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Investigating the Long-Run Sectoral Growth Linkages in Ethiopia: Is Agriculture or Service an Engine of Growth?

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Abstract. This paper investigates the long run relationship between agriculture, industry and service using cointegrated vector autoregressive (CVAR) methodology for the period 1981-2011. Using this approach, the article provides a fresh evidence for Ethiopia that has not been deployed by the previous researches in the country. The paper finds that service is a driving force of the growth of agriculture and itself, an evidence obtained from analysis of the long run impact matrix C. From the fully identified long run structure, growth in service has positive and significant impacts on agriculture and industry. It deeply investigates the effects on agriculture by disaggregating service into other service and distributive service whereas industry comprises manufacturing and non-manufacturing. Concerning the impacts of disaggregated service, other service sub-sector is found to be a pushing force for the growth of agriculture, non-manufacturing and service itself. A variable comprising transportation and communication is vital for the long term growth of agriculture. These results are robust to changes in sample size and sample source. The policy prescription is that government should invest on this small sub-sector as the returns to the whole economy are tremendous.

The paper finds positive and strong effects from non-manufacturing to manufacturing reflecting that improved access to electricity, gas and water triggers unprecedented growth in manufacturing productivity. Finally, a shock to agriculture has little impacts on the growth of entire economy as the variable is purely adjusting in most of the models considered in the paper while aggregate service is weakly exogenous.

Key words: growth, sectoral-linkage, Ethiopia

Introduction

Agriculture is dominant in terms of output and employment contributions for African countries in general, and for Ethiopia in particular. The Ethiopian government stresses the importance of agricultural growth for a successful economic transformation from agriculture to an economy composed of manufacturing and services. The government believes that agricultural productivity must be as high as 6 % per year to increase the employment and GDP share of the rural non-farm income. However, agriculture grows slowly compared to the non-agriculture in the last decade and this creates pessimism about its potentials as a means of structural change and transformation. It is argued that since the economy is initially largely agrarian, a high growth rate in agriculture yields a fast growth rate in GDP. In other words, enhancing agricultural productivity has far-reaching implications for economic development and transformation. As a result, the agricultural sector has gone through a number of reforms after the removal of the socialist government (DERG Regime) in 1991.

Some of the major reforms introduced during the new regime since 1991 include; complete removal of the compulsory grain delivery scheme of the DERG regime, market liberalization for agricultural output; removal of the huge taxation on agriculture; supporting private sector participation in farm and non-farm activities, removal of restrictions on grain movements; transfer of some state owned farms to private investors and launching multi-channel fertilizer distribution. However, these series interventions were not successful in escalating per capita agricultural productivity in the last two decades. Some sort of state

interventions still remain in the sector; for instance agricultural land is exclusively owned by the government; state monopoly in telecommunication industry as well as fertilizer distributions.

However, whether agriculture or industry is the source of growth is highly debated. For instance, Schultz (1964) argues that small farmers are often more efficient and productive, implying the potential of agriculture as growth engine or expedite the process of structural change, and economies of scale from trade. They argue that because governments of developing countries do have feeble and fragile institutions that are designed to patronage only the interest of the elites, small farmers are obliterated from taking advantages of reforms. In the dualistic economy, on the other hand, agriculture is often presumed to play a passive role, acting only as a major supplier of resources for the development of modern industrial sector (Lewis, 1954; Fie & Ranis, 1964). There is no backward linkage from industry to agriculture. In the dualistic model, there is no interdependence between agriculture and industry once industrialization has been met. Kuznet (1964), however, stresses the importance of both the forward and backward linkages of the sector with rest of the economy. Agriculture is not only a major source of input but also a huge market for the non-agricultural sectors.

In particular, the idea that agriculture has feeble growth linkages with the rest of economy as argued by Hirschman (1958) and Lewis (1954) has recently received ferment criticisms in the literature (Vogel, 1994; Adelman, 1984; Johnston & Mellor, 1961). They argue that agriculture, not only in the early phase but also in the later stage of development, has institutional ties with non-agricultural activities via production and consumption linkages. A growing demand for farm inputs can stimulate non-farm activities through a backward production linkage while a high non-farm activities provide investment incentives on milling, spinning and canning to process the rural based agricultural products via forward production linkage. Through consumption linkage, a large fraction of additional farm income can be used for the purchase of locally produced consumer goods and services. The dualistic economy model was not accepted empirically in many studies of developing countries (Yao, 2000; Diao et al., 2007; Blunch & Verner, 2006).

Since agriculture is the dominant sector in terms of employment and GDP share, a deep empirical analysis is crucial about the interdependence and linkages among the three sectors in Ethiopia: agriculture, industry and services. To the extent of my knowledge, this is the first paper that examines the sectoral growth linkages using cointegrated vector autoregressive (CAVR) approach in Ethiopia.

The paper finds that service sector has large growth spill-over effect on all other sectors of the Ethiopian economy. The paper is structured as follows. Section 2 offers the Institutions and Economic Reforms in Ethiopia. Section 3 presents the data and the methodology. Section 4 discusses the estimation results. The conclusion is portrayed in section 5.

Institutions and Economic Reforms in Ethiopia

It is worth discussing the evolution of institutions and economic reforms to shed light on the performance of the economy in general and linkage of agriculture to the rest of the economy in particular. Since hundred years ago, predatory institutions had been landmarked in Ethiopia even though it took different forms and in varying size at different point in times. All lands was virtually under the control of the state and the private sector was not entitled to land but had only use right whenever possible. The land holder had an absolute use right while the tenants were coerced to serve the landlord under the crop-sharing agreement, rendering a quarter to a third of their produce to the land holder as a tribute and a tenth of their produce as a tithe (Markasis, 1974).

The pre-1974 administration, however, was replaced by the socialist government, the so called DERG regime and nationalized all land and dismantled the previous land tenure system.

The state has distributed land fairly to the peasants. Even if the land reform policy certainly entitled land use right among peasants, the extraction of rents from the farmer was no longer disappeared. The government introduced a compulsory grain delivery system out of the agricultural produce. According to Chole (2004), farmers were forced to sell a quota of grains at a price as low as 22% of the market price. This has surely a negative repercussion on the capital accumulation of the peasant as it tends to plummet the farmers' motives for hard work and land improvements and other farm related activities. This was the main reason for the long –lasting stagnation of per capita agricultural output during the Derg regime. Chole argued that some peasants were coerced to sell their livestock to meet their quota requirements as failure to comply lead to eviction from their land right. Since the entire surplus is absorbed by the rent seekers, subsistence farmers dominate the economy.

As a result, the economy is placed with low saving, low human capital and physical capital accumulation and low initial per capita income. The predatory institution ended in 1991. But, the economy started with low initial saving, degraded agricultural land fraught with primitive technology, and weak financial markets. Yet, certain restrictions till remain in the agricultural sector.

The current government has introduced the so called agricultural development led industrialization (ADLI) with the belief that agriculture is key for successful structural transformation from agriculture dominant economy to the modern service and industry led economy. This implies that agriculture is presumed to be a pushing force for the growth process of other sectors in the early stage of development. Stated differently, it means that any productivity shock to agriculture has caused substantial growth effect on other sectors. The government argues that since agriculture harbours the livelihood of 70% of the population and a major source of employment and foreign exchange, a small change and improvements in this sector could have substantial effects in driving the growth of the entire economy. The first objective of this study is to examine whether agriculture is weakly exogenous or a driver of growth as perceived to be by looking at the long run impact matrix C.

The second objective is to investigate the role of service primarily on agriculture. The service sector has been resurgently expanded and now become the second dominant sector following agriculture in Ethiopia and it has started getting to be the source of physical and human capital.

Data and Econometric Approach

Data

This paper uses value added data spanning the period 1981 -2011 which are obtained from World Bank African Development indicators. The following variables have been used to investigate the presence of sector interdependence in Ethiopia.

$$x_t' = (agri_t, ind_t, ser_t)$$

Where, $agri_t$ stands for the log of agricultural value added, ind_t and ser_t respectively denote log of industrial and service value added. All variables are at constant prices and transformed into logarithmic scale. Thus, log linear model is preferred because cointegration analysis is a matter of stable linear relationship in the long run. Visual inspection of the variables gives a handful information about the pattern and trending behaviours of the variables. Hence, a graphical representation of the variables in levels and first difference is offered in Figures 1, 2 and 3. If a variable is found to be mean-reverting, any shock to that particular variable will have only transitory effect. The variable is said to be I(0). On the other hand, if a shock has permanent effect, then the variable is non-stationary and the converse is not necessarily true. For instance, if the non-stationary variable is purely adjusting to a shock, it does not have

permanent effects on other variables. Non-stationary variables I(1) can be generated from shocks cumulating once. It is of interest to discriminate variables as stationary or non-stationary using graphical inspection as presented in Figure 1. The levels of all variables seem to be I(1) while the differences are quite mean – reverting. Industrial and service value added exhibit some persistence and seem to be trending. Each sector can be decomposed into sub-sectors. A nice property of cointegration analysis is that it is invariant to both linear transformation of variables and changes in information set. A cointegration relation found in smaller variables can also be detected in an enlarged information set (Juselius, 2006). The econometric analysis begins with the three sectors, namely agriculture, industry and service and expands the model by splitting the variable of interest into its counterparts.

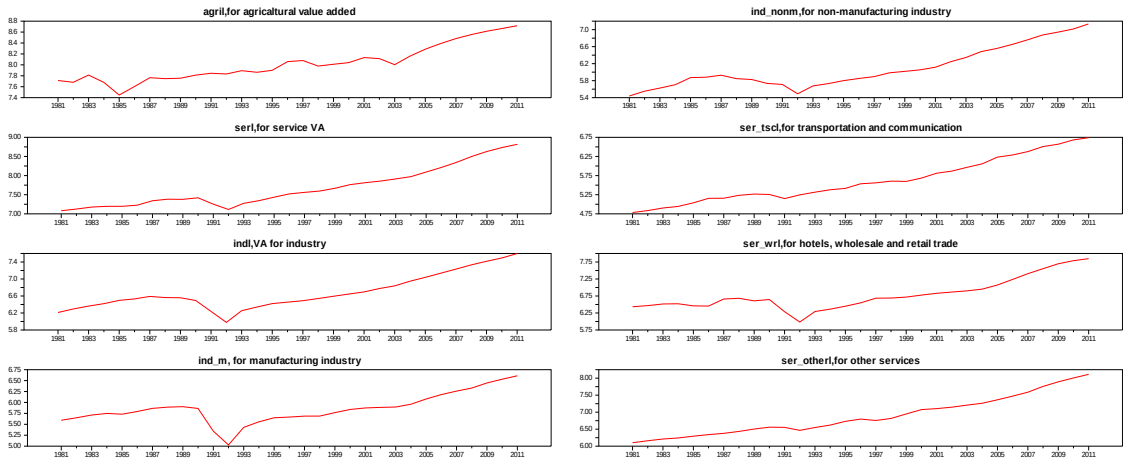

Figure 1. The log of Value Added (VA) for different sectors at level

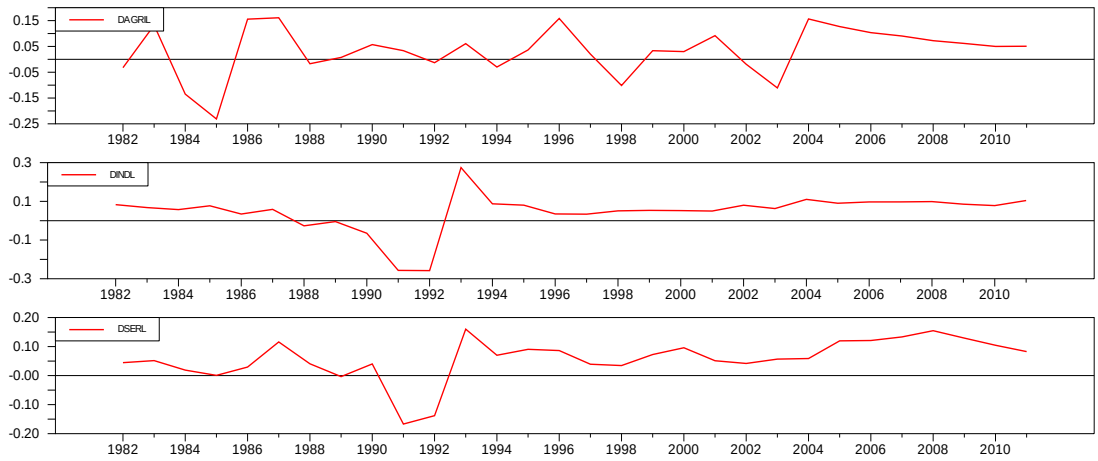

Figure 2. Graphs of the variables at first difference

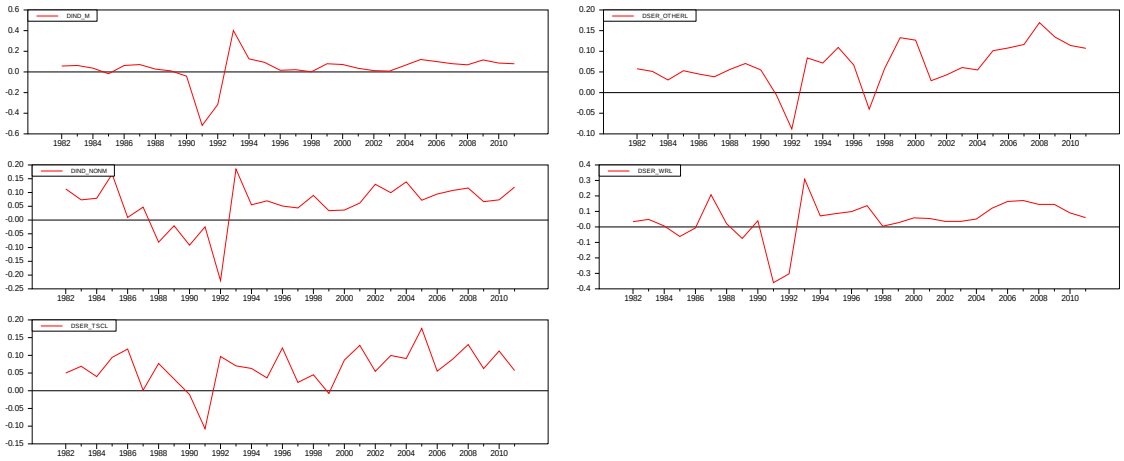

Figure 3. Graphs for the disaggregated variables at first difference

Model Specification and Tests

In the non-stationary environment, OLS estimation does not give a valid statistical inference because of the spurious regression that masks the true relation between variables. The conitegrated vector error correction model is well suited if the non-stationary variables share common stochastic trends from which their linear combinations form a stationary long run relation. In this case, the variables are said to be cointegrated. The cointegrated VAR model encompasses the short and long run information about the variables in the sense that it entails both the difference as well as the level information. The CVAR* model allows the data to speak freely without imposing prior restrictions on the data and thereby improves estimation efficacy (Hoover et al., 2008)

The VAR model comprises potentially endogeneous and exogeneous variables, in which the former can be specified as a linear functions of k of their own lags, k lags of other non-deterministic variables and other exogeneous variables. The p dimensional VAR model can be represented by

$$x_t = \pi_1 x_{t-1} + ... + \pi_k x_{t-k} + \Phi D_t + \varepsilon_t \text{ , t = 1 .....T} \quad (1)$$

Where $(\pi_1, \pi_2 ... \pi_k)$ represents a P*P matrices of unrestricted autoregressive parameters and Φ denotes unrestricted parameters for the deterministic part of the model, D_t having a p*m matrix which entails a constant, trend, seasonal dummies and intervention dummies. ε_t is independently and identically distributive (iid) error with mean zero and covariance matrix, Ω , that is , $\varepsilon_t \approx N_p(0, \Omega)$.

The VAR model can be reformulated elegantly into Vector Error Correction Model (VECM) just by subtracting x_{t-1} from both sides of equation 1 and then re-arranging yield

$$\Delta X_t = \prod X_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta X_{t-k} + \Phi D_t + \varepsilon_t \quad (2)$$

Where $\prod = -(I_p - \sum_i^{k-1} \pi_i)$ comprises the long run parameters of the model whereas $\Gamma_i = -\sum_{j=k+1}^{k} \pi_i$ represents a p*p matrix of short run dynamics. By keeping all the information as VAR, VECM representation is suitable for cointegration analysis just by revealing the long run

* The software CATS in RATS (Dennis, Hansen, Johansen, & Juselius 2006) packages was used to conduct all computations including graphs

and short run information separately. VECM is more likely to reduce the multi-colinearity problem in time series data (Juselius, 2006). Having looked at the left and right hand side variables in equation 2, the system is not balanced as the right hand side contains variables in levels which are not stationary while the variables in difference in the left hand side are stationary. To circumvent this problem, one can impose a reduced rank r on the long run level matrix $\prod$. The $\prod$ matrix is decomposed into two parts, α *and* β where both of them are p*r matrices (that is, $\prod = \alpha\beta$) with r<p.

The VECM can be re-written as

$$\Delta X_t = \alpha\beta' X_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta X_{t-k} + \Phi D_t + \varepsilon_t \quad (3)$$

Where $\beta' X_{t-1}$ describes the linear combinations of variables that produce stationary process even if the variables in levels standalone might be non-stationary. β' is a matrix of cointegration vectors representing the long-run coefficients. Stated differently, $\beta' X_{t-1}$ represents a stable long run relation towards which the system adjusts once it is off the equilibrium by shocks. The α matrix depicts the short run adjustment coefficients to the steady state relationships, $\beta' X_{t-1}$. In other words, it highlights the speed of adjustment with which the process is pulled back towards the long run relation.

As shown in Figure 1, most of the variables are trending and as a result, trend is restricted into the cointegration relation while the unrestricted constant is placed in the model equation as captured by the deterministic term, D_t. Intervention dummies will be included in the deterministic term only if a test for model specification permits us to do so. For this reason, the baseline VAR(2) model offered by eq(2) is first estimated without capturing any structural breaks caused by institutional and economic reforms in Ethiopia. In this case, the test fails to meet the assumption of multivariate normality of residuals ingrained in VAR model and it passes only the null of no second order autocorrelation of residuals. We find extra ordinary large standardized residuals ($|\varepsilon_t / \sigma| \geq 2.7$) for the period 1992, which is also visible in Figure 1 above. Large standardize residual outliers are also detected in the year 1985 and 2003[†]. The year 1992 was the period in which the country launched multitude reforms, inter alia, include a more than 100% devaluation of the Ethiopian currency (birr), the advent of foreign exchange liberalization and removal of trade restrictions, deregulation of markets and privatization of state owned enterprises. On the other hand, agricultural production in Ethiopia primarily depends on rainfall and that the sector was hit by severe drought and famine during 1985 and 2003. These outlier observations in the respective years have been captured by permanent impulse dummies. With dummies and deterministic terms included in the model, it passes most of the specification tests such as multi -variant normality of residuals and the null of no first and second order autocorrelation and the data fits the model reasonably well (cf. Table 1 in appendix). Even if the ARCH effect is detected, the cointegrated VAR model is robust for ARCH effects (Gonzalo, 1994; Rahbek et al., 2002).

After including intervention dummies and trend, the final model is specified as follow.

$$\Delta X_t = \alpha(\beta^* X_{t-1}^*) + \sum_{i=1}^{k-1} \Gamma_i \Delta X_{t-k} + \Phi_{92p} \Delta D_{bt,92t} + \Phi_{85p} D_{p,85t} + \Phi_{03p} D_{p,03t} + \gamma_0 + \varepsilon_t \quad (4)$$

Where $\beta^* = (\beta', \beta_0, \beta_1, \beta_2)'$; $X_{t-1}^* = (X_{t-1}, 1, t, bt_{92})'$. β_0 represents the intercept in the cointegration relation while β_1 is the vector of coefficients to the linear trend, t, which is restricted to lie in the cointegration space. The economic reforms in 1992 have triggered shifts in the mean growth rates of service and industry as shown in Figure 1. Graphical inspection of the data reveals that the year 1992 has also affected the trending behaviour of these variables. Based on this and historical facts in Ethiopia the broken linear trend bt_{92}, which is accumulated

[†] The standardized residuals for 1985 and 2003 are 2.25 and 2.23 respectively

shift dummy that starts at 1992 and offered as (…0, 0,0, 1,2,3,4…), is restricted to lie in the cointegration relation. The vector of coefficients, β_2 pertaining to t_{92} measures the slope of trend coefficients. The hypothesis that broken trend is excludable from the cointegration relation is rejected at any reasonable confidence level (i.e. p-value is 0.009 for r=2 and 0.024 for r=1). Moreover, the hypothesis that both broken trend and trend are not important in the cointegration relation is also rejected with a p-value of 0.022.

The Moving Average Representation (MA)

The VECM model presents the pulling forces that restore the equilibrium once it has been moved away by shock. The common trends representation is another way of perceiving the VAR model from the perspective of pushing forces (or stochastic common trend shocks). The MA representation of eq. (1) can be given by:

$$x_t = C\sum_{i=1}^{t}(\varepsilon_i + \Phi D_i) + C^*(L)(\varepsilon_t + \Phi D_t) + x_0 \ , \ \ t = 1,2,...,t \tag{5}$$

Where $C = \beta_\perp(\alpha_\perp^{'}\Gamma\beta_\perp)^{-1}\alpha_\perp^{'}$ is a matrix of rank p-r. $\alpha_\perp$ is the common stochastic trend and obtained from the orthogonal complement of α. $\beta_\perp$ is their loadings. Both $\alpha_\perp$ and $\beta_\perp$ are p*(p-r) matrices. $C^*(L)$ is an infinite order lag polynomial and x_0 represents initial values for the variables and includes also the short run dynamics. The C matrix recaps the long run impulse response of a shock to a particular variable. Following Johansen (1996, 1994) and Juselius (2006), eq. (5) can be re-written after replacing the deterministic term D, by the corresponding values of trend ,intervention dummies (shift and blip dummies) and constant and re-arranging yields

$$\begin{aligned} x_t &= C\sum_{i=1}^{t}\varepsilon_i + C\mu_0 t + \frac{1}{2}C\mu_1 t^2 + \frac{1}{2}C\mu_1 t + C\Phi_s\sum_{i=1}^{t}D_{s,i} + C\Phi_p\sum_{i=1}^{t}D_{p,i} + \\ & C^*(L)(\varepsilon_t + \mu_0 + \Phi_s D_{s,t} + \Phi_p D_{p,t}) + x_0 \end{aligned} \tag{6}$$

The final impact of the first term in eq. (6) on variables in level has been studied in the next section.

Determination of Cointegration Rank

After having obtained a well specified model, the next step is to determine the rank of the π matrix.

Since our variables are I(1), there could be a possibility to find one or more cointegration relationship in the data. As the rank of the π matrix will influence all the subsequent analysis including statistical inferences, it is of particular relevance determining the appropriate rank using a combination of several statistical criteria such as the trace test ,the significance of the α coefficients, the largest characteristic roots of the model, and the graph of the cointegration relation (Johansen, 1996). Investigating the cointegration rank in VECM model tends to split the data into two parts; one with r stable long run relations that error correct to any short run disequilibrium and the second with p-r relations which are pushing the system out of the equilibrium (pushing forces). The rank test is reported in Table 1. Based on the trace test, one cointegration relation is established. The p-value of the Bartlett statistic suggests a rank of 1 only at 10% significance level. It is hard to rely exclusively on the trace test because of its low power in small sample settings. It is vital to look for other rank indicators as well. As the table shows, the Eigen values are different from zero suggesting that the corresponding vector associated to the eigen value can be a stationary relation. Examination of the significance of the largest t-value of the adjustment coefficients (alpha) for the $(r+1)^{th}$ cointegration vector indicates the existence of full rank (i.e. r=3).

In addition, the magnitude of the largest characteristic root of the companion matrix has been used to determine the number of cointegration relation. If the largest characteristic root closes to unity, then the $(r+1)^{th}$ cointegration vector becomes non-stationary. The largest unrestricted root for r= 3 is 0.7 which seems close to unity while it is 0.58 for r=2. However, as argued in Julius (2006), whether the root closes to unity or not is subjective as it is reported without confidence bands. Instead, the movement from the largest to the next largest root provides powerful information in determining the rank. As we move from r=3 to r=2, the largest root declines significantly (0.7 vs 0.58) suggesting substantial gain in terms of the stationarity of the second cointegration. In fact, reducing the rank from r=2 to r=1 also reduces the largest root left in the model. On the basis of this criteria, the rank should be equal to two or one. The graphs of the cointegration relations, both from concentrated model (R-form) and full model (Z-form), are relegated in appendix and are complementing the rank test result of the companion matrix. Given that the focus is on long run relation, the concentrated model is a preferred one. Visual inspection of the graphs in the appendix reveals that the first two relations are quite mean reverting. Based on the significance of the alpha coefficients, the largest unrestricted root and the graphs of the cointegration relations, there are two cointegration relations (r equals to 2). Nevertheless, sensitivity analysis for the second best choice (r=1) can be conducted.

Finally, the paper tests whether the long run relationship, $indl - \beta\ Agril$ or $(indl - \beta_1\ Agril - \beta_2 T(1992)$ is I(0). I find a stable long run relation between agriculture and industry at any reasonable significance level, suggesting the importance of agriculture to industry and vice-versa (result is available up on request).

Table 1. Rank test

p-r	r	Eigen value	Largest root	p-value for trace test	p-value for Bartlett test	alpha
3	0	0.55	-	0.04	0.075	
2	1	0.45	0.243	0.079	0.101	5.2
1	2	0.42	0.58	0.097	0.102	-2.67
0	3	-	0.71	-	-	-4.5

Estimation Results

This paper presents the identified long run structure and moving average representation. The estimation results of the three models are presented. The first model (model 1) comprises the three major sectors namely agriculture, service and industry. In Model 2, the service is disaggregated into other service and distributive service whereas industry comprises manufacturing and non-manufacturing sectors. The distributive service is further decomposed into two: restaurant, hotels, whole sale and retail trade on the one hand and transportation and communication service on the other hand.

The discussion is organized by presenting the identified long- run structure first and then the long-run impact matrix next. It is of interest to present the long run impact matrix without imposing any restriction of the parameters of the model.

Table 3 presents the identified long run structure for model 1. In an identified model, all cointegration vectors are unique in the sense that they cannot be obtained by a linear combinations of other vectors. We start with an identified model by normalizing the corresponding cointegrating vector by the most adjusting variable and then eliminate the insignificant coefficients from the model. In model 1, agriculture is the most adjusting variable in the first relation while industry equilibrium corrects to the second cointegration relation. A just identified model requires (r-1)*r restrictions which do not change the log-likelihood

function of the model and hence are not testable. Whereas an over-identified model is likely to change the likelihood function which requires a test whether the restrictions are acceptable or not. Though there are different just identified models that satisfy the r*(r-1) restrictions, there is only a unique just-identified model that meets the three criterion: generic, economic and empirical identifications [‡](Johansen, 1996). Pertaining to this criterion, the identified long run structure of all the three models is established.

Before the long run structure of the model, tests for stationarity, weak exogeneity and a test for a unit vector in alpha(test of endogeneity) for the first best choice of rank (r=2) and second best choice of rank (r=1) are presented in appendix (cf. Table 2). None of the variables in levels are either trend stationary or stationary by itself. With broken trend included in the cointegration relation, service has remained non-stationary while the other two variables become stationary. Service is found to be weakly exogenous variable while agriculture seems to be endogeneous. A weakly exgoneous variable is expected to have strong permanent impacts on all variables while endogenous variable does have little or no long run impacts on other variables. First, we present the estimated identified long run structure for model one (3 main sectors) which is accepted based on a high p-value of 0.762. Second, the estimated results for model 2 (disaggregated sectors) will be reported next.

Table 3. Identified long run structure for model 1

	Eigen vectors β (r=2)			Weights α (r=2)		Eigen vectors β (r=1)		Weights α (r=1)
Var	$\hat{\beta}_1$	$\hat{\beta}_2$	Eq.	$\hat{\alpha}_1$	$\hat{\alpha}_2$	$\hat{\beta}_1$	Eq.	$\hat{\alpha}_1$
agril	1	-	Δagril	-0.865 (-4.793)	*	1	Δagril	-0.468 (-2.479)
Indl	-	1	Δindl	*	-0.819 (-2.849)	1.153 (5.063)	Δindl	-0.549 (-2.275)
Serl	-0.57 (-14.099)	-0.552 (-4.447)	Δserl	*	*	-1.223 (-5.280)	Δserl	*
T(1992)		-0.041 (-4.477)				-0.048 (-4.542)		
Trend		0.017 (2.272)				0.022 (2.367)		

Note: t-values are reported in brackets

$\hat{\beta}_1 x_t$ describes the relation between agriculture and service and this relation is often denoted as agricultural relation as the short run adjustment has occurred through agriculture. The service sector has positive and significant impact on agriculture. Noting that the estimated coefficients represent elasticities, a 10% increases in the service sector leads to a 5.3% increase in agriculture albeit the estimate is inelastic. Given that agricultural possesses a lion share of the total employment and GDP, the marginal increase in this sector has a marked impact on the overall growth. This inelastic estimate has far reaching implications in controlling for poverty and mitigating rural –urban income disparity. The service sector has played a substantial role in raising agricultural production. The rapid progress in private banking and insurance and the advent of microfinance institutions and commercial banks in small rural towns are believed to

[‡] See the condition under which a long run structure is generically, empirically and economically identified

have sustainable effects on whole economy in general and on small scale farmers in particular through creating access to rural finance and eliminating credit rationing.

Even if, the government has made effort to create a close tie between agricultural and service, agriculture is still constrained in a number of dimensions: exclusive control of fertilizer distribution by the state and exclusive state ownership of lands. The strong relationship between agriculture and industry now disappears when service enters the model unrestrictedly (cf. Table 6). The insignificant effect of industry on agriculture seems sound given the fact that agriculture still uses primitive technology mainly because of low demand for industrial products (agricultural machinery and equipment). Inspection of the unrestricted estimates of the pi-matrix (not reported here but available up on request) supports the insignificant impact of industry on agriculture.

Since the objective of the paper is to analyse sectoral growth interdependence in Ethiopia with especial emphasis on the spillover effect of services to agriculture, there exists three important evidences on the role of service as deriver of growth in Ethiopia. First, based on the test of stationarity of a variable (Table 2), after correcting for trend and broken trend, the service still is not stationary. Shocks to non-stationary variables attribute to common trends and do have long run impacts on other sectors. As shown in Table 7, a shock to service has positive and significant impacts on agriculture and industry. Second, from the fully identified long run structure presented in Table 3, service is found to have positive and significant impacts on agriculture and industry. Third, the quantitative significance of service to other sectors has also been observed from unrestricted estimates of the pi matrix.

$\hat{\beta}_2 x_t$ Offers the strong association between industry and service where the former error corrects to short run disequilibrium at a rate of 82% every year. This relation can be described as industrial relation as the short run adjustment has occurred only through industry. Service has a discernible impact on industry with an estimated coefficient of 0.55.

Using rank equals one, there is substantial positive impact from service to agriculture. A 10% increase in service is accompanied by a 12.2% increase in agriculture reflecting a spillover greater than unity. Industrial sector is appeared to have strong negative impact on agriculture (11.5%) because of the fact that both service and industry compete for the same resources. The recent upsurge in rural-urban migration might be a possible explanation through which industry affects agriculture. In one hand, migration provides cheap labour for industry but decreases agricultural production by reducing land under cultivation or agricultural intensification. Alternatively, migration may enhance agricultural productivity by withdrawing the excess labour working on a specific plot of land. Thus, the impact of industry on agriculture depends on the strength of these two factors.

The high productivity does not in turn pour into agriculture significantly because of the low agricultural income. The negative significant effect of industry, however, disappears when r equals two implying that the negative effect by withdrawing labour from agriculture is equally compensated by the cheap agricultural inputs provided by industry. The impact of service on agriculture is robust as it has positive spill-over effects in both ranks considered in the analysis.

Based on the estimated long run structure in Table 3, I find significant long run relationships among industry, agriculture and service. These interdependence in sectoral growth stands in a stark conflict with the dual economy model where agriculture is considered as an isolated sector

One of the overriding objective of the paper is to examine the permanent impact of shocks to the variables in the system. The long run impact matrix is estimated uniquely. The impulse response matrix without imposing any parametric restrictions on α and β is reported because imposing identifying restrictions is misleading.

The long run impact matrix recaps crucial information about the effects of the stochastic pushing forces on system variables. The column of the C matrix offers the effects of a shock to variable x_{ij} on all variables in that specific column whereas the row summarizes the extent by which variable x_{ij} is affected by permanent shocks to variables in the system**.**

A test for a unit vector in alpha and a test of weak exogeneity are presented in Table 2. Both agriculture and industry are individually (p-value of 0.525 and 0.449 respectively for agril and indl) and jointly (p-value of 0.664) accepted as endogenous variables based on a test for a unit vector in alpha. But service is found to be weakly exogeneous.

Table 4. The long run impact matrix C (model 1)

	ε_{agril}	ε_{indl}	ε_{serl}	ε_{serl} *
Agril	-0.139 (-0.765)	-0.241 (-1.070)	**1.015** (3.054)	**0.853** **(2.208)**
Indl	-0.114 (-0.765)	-0.198 (-1.070)	**0.833** (3.054)	1.011 (1.572)
Serl	-0.221 (-0.765)	-0.384 (-1.070)	**1.615** (3.054)	**1.650** **(2.952)**
*impulse response when r=1				

For r equals 2, a shock to agriculture does not have any impact on the system variables reflecting the fact that it is a purely adjusting variable. This holds true for industry as well.

While agriculture and industry are found to be pulling forces, service is seen to be a pushing force where the variable itself constitutes a common stochastic trend. As a result, service has a permanent impact on the system variables playing as a main driver of growth of all sectors (cf. Table 4). This finding accords with the fully identified long run structure where service has positive and significant impacts not only on agriculture but also on industry. Considering the second best choice of rank of 1, the growth deriving role of service has still persisted for agriculture and itself (see last column of Table 4).

Model 2 is re-estimated after decomposing industry into manufacturing and non-manufacturing sub-sectors and the result reported in Table 5. The service has been disaggregated into other service and distributive service. The estimated fully identified long run structure is accepted with a high p- value of 0.769. The disaggregation into smaller subsectors helps identify the sector that derives the economy most, in particular the unit that has a close tie with agriculture because the latter is the main source of employment and foreign exchange in Ethiopia.

Table 5. Identified long run structure for model 2

	Eigen vectors β				Weights α		
Var	$\hat{\beta}_1$	$\hat{\beta}_2$	$\hat{\beta}_3$	Eq.	$\hat{\alpha}_1$	$\hat{\alpha}_2$	$\hat{\alpha}_3$
Agril	-	-	1	Δagril	-0.372 (-3.306)	*	-0.504 (-4.170)
Ind_nonm	-1.157 (-6.439)	-	0.460 (2.884)	Δ ind_nonm	*	0.517 (6.778)	0.133 (2.344)
Ind_m	1	-	-0.401 (-2.128)	Δind_m	-0.746 (-4.024)	-	*
Ser_otherl	-	1	-1.248 (-5.943)	Δ ser_otherl	-0.181 (-3.237)	-0.308 (-3.818)	0.202 (3.371)

Ser_Disl	0.939 (4.496)	-1.340 (-14.927)		Δser_disl	-0.505 (-3.643)	*	*
T(1992)	-0.162 (-10.349)	0.133 (15.435)	0.062 (5.606)				
Trend	0.092 (6.978)	-0.071 (-11.689)	-				

Note: t- values are reported in brackets

$\hat{\beta}_1 x_t$ comprises the association between manufacturing, non-manufacturing and distributive service. In this relation, manufacturing and distributive service are purely adjusting variables. An interesting finding emerges concerning the strong positive relationship between manufacturing and non-manufacturing. To put a little more perspective, a 10% growth rate in non- manufacturing leads to a marked growth of about 11.57% in manufacturing. Public utilities (electricity, gas and water) and construction industry, which are classified under non-manufacturing, are the most likely factors that spur growth in manufacturing. Improvements to the endemic electricity blackouts can affects firms' growth in developing countries. The construction industry has escalated as the demand of house exceedingly larger and make it a lucrative investment in Ethiopia. The high demand of housing for investment in turn creates an elastic derived demand for manufactured products such as metals and cement. Thus, growth in the construction industry directly leads to growth in manufacturing sector.

$\hat{\beta}_2 x_t$ is a function of two service sub-sectors : other service and distributive services. Other service reacts positively and significantly with an elastic estimate of 1.34 to changes in the distributive service. The possible explanation is that investment in other services such as banking and insurance and social development services (schooling and health) accelerated rapidly in an environment having better distributive services that include access for transportation and communication, and an influx of hotels, restaurants and trade.

$\hat{\beta}_3 x_t$ is a relation comprising agriculture ,manufacturing and other service. The adjustment is taken place both in agriculture and other service based on the estimated alpha coefficients (cf. Table 5). A stable long run relation is established between agriculture, industry and service. Yet, further disaggregation gives additional information. For instance, the non-manufacturing sector is appeared to have negative relation with agriculture. On the other hand, there is a strong positive impact from manufacturing to agriculture. A more productive manufacturing sector can provide cheaper agricultural inputs such as chemical fertilizers, machinery and equipment. Since agriculture is a big market for manufacturing, agricultural farm income increases following the price incentive from manufacturing. The high farm income in turn raises both the demand for agricultural inputs and demand for manufactured food items. The dualistic model has been rejected as agriculture has a backward linkage with manufacturing.

Finally, other service has a marked spill-over effect into agriculture. From the $\hat{\beta}_3 x_t$ relation, other service spurs long term growth in agriculture (cf. Table 5). Financial outreach by the competing financial institution to small towns in rural area encourages savings which leads to efficient agricultural activities (live animals, cash crops) that would have been otherwise difficult and unavailable without having access to credit from banks and micro finance institutions. In January 2005, the government has issued land certificate of ownership

that offers farmers incentive to invest on land improvements. Land is used as a collateral for loan. Improved credit access; better agricultural extension service; access to health service and increased supply of female health extension workers are possible channels to raise agricultural productivity. The main finding is that other service has a strong backward and forward linkages with agriculture.

The final impact matrix is reported in Table 6. Column wise investigation of the C matrix suggests that a shock to other service has positive and strong effects on all variables except manufacturing. Therefore, other service has been considered as a driving force for the growth of manufacturing (e.g. construction industry), agriculture and distributive service (comprises transportation and communication, whole sale and retail trade). Shocks to manufacturing and non-manufacturing have little impacts on all variables as they are adjusting variables[§]. A shock to agriculture has substantial impact on manufacturing and non-manufacturing variables. The last column also reports the long run impulse matrix for the second best choice of rank (r=4). Other service is found to be a pushing force again in congruous with the finding obtained when r=3.

Table 6. Long run impact matrix C (model 2)

	ε_{agril}	ε_{ind_nonm}	ε_{ind_m}	ε_{ser_otherl}	ε_{ser_disl}	ε_{ser_otherl}*
Agril	0.606 (-1.323)	0.218 (0.901)	-0.513 (-1.203)	**1.176 (2.290)**	-0.071 (-0.123)	**0.928** (2.032)
Ind_nonm	**0.870 (2.103)**	0.287 (1.311)	0.483 (1.255)	0.725 **(1.60)**	**-1.581 (-3.041)**	**0.808** (2.032)
Ind_m	0.573 **(1.873)**	0.176 (1.085)	**0.928** (3.257)	-0.003 (-0.009)	**-1.781 (-4.629)**	**0.271 (2.032)**
Ser_otherl	0.646 (1.376)	0.231 (0.931)	-0.478 (-1.094)	**1.199 (2.278)**	-0.159 (-0.269)	**0.960** (2.032)
Ser_disl	0.521 (1.492)	0.184 (0.996)	-0.273 (-0.840)	**0.878 (2.243)**	-0.265 (-0.603)	**0.726** (2.032)

Note: *denotes that results are based on the second best choice (r=4), t-values are in brackets

Model 3 extends model 2 by disaggregating the distributive service (ser_disl) into transportation and communication in one hand (ser_tscl) and restaurants, hotels, whole sale and retail trade on the other hand (ser_wrl). The estimation result is portrayed in Table 7. Given that agriculture accounts for 84% of exports and 80% of total employment in 2002/2003, it is of interest to shed light on how the different type of services explain the growth in agricultural production.

Table 7. Identified long run structure (model 3)

	Eigen vectors β (t-values in brackets)				Weights α (t-values in brackets)		
Var	$\hat{\beta}_1$	$\hat{\beta}_2$	$\hat{\beta}_3$		$\hat{\alpha}_1$	$\hat{\alpha}_2$	$\hat{\alpha}_3$
Agril	1	-	-	Δagril	-1.861 (-6.268)	-0.564 (-4.490)	-1.414 (-4.958)
Ind_nonm	1.013 (25.153)	-0.338 (-2.663)	-	Δ ind_nonm	*	-0.201 (-2.556)	*

[§] Based on test for a unit vector in alpha, the variable is purely endogenous(result is available up on request).

Ind_m	-	1	-	Δind_m	1.034 (1.796)	-0.446 (-1.832)	*
Ser_otherl	-0.781 (-22.096)	-	1	Δ ser_otherl	*	-0.366 (-4.904)	-0.451 (-2.659)
Ser_tscl	-1.071 (-14.675)	-	-0.592 (-6.784)	Δser_tscl	*	*	0.534 (1.925)
Ser_wrl	-	-	-0.631 (-17.465)	Δser_wrl	*	-0.555 (-2.299)	*
T(1992)	-0.046 (-14.790)	-0.124 (-11.713)	0.075 (14.171)				
Trend	0.072 (18.215)	0.072 (6.851)	-0.050 (-7.613)				

Unlike the dualistic model, there is a staunch relationship amongst industry, service and agriculture. Agriculture supplies unprocessed raw materials such as coffee, live animals, pulses and oils and unpacked cut flower either directly to export market or to domestic manufacturing firms for further processing to increase the value added. However, there is less robust sectoral growth linkages between agriculture and manufacturing because agriculture is mainly exporting primary products instead of processed products. The more productive service increases the export competitiveness of agriculture primarily by reducing transport cost and by updating producers' current information on new technology and product market (cf. Table 7). Improved transport infrastructure is crucial as most of primary products unleashed into export comes from remote rural areas. There is a long run positive impact from transportation and communication on agriculture (cf. Table 7 and 8).

$\hat{\beta}_1 x_t$ is a relation comprising agriculture ,non-manufacturing, transport and communication and other service. Adjustment is taken place only through agriculture and hence, the relation is said to be agricultural relation (see Table 10). As other service increases by 100%, agriculture increases by 78% implying that other service has been still exerting substantial influence on agriculture consistent with the finding in model 2. We have seen positive and significant impact from the growth in transportation and communication into growth in agriculture. The estimated elasticity stood at 1.07, suggesting a substantially high growth spill over into agriculture. What does a 7% more increase in agriculture imply?. This figure has two important policy implications: first, the extra investment on hard infrastructure is fully recovered. Second, that investment generates additional growth benefit in agriculture. Given the size of agriculture is 6 times large compared to the size of transportation and communication, investment on the later gives tremendous return.

The possible channel is that low transport margin and access to information can enhance specialization and export competitiveness. For instance, honey production in Tigray region today has received top priority as a means of achieving the region's food security strategy. Concerning the development of transport infrastructure, the Ethiopia airlines today has 18 domestic destinations and offers cheap domestic flights and also served places where land transportation is cumbersome.

$\hat{\beta}_2 x_t$ illustrates the relation between manufacturing and non –manufacturing sectors, suggesting that the two sectors inter-related through input and output markets. Cheap inputs from non-manufacturing sector (electricity, water, and gas etc) could increase the productivity of manufacturing. The cheap input supply (cement, metals, tin and furniture) by the manufacturing, in turn, raises the effective demand of the construction sector. Moreover, the

change in the slope of the broken trend shows that there is a shift in the growth of manufacturing after the introduction of economic reforms in 1992.

$\hat{\beta}_3 x_t$ is a stable long run relation of 3 sub-sectors namely, other service, transport and communication (ser_tscl) and whole sale and retail trade (ser_wrl). Ser_tscl and and ser_wrl have exhibited strong positive effects on other service (financial and social development services). This finding can be explained by the fact that financial and social development services expand rapidly in an environment where there is a better access to transportation and communication, availability of hotels and restaurants, and trade centre. This substantial sectoral growth spillovers confirms the importance of Ser_tscl not only for agriculture but also for the other service sub-sector.

The long run impulse response as reported in Table 8. Consistent with the finding in the identified long run structure, a shock to transportation and communication infrastructure brings a marked effect on agricultural value added. Manufacturing, transport and communication and other service itself have been strongly affected by a shock to other service, indicating that other service has continued to be the driver of growth[**] as demonstrated in a similar fashion in the C matrix of model 2. Agriculture has little impact on the long term growth of other sectors. In line with the results in the identified long run structure, a productivity shock to non-manufacturing drives the steady state growth of manufacturing.

Table 8. Long run impact matrix C (model 3)

	ε_{agril}	ε_{ind_nonm}	ε_{ind_m}	ε_{ser_otherl}	ε_{ser_tscl}	ε_{ser_wrl}
Agril	-0.068 (-0.2)	-0.553 (-1.754)	-1.081 (1.414)	0.620 (1.283)	**1.898 (1.96)**	0.925 (1.290)
Ind_nom	-0.231 (-1.729)	0.314 (2.521)	-0.248 (-0.824)	0.265 (1.387)	-0.245 (-0.638)	0.137 (0.484)
Ind_m	-0.471 (-1.765)	**0.568 (2.289)**	-0.783 (-1.301)	**0.844 (2.217)**	-0.015 (-0.019)	0.378 (0.670)
Ser_otherl	-0.453 (-1.688)	-0.133 (-0.531)	**-1.453 (-2.401)**	**0.850 (2.222)**	**1.476 (1.911)**	**1.291 (2.272)**
Ser_tscl	-0.172 (-1.010)	0.107 (0.676)	-0.687 (-1.785)	**0.753 (3.092)**	0.696 (1.416)	0.280 (0.775)
Ser_wrl	**-0.609 (-1.978)**	-0.222 (-0.774)	**-1.656 (-2.384)**	0.640 (1.458)	1.527 (1.723)	**1.790 (2.746)**

Note: t-values are reported in the brackets

Robustness of the Results

The Conitegated VAR model is re-estimated using another source of data and different sample sizes. First, data drawn from United Nations Development programme (UNDP, spanning 1981-2012) is used in place of the data obtained from the World Bank African Development indicators (a data used throughout the paper and spanning 1981-2011. I denote this as original data). Second, I use a large data set from UNDP spanning the year 1970 to 2012. Using the original data, it is found that service sector is driving the growth of the whole economy and that service has a considerable impact on agriculture irrespective of the choice of the cointegrating rank. The overriding objective of re-estimating the CVAR model, therefore, is to investigate the consistency of these findings for changes in data source and sample size. In all different scenarios, service is weakly exogeneous. The impact matrix suggests that

[**] Considering the C matrix in the second best choice of rank 4, other service has still been a driving force.

service is found to be a pushing force in almost all scenarios (across sample size and choice of rank). The results will be available upon request. Agriculture is endogenous and has little impact on others. Like the finding in the original data, the effect of other service on agriculture is elastic in the period 1981-2011. In addition, both distributive and other service significantly affect agriculture in the year 1970-2012. The finding has far reaching implication regarding the decisive role of the hard infrastructures(road, transportation and communication) and soft infrastructures (the financial service, education and health) in lifting agricultural productivity or providing incentives for farmers to expand land under cultivation or facilitating intensive use of agricultural inputs(through better extension service) or efficiency in production emanating from specialization on specific crops and livestock production depending on agro-ecological zones or a combination of two or more of these factors.

Conclusion and Policy Implication

To achieve food security and thereby structural transformation of agriculture, the Ethiopia government puts in place a series of reforms and priority to raise agricultural production and productivity in the last two decades. Though agricultural production increases in the last decade except in 2003, productivity of agriculture remains stagnant. Using a Cointegrating Vector Autoregressive model (CVAR), this paper investigates if agriculture has a backward and forward linkages with industry and service sectors. The dualistic model that considers agriculture as an isolated sector has been rejected. Instead, there exists interdependence between agriculture, service and industry as evidenced by the presence of two cointegrating vectors depicting the long run relationship between the three sectors.

Analysis based on the long run impact matrix suggests that agriculture has played little or no role to derive the growth of the whole economy as it is found to be purely adjusting in most of the scenarios and this is just a reflection of its low productivity.

Based on the CVAR model, I have succinctly demonstrated the positive impact of service on agriculture. The aggregation bias has been overcome (if any) by splitting the major sectors into smaller units and re-examine the sectoral growth relationships. Investments on hard and soft infrastructures have paramount importance in the sectoral growth spill overs. Other service[††] is found to be a driver of growth in agriculture, non-manufacturing and service itself. Transport and communication and other service variables are vital in promoting long term growth in agricultural production and productivity. The paper finds substantial growth externality effect from investment on transport and communication into agriculture and other service. Based on this robust result, the paper recommends government and development actors to pour funds into this stimulant sector. Access to information and efficient digital communication covering peripheral areas (i.e. information superhighway) can reduce transaction costs and transport margin, which in turn shrinks regional differences in prices and wages. On the basis of this finding, it is important for the government to liberalize the telecommunication industry to make it more competitive and a cheap source of information accessible by small scale poor farmers. Because there are still commands and controls in the economy. For instance, state monopoly in the production and distribution of seeds and fertilizers and state led telecommunication industry (DSA, 2006; Dercon et al., 2009).

Moreover, the second policy recommendation goes to other service sector as it is found to be an important force for sectoral growth linkages[‡‡]. The government should further

[††] Other service comprises banking and insurance, public administration, real state and ownership and social development services(health and education)

[‡‡] Other service comprises many subsectors and it is difficult to determine which one is most important unless one carries out a general equilibrium analysis or micro level study. But, we raise and discuss the more likely channels through which other service is affected most by its component based on historical data and from some other micro studies. This is done for other macro sectors as well. For instance, the recent increase in health extension workers and agricultural extension workers (as

liberalize the financial market and interest rate as they can stimulate rural finance and insurance schemes. A competitive and liberalized financial institutions can stir productivity of agriculture and construction industry by supplying cheap and sufficient credit. In particular, the government has to liberalize agricultural input supply markets in order to raise agricultural production and productivity. The reason for this recommendation come from the finding that the liberalization dummy is positive and significant in most of the long run relationships established in this study. Liberalization dummy for Industry is positive and significant throughout the whole analysis as this is the sector most liberalized after the current regime took power in 1991/1992 while agriculture is the least liberalized. The liberalization for service is very gradual compared to industry. Finally, the paper finds that investment on public utilities and the recent surge in construction demand derive the long term growth of manufacturing industry.

This study establishes sectoral growth linkages at macro level. Future study on micro level, however, is required to identify the most important variables that affect the growth of a specific sector.

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Appendix

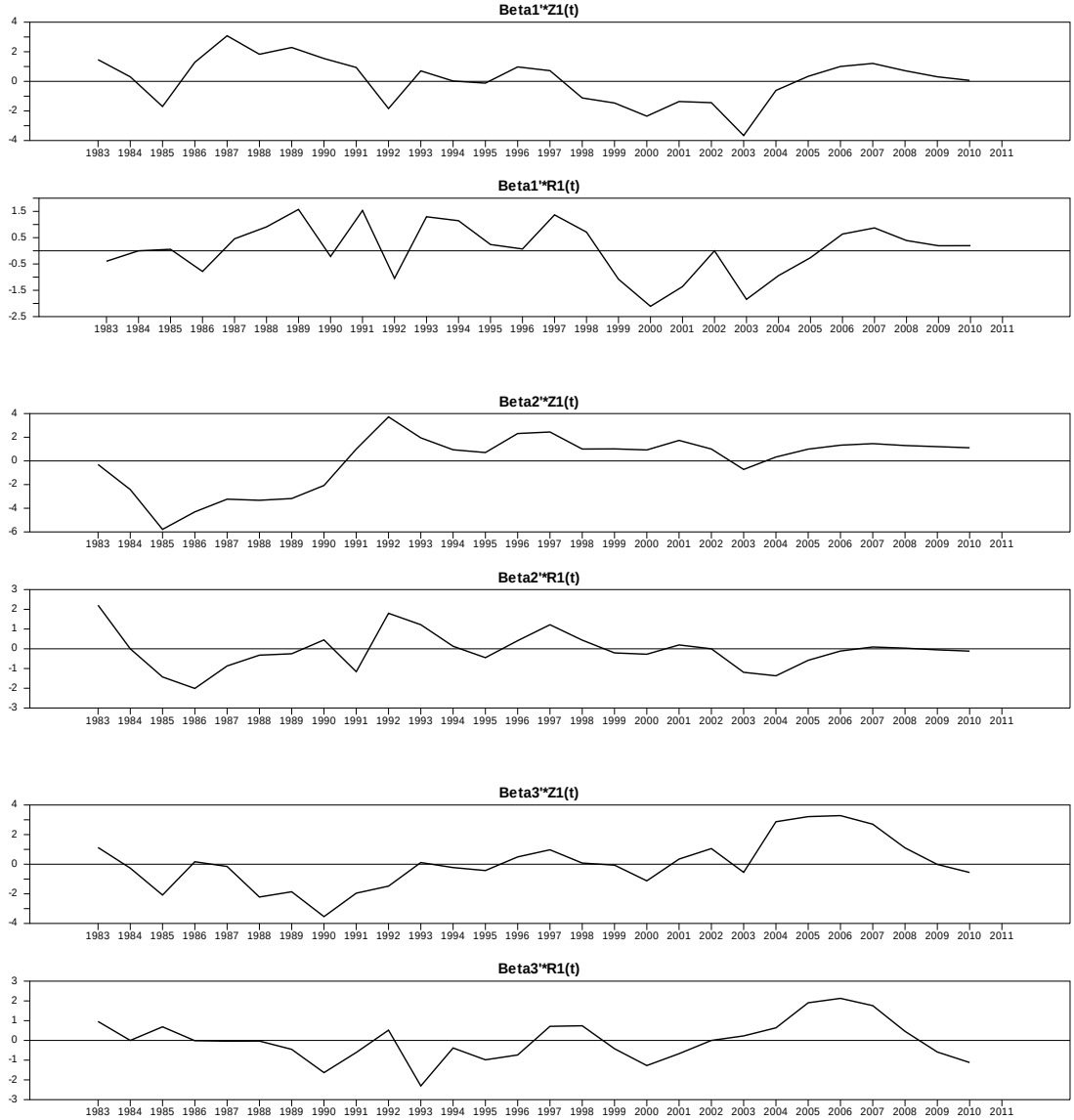

Figure 4. Graphs of Cointegration Relation

Table 1. Specification tests for auto-correlation, normality and test for ARCH for the three models

		Model 1	Model 2	Model 3
Autocorre.	LM(1)	ChiSqr(9) = 12.48 [0.187]	ChiSqr(25) = 42.9 [0.107]	ChiSqr(36) = 53.63 [0.030]
	LM(2)	ChiSqr(9) = 5.852 [0.755]	ChiSqr(25) = 15.9 [0.917]	ChiSqr(36) = 31.204 [0.696]
Normality		ChiSqr(6) = 2.499 [0.869]	ChiSqr(10) = 10.14[0.43]	ChiSqr(12) = 6.691 [0.877]
ARCH	LM(1)	ChiSqr(36) = 61.9 [0.005]	chiSqr(225) = 61.48 [0.048]	ChiSqr(441) = 491.356[0.049]
	LM(2)	ChiSqr(72) = 107.24[0.004]	ChiSqr(450) = 1457.49 [0.000]	ChiSqr(882) = 609.00 [1.000]

Table 2. Tests on alpha and beta coefficients

	r	DGF	5% C.V	Agril	indl	Serl
Stationarity (trend & shift)	1	2	5.991	5.101 (0.078)	4.167 (0.124)	8.153 (0.017)
	2	1	3.841	2.377 (0.123)	1.666 (0.197)	7.598 (0.006)
Test of weak exogeneity	1	1	3.841	1.729 (0.188)	2.371 (0.124)	0.818 (0.366)
	2	2	5.991	9.852 (0.007)	4.641 (0.098)	0.820 (0.664)
Test of a unit vector in alpha	1	2	5.991	2.502 (0.286)	2.026 (0.363)	5.576 (0.062)
	2	1	3.841	0.403 (0.525)	0.572 (0.449)	4.640 (0.031)