Gimbichu	0	2	0	0	2
Goma	0	0	35	0	35
Gonder Zuria	0	33	0	0	33
Gumer	0	0	0	32	32
Habru	0	38	0	0	38
Hawzien	36	0	0	0	36
Hitosa	0	0	40	0	40
Horo	0	0	35	0	35
Insarona wayu	0	40	0	0	40
Kersa	0	0	40	0	40
Kobbo	0	37	0	0	37
Kuni	0	0	40	0	40
Legambo	0	27	0	0	27
Merawi	0	38	0	0	38
Metu	0	0	39	0	39
Raya Azebo	38	0	0	0	38
Shashemene	0	0	39	0	39
Silti	0	0	1	30	31
Shinasha Dinsho	0	0	40	0	40
Sodo zuria	4	0	0	35	39
Soro	0	0	0	37	37
Tiyo	0	0	38	0	38
Wegera	0	34	0	0	34
Wolmera	0	0	36	0	36
Wuchalena Jedu	0	0	38	0	38
Yirga Chefe	0	0	0	6	6
Awlalo	37	0	0	0	37
Misha	0	0	0	36	36
Alemaya	0	0	38	0	38
?	0	0	0	1	1
?	1	0	0	0	1
	224	519	1,009	390	2,142

Table 2: Description of variables

Variable	Description
Ln WoredaAgd	Woreda spending in agriculture (natural logs)
lnLand_size	Land size in ha (natural logs)
lnfamily_l~r	Family labor (days)(natural logs)
lnfertilizer	Fertilizers in kg(natural logs)
lnSeed	Seeds in kg (natural logs)
lnManure_	Manure in kg (natural logs)
lnOxen_day	Oxen days (natural logs)
School_years	Grade completed
Efficiency	Efficiency scores from (SFM)-Stochastic frontier model
Pop_density	Population density ('000)
Rain_dev	Rainfall-Mean deviation (mm)
Soil_quality	Soil quality
Quality_se~s	Quality of extension services in improved seeds
Quality_Fe~r	Quality of extension services in fertilizer provision
Woreda_bud~t	Woreda budget
Woreda_recur	Woreda level recurrent spending in agriculture

Table 3: Spearman's test for the ranking of efficiency scores

	lnValu~x	lnWore~d	lnLand~e	lnfami~r	lnfert~r	lnSeed	lnManu~_	lnOxen~y
lnValue_In~x	1.0000 2142							
lnWoredaAg~d	-0.2173* 2142 0.0000	1.0000 2142						
lnLand_size	0.3118* 2142 0.0000	-0.1232* 2142 0.0000	1.0000 2142					
lnfamily_l~r	0.4447* 2142 0.0000	-0.1251* 2142 0.0000		1.0000 2142				
lnfertilizer	0.4611* 2142 0.0000	-0.2077* 2142 0.0000	0.3275* 2142 0.0000	0.5760* 2142 0.0000	1.0000 2142			
lnSeed	0.4364* 2142 0.0000	-0.1176* 2142 0.0000	0.1804* 2142 0.0000	0.3553* 2142 0.0000	0.4330* 2142 0.0000	1.0000 2142		
lnManure_	0.2404* 2142 0.0000	-0.1914* 2142 0.0000	0.5646* 2142 0.0000		0.4441* 2142 0.0000	0.2549* 2142 0.0000	1.0000 2142	
lnOxen_day	0.4288* 2142 0.0000	-0.1472* 2142 0.0000	0.2619* 2142 0.0000	0.7162* 2142 0.0000	0.5839* 2142 0.0000	0.2492* 2142 0.0000	0.3102* 2142 0.0000	1.0000 2142

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