INTER-SECTORAL DYNAMIC GROWTH LINKAGES: EMPIRICAL EVIDENCE FROM SRI LANKA

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ABSTRACT

The Sri Lankan economy has been undergoing structural changes for the last few decades. The existence of dynamic linkages among the three major sectors- agriculture, industry and services of the Sri Lankan economy are examined in this paper for the period of 1960-2011. We employed graphical analysis including scatter plot, line graph, Confidence Ellipse and Nearest Neighbor fit to identify the basic features and the relationship between selected variables. The dynamic sectoral growth linkage results suggested the existence of inter-linkages across different sectors of the economy. ADF test and PP test were used to test the unit root characteristics of the time series variables. Inter temporal correlation results show that there exists a high positive statistically significant correlation between all sectors. Engel-Granger (EG) co-integration test provides further evidence for this. Error correction model estimates indicate that short run changes in Industry GDP have a positive impact on short run changes in Agriculture and services GDP. The results of Granger-causality test suggested that services growth causes agricultural and industrial growth significantly. The findings implied that by developing the services sectors, agricultural and industrial growth can be stimulated.

Key Words: *Growth linkages, Sectoral GDP dynamics, Cointegration, Causality*

Introduction

Sri Lankan economy has been experiencing structural changes in sectoral composition over the last few decades. The contribution of the agricultural sector to national GDP has been fast declining and service sector is dominating and has been showing remarkable improvements. The high dependency of the Sri Lankan economy on agriculture during 1950s constituting 46.3% of GDP in 1950 indicated a downward trend in later years. The emergence of Sri Lanka from agricultural to service-driven economy during the mid-1990s is an important milestone, changing production linkages across sectors in contributing to economic growth.

Problem Statement

Most early development strategies, advocated by Rosenstein-Rodan, Nurkse, and Hirshman among others, emphasized industrial development as the main source of economic growth. (Schiff and Valdez, 1998). The role of agriculture in generating economic growth was shown to be minimal with the experience from the newly industrialized countries and others. The services sector was identified as an emerging sector. Based on this evidence, the present paper identifies the importance of investigating the dynamic relationships between these sectors. We try to identify uni-directional and bi directional relationships between major economic sectors and investigate whether the sectors are able to generate growth in other sectors. We select Sri Lanka as the context for identifying sectoral growth linkages.

There is a significant gap in the growth literature in Sri Lanka. Most of the studies on inter-sectoral linakges were conducted for African countries and India. So far there were no in-depth analyses on sectoral dynamic growth linkages in Sri Lanka. This study fills this gap in the existing literature by providing a comprehensive analysis of inter-sectoral linkages in the Sri Lankan economy. An in-depth

understanding of sectoral growth dynamics becomes more important for policy formulation in designing structured and balanced growth in the economy. The use of studying these dynamic linkages between sectors is found to be very important in development planning to achieve a balanced sectoral development within the country.

As mentioned before, proper understanding of the linkages between sectors and identifying the key growth-boosting sectors is crucial for the formulation of long term policy in Sri Lanka to achieve sustained economic growth of around 6% which is projected by *Mahinda Chinthana*.

The motivation of this study is to answer the following set of questions; (i) Are there positive significant linkages between all three sectors? (ii) Are these linkages unidirectional or bidirectional? The present study incorporates visual inspection and time series analysis to answer the above research questions.

Objectives

The main objective of this paper is to study the dynamic growth linkages between agricultural, industrial and service GDP's for Sri Lanka. The objective is achieved by studying the long run relationship and the causal relationship between the three major sectors on the economy for the period of 1960-2012. Specific objectives of this study are:

1. to investigate the dynamics growth relationships among sectors during the sample period
2. to investigate the direction of causal relationships between growth of sectors

The paper will be structured as follows. Section 2 gives an overview of the theoretical and empirical background to the study, section 3 explains the methodological framework, section 4 presents the empirical results, sections 5 discusses the conclusions and recommendations and section 6 provides the limitations of the study.

Theoretical and Empirical Background

Literature Review

As a result of industrialization, resulting in the emergence of the contribution of non-agricultural sectors to national GDP, many economists developed the interest in studying the linkages between the major economic sectors: agriculture, industry and services. 'The concept of sectoral linkage, which evolved from Hirschman's theory of 'unbalanced growth', has been recognized as playing a crucial role and providing substantial contributions towards guiding the appropriate strategies for future economic development' (Saikia, 2011).

The sectoral linkages literature begins with the discussion of structural transformation in economies. Lewis (1954), one of the influential contributors in this regard, models the development process in terms of a structural transformation from agriculture to industrial activities. This provides evidence of a inter relationship between agriculture and industrial sectors as Dorwrick and Gemmell (1991) investigate in their study that high productivity in the industrial sector has positive externality effects on the agricultural sector.

Hwa (1988) has recognized that agricultural growth is strongly linked to industrial growth; he identifies this relationship as one of interdependence and complementarity. Although the literature stresses the agriculture-to-industry links, there could be also a possibility and potential for reverse linkages. Gemmell et al. (1998) points out that "a domestic source of industrial input to the agricultural sector can release bottlenecks: rising industrial wages can foster growing agricultural demand". Moreover, Bhagwati (1984) explains how services sector links with the production of goods through splintering process (production of goods emerge from services and vice versa). "The contributions of intermediate services such as distribution and retailing to both agriculture and manufacturing

are obvious and frequently observed (from input-output tables) to increase overtime in LDCs" (Gemmell et al, 1998).

Authors (Saikia 2011, Rashid 2004, Fiess and Verner 2001 etc.) have come up with interesting findings regarding the linkages between sectors for different economies, amongst few are listed below. In India, 'agriculture-industry' linkage has undergone directional changes as both the production and demand linkages, which were primarily from industry to agriculture in the pre-reform period, transformed to agriculture to industry in the post-reform period (Saikia 2011). In the same study, the author has found no any significant interdependence between agriculture and service sectors, while there is strong interdependence between industry and service sectors and it has improved in the post-reform period.

Fiess and Verner (2001) found that agricultural sector as a major driving force in sectoral growth in Ecuador. Study by Rashid (2004) investigated that industrial sector is the leading sector in Pakistan economy because the industrial sector granger causes aggregate GDP growth, agriculture growth as well as service sector growth. Study by Kaur et al. (2009) for the Indian economy, found that the agricultural sector exhibits strong association with the industrial sector, while the converse connection in terms of demand linkages of industry with the agricultural sector have weakened in the last two decades. Demand linkages of the services sector were observed to have strengthened in relation to the industrial sector overtime. Similarly, study by Gemmel et al. (1998) suggests that productivity techniques in manufacturing tend to spill over to agriculture, so encouraging convergent tendencies in sectoral productivity levels. The results for Romania indicated that the industrial sector is detrimental to agriculture however, the service sector contributes positively (Subramaniam and Reed, 2009). In the same study,the long-run relationship of industrial, service and trade sectors to agricultural sector were established, and the results show that the industrial sector in Poland contributes positively to the agricultural sector while the growing service sector shows mixed results. Craigwell et al. (2008) found that in Barbados in recent years, an expansion in services output was found to be the only determinant of industrial output in both the short and long run, as agricultural output did not appear to have any statistically significant.

Theoretical Background

The idea of the importance of sectoral linkages in economic growth is clearly advocated by Hirshman(1958) in his theory of unbalanced growth. This theory stresses on the need of investment in strategic sectors of the economy instead of all the sectors simultaneously. According to this theory the other sectors would automatically develop themselves through what is known as linkages effect. Creating unbalances are a pre-requisite of economic growth, according to Hirschman. However the question arises, how to identify the activities with which to create imbalances in the system. This necessitates the knowledge of inter linkages across different sectors of the economy. Hirshman classified these linkages as forward and backward linkages.

Thirlwall (2006) defines forward and backward linkages as follows. "Backward linkages measure the proportion of an activity's output that represents purchases from other domestic activities. Forward linkages measure the proportion of an activity's output that does not go to meet final demand but is used as inputs into other activities."

This study investigates the existence of linkages between major sectors of the economy and quantifies their extent. This measurement aids in identifying what sort of linkages exist between sectors in the Sri Lankan economy which is further explained in sections 4 and 5.

Methodological Framework

Data:

The variables used in this study are Agriculture, Industry and Services Gross Domestic Product (GDP) at current market prices (given in Rs. Million). The data for the study period 1960-2011 are collected from the Central Bank Annual Report 2011. All variables are transformed into natural logarithmics.

Analytical tools:

In this study, the graphical analysis (scatter plot, line graph, Confidence Ellipse, Nearest Neighbor fit) is used to identify the basic features of the variables and to identify the relationship between selected variables. ADF test and PP test are used to test the unit root characteristics of the time series variables. Moreover, co-integration technique and error correction model are employed to study the long run equilibrium and short run inter-sectoral equilibrium relationship. In addition, Granger causality method is used to identify the direction of causal relationship between sectoral growth rates.

Empirical Results

We employ visual inspection to identify the behavior of variables and their relationships. Firstly,it would be useful to review the changes in sectoral composition of Gross Domestic Product before identifying the sectoral linkages in the Sri Lankan economy. Figure-1 (a) shows Agriculture, Industry and Services GDP dynamics from 1960-2011.

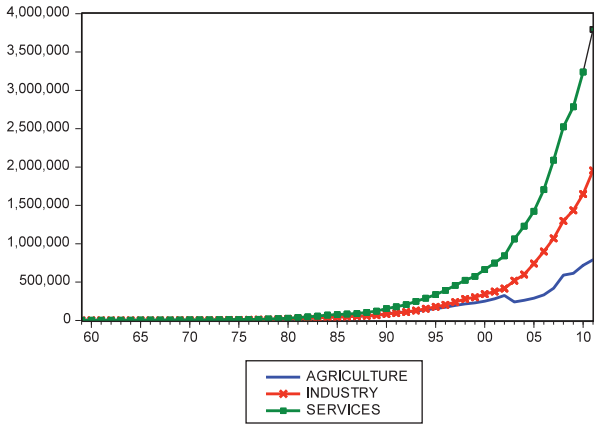

Figure-1 Sectoral GDP dynamics

The pick-up in GDP growth for Sri Lanka was supported by all the sectors with a marked acceleration. Sectoral GDP of all three sectors are rising although the importance of each sector started to vary from late 1970s.

In respect of comparison of sectoral shares in GDP since the 1960s, the relative share of agriculture is declining overtime. In 1960, the contribution of agriculture to GDP is 37.8% and it continuously decrease with slight fluctuations to 12.1% of GDP in 2011, become the relatively least contributor to GDP. The share of industrial sector to GDP increases from the lowest contribution of 16.8% in 1960 to 29.9% by 2011 becoming the second largest contributor. However, the share of industry remains more or less unchanged (between 26% to 29%) since early 1980s to present. Services sector on the other hand, remains the highest contributor to GDP throughout the period whose contribution largely accelerates after the economic liberalization in 1977. Services sector share rise up to 58% by 2011.

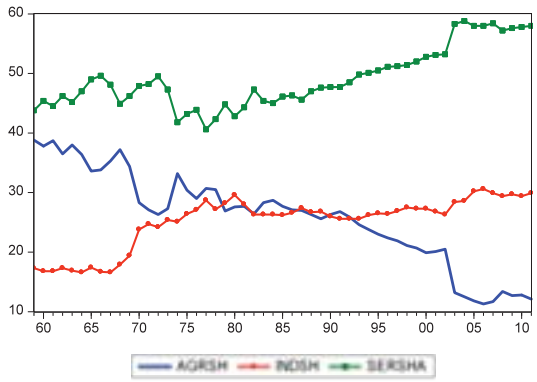

Figure 2: The Dynamics of sectoral share of GDP

Next, the growth rate of the three sectors are plotted to visualize the dynamics of each sector growth throughout the study time period. According to Figure-3 and summary statistics given in appendix 1, the growth of agricultural sector exhibits the highest variability of the growth rate than industry or services growth rates.

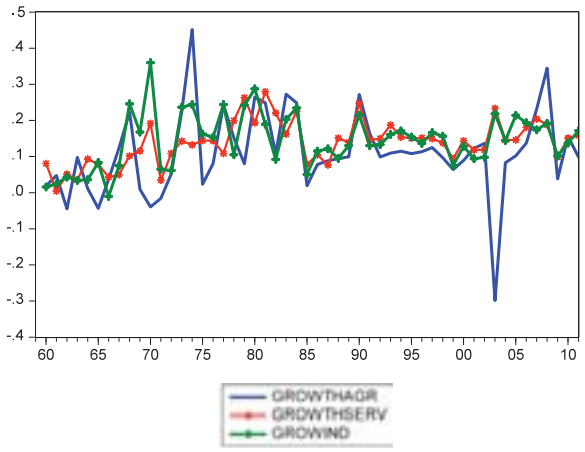

Figure 3: The Dynamics of Sectoral Growth rates

Volatility in growth was measured by coefficient of variation (Table 1). Services sector remained the least volatile sector as compared to agriculture and industry. Agricultural growth displays the highest volatility during the study period.

Table- 1: Growth rates volatility

Sectors	Coefficient of variation (1960-2011)
Agriculture	1.0393831
Industry	0.5270767
Services	0.4320362

The following part of the analysis focuses onthe relationships between variables using the confidence ellipse plot. Firstly, the confidence ellipse was plotted for the sector GDPs. Figure 4 illustrates how the sector GDPsare related with each other from 1960 to 2011.

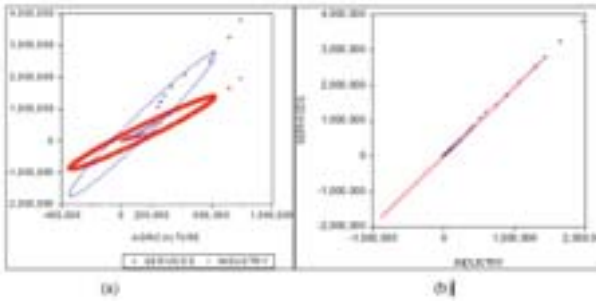

Figure-4 Sectoral GDP linkages

We visualize the highest degree of positive association between services sector and industrial sector, in which the degree is association compatible with inter temporal correlation results; r = 0.9998 (refer appendix 2). The confidence ellipse of agriculture and services GDP (r = 0.9775) and agriculture and industry GDP (r= 0.97728) also display a strong positive association. All correlation results are statistically significant different from zero at 5 percent level.

The same visual analysis was carried out in log forms as shown in figure 5. A similar but a more strong relationship was observed between the sectors when confidence ellipse was plotted using the log transformation.

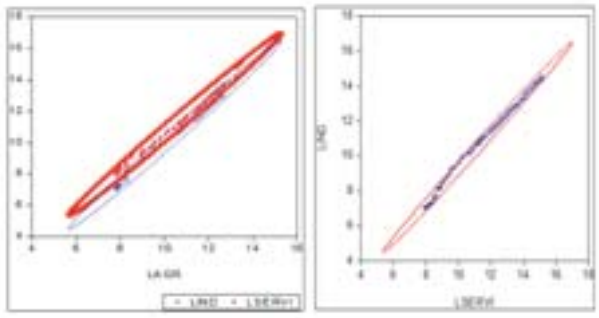

Figure 5: Sectoral GDP Linkages in log form

A more positive association between all sectors is displayed with a greater magnitude. Correlation results support the above graphical analysis indicating pairwise correlation values above r = 0.99 in all (see appendix 2).

Next, confidence ellipse was plotted for the growth rates of the three sectors. Although the association between sectors is not so strong when compared with figure 4 and 5, the growth rate association still remains positive and statistically significant, but weak. A relatively more positive relationship could be identified between industrial sector and services sector (r =0.66) when considering the growth rates. Agricultural and industrial sectors display a positive association of r=0.386 whereas agricultural and services sectors association is given as r=0.287 (appendix 2). This preliminary analysis demonstrates that these sectors are positively related and provides evidence that all growth linkages are statistically significant.

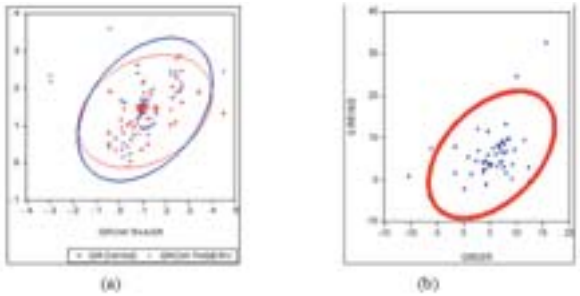

Figure 6: Sectoral Growth Association

Unit root test:

Prior to testing for co-integration, unit root tests are performed on each of the sectoral GDPgrowth series. In order to check the stationarity, this study analyses the order of integration of sectoral GDP growth ratesbyusing unit root test based on Augmented Dickey Fuller (ADF) in table 3. The variables under study are checked for stationary with an equation with intercept on the basis of ADF. All the variables arenon-stationary, integrated order one, I(1) at levels. The ADF test statistics are found not significant at 1% with comparison MacKinnon critical values.

As all the variables are found stationary at first difference so it is now feasible to apply co integration test to verify the long run relation between variables.

Table 2: Unit root test

Variable	ADF statistics (P values)	
	Levels	First differences
GROWTHAGR	-0.354568 (0.5517)	-6.596267 (0.0000)
GROWTHIND	-0.413705 (0.5290)	-9.229887 (0.0000)
GROWTHSERV	-0.532747 (0.4811)	-11.78394 (0.0000)
Critical values		
1%	-2.612033	
5%	-1.947520	
10%	-1.612650	

Engel-Granger (EG) co-integration test:

Engel-Granger (EG) co-integration test results show that there exists a strong long run equilibrium positive relationship amongst each sector GDP growth rates in a bivariate framework. Residual series of each cointegration regression equation is tested for unit root. These test results confirm all residual of cointegration regression equation is stationary. Unit root test results of each residual series are in appendix 3. Therefore, sets of concerned variables are cointegrated and have long run equilibrium relationship.

The results of estimated cointegration regression equation are given below.

GROWIND = 0.1156 + 0.253943GROWAGR (1)

P value (0.0000) (0.0047)

GROWSERV = 0.122061 + 0.149415GROWAGR (2)

P value (0.0389) (0.0000)

GROWSERV = 0.062889 + 0.526845GROWIND (3)

P value (0.0000) (0.0000)

GROWIND = 0.026862 + 0.843164GROWSERV (4)

P value (0.1877) (0.0000)

GROWAGR = 0.034208 + 0.552608GROWSERV (5)

P value (0.3879) (0.0389)

GROWAGR = 0.026455 + 0.586853GROWIND (6)

P value (0.4146) (0.0047)

Equation 4 shows that growth of services sector influences growth of industrial sector by 0.84 percent which is considerably higher. Similarly, equations 3, 5 and 6 indicate high long run equilibrium relationships. Lowest long run relationships could be identified in growth of agricultural sector influencing growth of industrial sector and growth of services sector.

Table 3: Long run and Short run responses and adjustment speeds

Response variable (Growth rates)	Explanatory variable (Growth rates)	Marginal effects -Long run	Marginal effects-Short run	Speed of adjustment
Agriculture	Industry	0.586 (0.004)	0.468 (0.008)	-0.89(0.000)
Agriculture	Service	0.552(0.03)	0.195(0.468)	-0.906(0.000)
Industry	Agriculture	0.253(0.04)	0.189(0.006)	-787(0.000)
Industry	Service	0.843(0.000)	0.812(0.000)	-0.919(0.000)
Service	Agriculture	0.149(0.000)	0.013(0.788)	-0.582(0.000)
Service	Industry	0.526(0.000)	0.404(0.000)	-0.677(0.000)

*p values are in parenthesis

Highest long run statistical significant effect come from service sector to industrial sector. Least long run significant effect comes from agriculture to service sector. The highest short run statistically significant marginal effect comes from service to industry. Service and agriculture have no significant short run effect in both directions.

Error Correction Model

The Error Correction Model results of agriculture and services growth equation indicate that error correction coefficient is -0.906 and is statistically significant. The short run marginal impact (0.19) of service sector growth on agriculture growth is not statistically significant (p=0.46). The negative sign of error correction coefficient indicates that agriculture growth moves towards the long run time path. 90 percent of the disequilibrium is corrected each year.

Short run impact of industrial sector growth has a statistically significant positive impact (0.468) on growth of agricultural sector. Error correction coefficient estimate is -0.89 (0.000) statistically significant. The negative sign of error correction coefficient indicates that agriculture growth moves towards the long run time path in the industrial and agricultural growth linkages.

Short run impact of industrialsector growth have a statistically significant positive impact of 0.404(0.000) on growth of service sector. Error correction coefficient estimate is -0.677(0.000) and it is statistically significant. It shows the speed of the services growth towards the equilibrium state. It indicates that 67 percent of the deviation from long run equilibrium path is corrected in each year.

Granger Causality test

The Granger causality test exhibits the pair wise causal relationship between the variables under consideration. It may be unilateral or bilateral either way. So, this study also uses the test to find the causal relationship between growth rates of each sector separately. Table 4 illustrates the pair wise Granger Causality estimation. The first column shows theNull hypotheses for possible rejection at different significance level while third and fourth columnsindicate F statistic and probability respectively.

The Granger Causality estimation was undertaken for lags 4, 5 and 7 to identify the causal relationship between growth rates at

different levels. At 7 lags, significantbidirectional causality is observed between agriculture and services growth rates whereas only unidirectional causality exists between agriculture-industry and industry-services. Agriculture granger causes industry and industry granger cause services significantly based on the growth rates. At 5 lags, bidirectional causality was observed between the sectors agriculture-services and industry-services. But only agriculture Granger cause industry growth rates and not vice versa. At 4 lags, we obtained similar results as in 5 lags. The results of the Granger causality tests imply that the growth of Agriculture and services sectors are able to generate growth in each other strongly which proves the existence of inter linkages in-between. Growth in Industrial sector has long term impacts on the growth of services but the two sectors are highly causal in the short term thus showing inter sectoral linkages. Growth of agricultural sector at all times is only able to generate growth in industrial sector, hence there exists bidirectional linkages.

Conclusions and Recommendations

The overall analysis of the empirical results establishes evidence for inter sectoral linkages at different extents. The preliminary analysis (figures 3,4 & 5) graphically demonstrates the strength of the relationship between sectors. The confidence ellipses substantiate a stronger relationship between industry and services sectors than the rest which is backed by the correlation and causality results at level more depth and concrete.

The inter relationship between industry and services sectors provides evidence for the existence of forward and backward linkages between the two sectors. As stated by Thirlwall (2006), one sectors output is used as inputs in another sector creates forward linkages and that production one sectors' output requires the purchase of inputs form another sector creates backward linkages as further explained in section 2.2. This is bidirectional according to the results of above two sectors in Sri Lanka.

Although agriculture is able to generate growth in the industrial and services sectors, industrial sector is not capable of generating growth in the agricultural sectors based on the results. The absence of backward linkages could be a reason in the sense that agricultural sector production does not require inputs form the industrial sector. Growth of agriculture can help the emergence of many industrial sector activities but the opposite is absent for the Sri Lankan scenario.

Services sector appears to be very significant in generating growth in both sectors thus, identified as a strategic sector of the Sri Lankan economy. This highlights the importance and the need of government policies to be focused towards developing this so called strategic sector so that it would enable the growth and development of the other two sectors.

Limitations

The analysis in this study in only limited to identifying whether there exists linkages between major economic sectors of the Sri Lankan economy and the degree of the relationship. It does not go to the extent of identifying what are these forward and backward linkages between each sector, which leaves space for further developments in research in this regard.

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