ECONOMETRIC ANALYSIS OF LINKAGES BETWEEN SECTOR OUTPUT GROWTH, HUMAN DEVELOPMENT AND PUBLIC SPENDING IN UGANDA

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DECEMBER 2012
Declaration

I Matte Rogers, wish to declare that this study is original and has not been published and or submitted for any other degree award to any other university before.

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Date

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Acknowledgement

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Abstract

Uganda pursues a long-term policy objective of transforming the country’s society from the state peasantry to modernity and prosperity and increasing per-capita income to middle-income economy levels, government committed itself to redirect public investment to the critical growth sectors of the economy that lead to productivity enhancement. Government seeks to enhance productivity by increasing public expenditure on the key sectors and on human development.

Building on the Lewis’ dual economy theory with extensions to the endogenous growth by Lucas (1988), Barro (1988), Rebelo (1987) and Romer (1990), this study models and examines the endogenous relationship between sector output growth, human development, and public expenditure; and Uses the Error Correction Model to analyze economic behaviour of the three production sector over the long run. It was found that Industrial output growth and changes in service sector output growth lead to agriculture output growth, although industrial and services output growth are found not to be granger causd by agriculture output growth.

The study found that human development matters for economic growth and its indicators have short run rather than long-term links with sector output changes. Public spending on health, education and road and communication infrastructure had positive relationship with output growth across sectors. The study identifies strategies for taking advantage of identified linkages. There is need to strengthen the causal links from agriculture to other sectors of the economy through focused public spending in order to increase the benefits of economic transformation over the longterm.
1.1. Background

The improvement of economic growth and development trends remains an important issue of concern for many developing countries. These countries, among their development aspirations, wish to transform society from a status characterised by dominance of low-income peasantry to the status characterised by dominance of modernity and affluence. In the case of Uganda, this is reflected in the long-term vision and the National Development Plan (Republic of Uganda, 1999; 2010b). In its long-term vision, Uganda expects to achieve prosperity by creating a resilient, dynamic, integrated, diversified, and competitive economy. Among the key concerns that the vision further identifies is the need to strengthen sectoral linkages and multiplier effects for employment generation and agro-industrial growth, thereby enhancing structural economic transformation (Republic of Uganda, 1999).

There is a large stock of knowledge on the triangular relationship between government pending, human capital, and economic growth. This literature helps in making Uganda’s growth and development situation appreciated. This relationship is useful in analysing and explaining economic growth, economic transformation and human development. Uganda’s development frameworks such as the vision 2025 and the National Development Plan 2010/11-2014/15 endorse this relationship (Republic of Uganda, 2010b). Conceptually, the relational analysis of this nature fits well in the Lewis’ dual economy theory (Lewis, 1954; 1979) with its extensions to endogenous growth (Lucas, 1988; Romer, 1990; Ranis, 2004). For instance, Lucas (1988) and Romer (1990) analyse the endogenous relationship between human capital accumulation and economic growth, and thus explain sector output growth. Factors such as increasing returns to scale,
innovation, openness to trade, international research as well as human capital formation are found to be important factors in the economic growth process and hence determine the growth rate of an economy. Barro (1988) in studying the role of government in generating economic growth emphasizes the role of expenditures on public services as a complimentary input to private production. Whatever government purchases is availed to households, and if those goods and services are non-rival to the consumers, then the total amount of government purchases rather than the amount per capita matters for each user. This element is very useful when determining the desirable scale of government activity. The productive role of the public sector thus creates a positive linkage between government spending and economic growth.

The application of the endogenous growth models that incorporate government spending, human capital and sectoral growth and assesses their dynamic impacts on economic growth is of interest for at least two reasons. First, the government of Uganda still depends heavily on services provided by the public sector and less by the private sector. The dependency on and the growth of the public sector in developing countries have been cited as causes of the poor growth that face developing countries (Landau, 1983; Marsden, 1983; Eugen and Skinner 1991; and Barro, 1991). Second, the government of Uganda is expanding its investment in human capital particularly education with programmes like Universal Primary Education (UPE), Universal Secondary Education (USE) and student loan programmes which might be to the detriment of other sectors. This study attempts to demonstrate that government spending that is human capital intensive encourages growth.

Many studies have been undertaken with a focus on analysing the link between economic growth, government expenditure and development and these have largely analysed the role of both physical and human capital. The fact that human development improves the
quality of human capital has also been analysed. These studies include Landau (1983; 1985), Ram (1986), Lindauer (1988), Barro (1991), Mankiw, et al., (1992), Agiomirgianakis, et al., (2002), Narayan and Smyth (2004), Francis and Sunday (2006), Bas and Földvári (2008), Benos and Karagiannis (2008), Highum (2008), Naeem, et al., (2008), Alexiou (2009), Chobanov and Mladenova (2009), and Alam and Sultana (2010). Most of the analyses, however, have concentrated on providing general results because of their methodology of cross-country and panel analysis, and not being specific to a particular country. The reason why cross-country panel analyses have been widely preferred and used is the lack of data spanning long periods to permit single country case studies. Those studies that have undertaken single country analysis using time series analysis have concentrated on analysing one sector. For instance, the role of government expenditure in education or health on economic growth has been widely investigated (Barro (1991), Mankiw, et al., (1992), Agiomirgianakis, et al., (2002)). However, the effectiveness and direction of government spending on multisector growth is still inconclusive. While some studies have found a positive and significant impact of government spending on growth (Ram, 1989), others have found a negative and small impact of government spending on growth. Such findings suggest that we should examine the type of government spending and the interaction that such spending has with other sectors of the economy.

This study examines the relationships between the proportions of government spending on human capital (particularly education and health), on physical capital particularly roads and works, and on goods and services particular agriculture in Uganda.
Table 1.1: Budget Resource Allocation to Functions as a Percentage

<table>
<thead>
<tr>
<th>Year</th>
<th>1998/99</th>
<th>1999/00</th>
<th>2000/01</th>
<th>2001/02</th>
<th>2002/03</th>
<th>2003/04</th>
<th>2004/05</th>
<th>2005/06</th>
<th>2006/07</th>
<th>2007/08*</th>
</tr>
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<tbody>
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<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Public Administration</td>
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<td>20.3</td>
<td>20.2</td>
<td>19.2</td>
<td>16.4</td>
<td>11.7</td>
<td>12.5</td>
<td>22.1</td>
<td>28.2</td>
<td>23.9</td>
</tr>
<tr>
<td>Security</td>
<td>19.9</td>
<td>15.4</td>
<td>13.9</td>
<td>12.7</td>
<td>13.1</td>
<td>10.3</td>
<td>11</td>
<td>8.0</td>
<td>8.2</td>
<td>7.4</td>
</tr>
<tr>
<td>Justice, Law and Order</td>
<td>7.2</td>
<td>7.3</td>
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<td>5.0</td>
<td>5.9</td>
<td>4.1</td>
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<td>Education</td>
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<td>24.9</td>
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<td>18.6</td>
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<td>Agriculture</td>
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<td>8.5</td>
<td>8.1</td>
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<td>9.4</td>
<td>12.1</td>
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<td>1.5</td>
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<td>1.1</td>
<td>1.2</td>
<td>1.3</td>
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<td>6.1</td>
<td>0.0</td>
<td>0.0</td>
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<td>Economic Functions and Social Services</td>
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<td>9.3</td>
<td>8.4</td>
<td>8.7</td>
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<td>7.7</td>
<td>5.8</td>
<td>0.3</td>
<td>0.2</td>
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<tr>
<td>Pensions</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2.1</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
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<tr>
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<td>100</td>
<td>99.9</td>
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<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Sources: Background to the Budget and Budget Speech 2002/03; Budget Framework Paper 2005/6-7/8; Background to the budget 2008/9; Statistical Abstract 2008

Whereas agriculture is one of the key areas in the public sector, it has not attracted adequate budget allocations (as shown in table 1.1) although its share has been increasing of recent. Understanding a country’s long-term transformation process and the underlying factors for such transformation, and in particular, the joint role of public expenditure as well as human development is therefore very important for developing countries. One would have expected to see huge allocation of public expenditure on agriculture, health, and education on the basis of per capita of the population directly affected to sustain adequate food and income growth, and adequate quality human capital stock in the country. Despite the expectation that agriculture output is largely private, it still requires huge public investment as an underdeveloped primary sector on which a large proportion of the population depends.
A country with the desire to achieve economic transformation involving the modernisation of a country’s economy, society and institutions with fundamental impacts on human life, values, norms, beliefs and customs needs knowledge about the above relationships. The process is characterised by changes occurring in production structure, urbanisation and in transport and communication services. Such changes, particularly those in production lead to changes in incentive structures, education requirements and the relative positions of different groups in society. Breisinger and Diao (2008) categorise the sources of transformation into four: productivity growth due to technology, rapid capital accumulation, the role of sectoral linkages, and the roles of markets, institutions and governments. The advancement of innovation and technology is a necessary source of development, which works through a process facilitated by entrepreneurship and capital development, and characterised by Schumpeterian creative destruction (Schumpeter, 1947).

In the dual economy theory, rapid productivity growth leads to the transformation of agriculture and non-agriculture sectors. Differences in marginal productivity across sectors induce movement of factors of production including labour through migration from low productivity sectors especially agriculture to high productivity sectors such as industry and services. Until there is equality in the productivity across sectors, when there is convergence into a mono economy, movement will go on without compromising output of the previously lower productivity sectors, particularly in agriculture.

The adoption of modern technologies in the low productivity sector is a driver of growth and should be rapid to outpace population growth and the force of diminishing returns in land and other fixed factors. When there are rapid productivity increases and growth in previously low productivity sectors, they experience a revolution, yet low productivity constrains growth. The public sector plays a critical role in technology development and
adaptation through financing and coordinating adaptive research, complimented with investments in roads, transportation and other adaptive investments such as irrigation in the early stages of the revolution (World Bank 2007). The quality of governance including the complexity of institutional capacity and the availability of expertise in the management of established systems affect the efficiency of public spending or public investment aimed at achieving the above changes in transformation.

With regard to rapid capital accumulation, modern capital goods embody most technologies. Increased investment finances from increased saving rates at country level are important for a successful economic growth programme including recovery and reconstruction where investments in infrastructure and industry are a necessity. In the dual economy model, the agriculture sector provides surplus that finances industrialisation through agricultural taxes and other measures to transfer resources to the preferred sectors (Krueger, et al 1999). Agriculture productivity and profitability are both important for the accumulation of capital and change the saving behaviour of farmers, requiring increased returns to investment.

The role of linkages is in the context of the interactions between agriculture and non-agricultural sectors, where agriculture is a dynamic source of growth, employment and more equal income distribution. Inter-sectoral relations may determine the course of transformation. For example, the decline in the share of agriculture in the economy as transformation progresses is a result of successful agricultural development in the short and medium term (Meier, 1989) as it enhances both consumption and production linkages. Consumption linkages lead to higher growth multipliers and poverty reduction effects (World Bank 2007).
In considering the impact of human capital on economic growth, growth economics has concentrated on the narrow definition of human capital by considering mainly education and taking into account, for instance, the link between years of schooling and economic growth, and ignoring the role of health on human capital. Economic literature however broadly defines human capital to include education, health, training, migration, and other investments that enhance an individual’s productivity (Akram et al, 2008). For instance, one third of Britain’s GDP between 1790 and 1980 resulted from improvements in health particularly improvements in nutrition, public health, and medical care facilities; and that improved health facilities were labour enhancing technical change (Akram et al, 2008). Akram et al (2008) further find that health indicators over the long run influenced positively Pakistan’s per capita GDP for the period 1972 to 2006. This therefore means that using education indicators alone in analysing the role of human capital on economic growth may not provide sufficient explanation of results of their relationship. This is why the concept of human capital extends to that of human development, so that a wider range of indicators applies in analysing sources of economic growth as well as economic transformation.

The pursuit of economic growth is about increasing income, while human development is about gaining greater freedom and greater capabilities and choices enjoyed by economic agents (Sen, 1985; Ranis, 2004). The capabilities approach enables the analysis of linkages between economic growth, welfare and the role of institutions, and considers well-being achievements to be a result of capabilities that people have thus human development. Capability measured along functioning vectors that yield enjoyable well-being achievements means considering human welfare as a vector of both attributes, such as income, education and health, and possible opportunities available to the individuals. For example, a healthy and educated population has better choices than a functionally illiterate and highly morbid population. The approach further considers that in analysing
human development, the environment within which people carry out their economic functions, consisting of; societal freedom, economic liberty, and democracy, is important because it affects human choice and agency. However, the extent to which capability is used to measure human development faces much difficulty because of the unobservable nature of human functioning.

Education status is used to partially measure capabilities and has years of schooling, gross enrolment, and net enrolment have been used as its indicators. Indicators of health status, which is another measure of capabilities used in empirical studies on the relationship between health and economic growth are several. These include adult survival rate (Bhargava, et al., 2001; Mayer, 2001; Jamison, 2003; Weil, 2005), life expectancy (Sachs and Warner, 1997; Arora, 2001; Gallap and Sachs, 2001; Bloom, et al., 2004; Weil, 2005; Malik, 2006; Marc, et al., 2006). Others are average height (Weil, 2005), adult mortality rate (Lorentzen, et al., 2005; Marc, et al., 2006), Infant mortality rate (Malik, 2005), health care spending (Scheffler, 2004; Gyimah-Brempong, 2004), fertility rate (Marc, et al., 2006), demand for health services (Zon, 2001), and child mortality rate (Gyimah-Brempong, 2004). The other indicators used are age dependency and population per bed (Akram, et al., 2008).

Economic growth is a further manifestation of capabilities of a population and its development. Therefore, the link between economic growth and human development can be analysed by looking at the role played by command over resources provided by economic growth. Income growth enables a population to have access to facilities that improve their welfare, for example, by having a relationship with social consumption, life expectancy and literacy. Another example is where improved income distribution leads to higher school enrolment among children of school going age (Ranis, 2004).
After the year 2000, the framework for economic development considered human development as dependent on increased income and food, education, health, sustainable resource use, and institutional capacities (United Nations, 2003). There are bidirectional relationships between economic growth and human development. On one hand, most of the effects of economic growth on human development flow through effective government budgetary expenditure, with priority sectors being health and education. Public expenditure is more effective in affecting human development when the quality of governance, including accountability is high. On the other hand, the effect of human development on economic growth is through the relaxation in the constraints of profit maximization that human development creates to facilitate increase in factor productivity, in the notion of human capital. Therefore, the economic agents will have greater ability to discover and develop their comparative advantage when there is improvement in human development.

Following Rostow’s stages of development, economic agents at initial stages of economic development will discover their comparative advantage in sectors of the economy that are traditional in production such as agriculture and export of raw materials. At later stages, as human capital improves alongside technological development, industrial activity increases. Later, with increased specialisation the sector of exchange and consumption of services gains momentum, even surpassing the rest of the sectors’ contribution to the economic growth. Over time therefore, the attachment placed on the transformation process from traditional sectors to service based sectors gains importance and relevance in economics studies. The sectoral location of comparative advantage changes with the level of development, such that a link exists between human development and economic transformation.
Institutional change includes developing and adopting new approaches for making choices. The quality of institutions is important in the growth and transformation processes by determining endogenously the incentives for developing new technologies and innovations. For instance, transformation may require simultaneous and complementary investments in all links to the provision of resources for the development of market systems, including that of information, and supply chains built around the production units. The effectiveness and efficiency of simultaneous investments may, however, be complicated by coordination opportunism, rent-seeking costs and risk. Market and profitability risk of small farmers, for instance, result from increased use of modern inputs and growing agricultural production.

Government plays a role in accelerating the transformation process by having in place policies and direct public interventions related to market development, and facilitating market functioning. Strategies in this regard include stimulating capital accumulation, utilisation of rural surplus labour reserves, adoption of appropriate industrial strategies, and fostering efficient international trading and domestic marketing. Government interventions aimed at correcting market failures is not devoid of government failure. Therefore increasing understanding of the transformation process, particularly on the interaction between sectors and the role institutions in order to have a functioning country specific approach for transformation becomes important, particularly in sub-Saharan Africa, where economic transformation is still in early stages.

In 2005 Africa registered tremendous progress in improving trends in economic growth, reducing inflation, reductions in mortality and increased primary school enrolment, and increased public accountability. At the same time, Uganda was categorised among those best performing countries, although the World Bank report on development indicators shows that even with this progress, a lot more was required. Economic growth needed to
be more sustainable, less exposed, and more resilient to shocks by addressing issues regarding though not limited to governance, civil society and private sector development, and human development (World Bank, 2006).

Considering the case of Uganda, the country’s development agenda underscores the desire to transform the economy from a predominantly peasant agrarian to a modern industrial one. Over the last decade or so, the country experienced gradual changes in the sectoral composition of Gross Domestic Product (GDP), thus the location of comparative advantage has been changing. Public expenditure has played a role in changing this location of comparative advantage given that the thrust of the Poverty Eradication Action Plan (PEAP) for the periods 2002/3-2004/5 and 2005/6-2007/8 was on economic transformation (Republic of Uganda: 2002a, 2005). This was a basis for guiding the achievement of development objectives, especially ensuring fast and sustainable economic growth and sustainable transformation, as well as increasing the ability of the poor to increase their household incomes, during the period 2002-2005.

In the period 2005-2008, these objectives were refined to cover economic management through maintenance of macroeconomic stability, fiscal consolidation, boosting private sector investment and debt sustainability on one hand, and on the other, ensuring increased production competitiveness and incomes. In order to increase production, competitiveness and incomes, government opted to modernize agriculture, preserve the natural resources base, develop and maintain social infrastructure especially roads, electricity and railways, and compliment these with enhanced skills in the private sector coupled with business development (Republic of Uganda, 2004). Further, the policy framework identified the necessity of improving human development through the quality of life of the poor people and this required the devotion of resources on primary and
secondary education, improving health, increasing people’s ability to plan their families as well as increase adult literacy.

In Uganda therefore, transformation of the economy from the predominantly peasant agrarian production is synonymous with economic growth and poverty eradication. The status of income poverty at household level is attributed partly to the levels of human development measured partly in terms of changes in life expectancy, mortality rates for infants and mothers, literacy levels and enrolment at various education levels. Therefore influencing sector output growth and human development are jointly addressed in the national development frameworks. Trends of sector output show that for a long time from the 1970s until 2002, agriculture had remained the biggest sector in terms of contributing to national production as shown in figure 1.1.

**Figure 1.1: Economic Transformation of Uganda's Economy, 1970-2005**

![Economic Transformation of Uganda's Economy, 1970-2005](image)

**Source:** Analysis of sector percentage shares is based on statistics from Uganda Bureau of Statistics and World Bank.

The percentage contribution of agriculture to Uganda’s GDP in 1970 was 42.3 percent. Between 1978 and 1989, agriculture contribution remained above 50 percent of GDP but from 1985, the sector’s contribution started declining as the other sectors gained
increasing shares. By 2005, the industrial and services sectors contributed 24.7 and 48.4 percent respectively having taken over from agriculture, whose contribution was 19.2 percent that year. By occupation, the industry sector employed 4.5 and 3.5 percent of the labour force in crafts and related workers, and another 1.9 and 2.2 percent in plant and machine operations during the years 2002 and 2005. The services sector besides commanding an increasingly rising share in GDP has also shown an increasing share in employment. In 2002 employment in services (Sale, Maintenance, Repair of Vehicles and Personal Goods; Education; Transport Storage and Communications; and others) was 22.1 of the labour force. This proportion increased slightly to 22.5 in 2005.

The above observations show that despite the decline in the proportion of national output from agriculture, the sector is still a major source of employment for majority of Ugandans and the need to protect it. Explanations for this trend of increasing employment and a reduction in output could be found in the analysis of productivity in agriculture and high capital investment in industry and services sectors. Analysis of productivity trends in the three sectors has the potential of providing a further understanding of these phenomena and provides insight for their possible explanation.

The endogenous growth framework provided in the literature (such as; Barro, 1990, Barro and Salai-martin, 1992, Devarajan, et al., 1996, and Shanggen and Neetha Rao, 2003), complements the dual growth model in explaining the link between human development and economic transformation. The framework provides for human development by implying its contribution to a better quality labour force as input needed for higher sector output and economic growth. The implementation of policies for increasing production as well as human development should be supported by the resource allocation policy to determine the pace at which financial resources are injected as necessary inputs.
Therefore, the human development sectors, especially focusing on indicators in health and education already introduced, and economic growth sectors namely agriculture, industry or manufacturing, and services, are endogenously associated and understanding the nature of their link is important in Uganda’s public sector policy. The relationship is particularly important in the allocation and appropriation of resources to influence the outputs and outcomes of the sectors.

Since the 1990s, Uganda has implemented prudent budgeting and macroeconomic policies that consequently helped in the achievement of growth. Growth and development resulted from allocation of budget resources to sectors and areas identified in the poverty eradication action plans. Uganda’s planning has mainly focused at short-term and medium term outputs and outcomes as articulated in budget framework papers and 3-5 year plans. The need for articulation of long-term factors and indicators in the development frameworks is still outstanding, and required remedies to influence the allocation of resources to bring about faster sustained improvement in employment, per capita income growth, economic transformation, and human development. In view of this, the amount of financing allocated and appropriated in each sector will be in line with the desired targets of growth and human development over the both in the short and long run.

In Uganda, there still exist pressures regarding allocation of resources to the sectors, particularly those contributing to the Millennium Development Goals (MDGs) (Odaga and Lachoro, 2006). The need to increase budget resources allocated to human development activities, particularly in the health sector to at least 18 percent of the budget, is outstanding. The demand for budget resources in health sector for instance, without looking at how much is actually needed based on country specific factors might be misleading, and ignores the complimentary role played by the other sectors. This dissatisfaction in resources allocated to some sector is an indicator of existing weaknesses in
the economic governance and management for the maximization of the benefits of economic transformation on one hand, but also on the other hand, is just a result of non-satiety that is common in utilisation of resources.

Whether fixing a percentage of the budget resources for some sectors can help to achieve accelerated employment in industry and services for instance, without leading to a decline in agriculture and social sectors like education and health has not found explanation in the literature on Uganda’s economic development path. Tim (2003) in his analysis of the allocation policy in Uganda found that resource allocations for Education, Health and Roads sectors to local governments were on the basis of achieving national service delivery targets. Individual central institutions were largely not pressed to relate their actual performance to budget allocations. Government has tended to continue with incremental budgeting in the areas of the medium term expenditure framework and not allocate funds on the basis of performance.

Kappel, et. al., (2005) explored the changing growth regimes and incidence of public spending, sectoral dimension of growth, and its link to poverty reduction over short-term horizons using household survey data in Uganda. They found that low agricultural growth is responsible for increase in poverty after the year 2000 and further shows that incidence of public spending reveals that there is limited achievement of indirect pro-poor growth. A long-term analysis of the sectoral dimension of growth would help understand further the linkages between sector output growth, human development and public resource allocation.

1.2. Statement of the Research Problem
In the recent past, the country has registered impressive results in terms of economic growth and human development, which performance is associated with efforts in public
spending. However, it has not been clear whether economic links between spending, output growth and human developments exist empirically and if they drive public spending. The nature of these economic links, which may have both short and long-term dimensions lack adequate elaboration to guide government strategic prioritisation over the short and long-term.

1.3. Research Objectives
The main objective of this study is to examine the existing relationship between sector output growth, human development, and public expenditure, and assess the importance of these linkages on long run economic growth and development. The specific objectives of the study are:

(1) To determine the existence of economic relationship between the production sectors, public spending and human development;
(2) To examine the bidirectional effects of the economic relationship between sector output growth, public spending and human development indicators; and
(3) To separate short-run and long-term inter-sectoral linkages existing between sector output growth and the social sector expenditures in education and health, using dynamic error-correction cointegration model.

1.4. Hypotheses
Given the objectives of the study as presented above and basing on the theoretical framework presented in chapter four, hypotheses are tested. These hypotheses are that

(i) There exist strong economic relationship between the production sectors, public spending and human development.
(ii) Public spending has a longrun effect on sector output growth. This hypothesis considers the effect of public expenditure on physical capital especially infrastructure (roads) on agriculture output growth, effect of expenditure on agriculture on industrial
output growth which is endogenous through agriculture output growth, and the effect of expenditure on education (knowledge and skill) and supply of electricity on industrial output growth. Further, expenditure on public infrastructure (roads, transport and communications), health and education positively affects growth of the services sector output.

(iii) Cross-sector rather than internal innovations are responsible for longrun sector output growth. This hypothesis considers the effect of the lagged values of industrial and agriculture output on long run industrial growth; the ability of output growth in industry, agriculture and services to explain each others sector output growth over the longrun.

(iv) Human development positively affects the sector output growth in both the short and longrun.

1.5. Scope

This study focuses on exploring the strength of the links existing between sector output changes, public spending on selected human and physical capital, and the human development indicators in Uganda. Sector output covers the disaggregated components of national output, in agriculture, industry, and services. Human capital expenditures are those on education and health sectors, while expenditure on physical capital that is selected covers that on in agriculture as well as roads and communication. Human development focuses on life expectancy, under 5 mortality, adult literacy, and enrolment in education institutions at primary, secondary and tertiary levels. The period covered is 1975 to 2007 determined by data availability, with a time span of thirty years equivalent to the long-term that can provide strong statistical association in when applied in time series regression. Understanding Uganda’s past thirty years can help us explain the period ahead of the country’s 30-year national vision.
1.6. Significance
This research extends the two-sector model to three sectors and analyzes the linkages between these three production sectors and the allocation of resources to them. This is important in the analysis of the effect of public spending and human capital on economic growth through the representative indicators in the short and long run in line with Uganda’s development planning horizons. The study further forecasts the effect of the innovations in each of the variables on output in each sector in the future. The short run analyzed in the study contributes to the annual and five year planning of the country, while the long run relates to the long-term perspective plans and the national vision horizons.

Uganda’s development planning has embraced long-term macroeconomic development planning. The study therefore contributes to the call for a fundamental shift in the method by which resource allocation is centrally determined by first understanding how spending relates with economic growth and human development at sector level. The will be important for further analysis and understanding the implications of likely structural adjustment introduced as innovations and other policies of macroeconomic nature to the country’s growth process in the medium and longterm.

The study further defines a framework through which an alternative applied econometric model and database for the country to guide future prioritisation of resource allocation in the medium to longterm.

1.7. Organisation of the Dissertation
This report has seven chapters. Chapter 2 provides an overview of the development processes and their contribution to economic transformation and human development.
Chapter 3 is the literature review, while Chapter 4 provides the theoretical framework and hypotheses of the study. Chapter 5 presents the methods and procedures used in the study covering the sources of data and information, approaches to data modelling, and sector analysis. Chapter 6 is a presentation of the study findings, analysis and discussion. Lastly, chapter seven examines policy implications of the study, in line with objective three of the study.
Chapter Two
OVERVIEW OF DEVELOPMENT PROCESSES AS SOURCES OF ECONOMIC TRANSFORMATION AND HUMAN DEVELOPMENT

Economic transformation and human development that has been registered in the country over time is attributed to deliberate efforts of government, as part of the development processes. Development processes are the steps taken in planning and budgeting including the policies and plans, while the outcomes of the development processes are the changes in output in different sectors and the status in the quality of human capital and human development indicators. Whereas development processes have contributed to influencing growth in output and the structural transformation of the economy there are still outstanding constraints in respect of Uganda’s efforts to achieve a transformed economy and higher levels of human development. An overview of the current situation here is aimed at setting the ground for econometric analysis that will follow. This facilitates the understanding of how and why resource allocation process has been made. In this overview, resource allocation is part of the development process, while the human development indicators are development outcomes.

This chapter analyses the current processes that have been used to influence changes and sources of growth as well as human development. The overview shows how the public investment programmes and the national budget are linked in each year, and how the broad demands profiles are determined, discusses how it relates to mandated missions, including prioritization.
2.1 Development Processes: Planning and Resource Allocation

The socioeconomic development process is the conceptualisation and the provision for the conditions that enable changes to happen and to be self-sustained, be it in form of technology, institutional characteristics and behaviours, in shaping specific development patterns. The development of social and economic organisations, including the constitution, functioning, and growth of such organisation is the process of social and economic development.

In Uganda, the responsibility for managing the process of preparation and monitoring of the resource allocation to influence socioeconomic development, through the national budget is vested in the department of budget policy and evaluation assisted by the infrastructure and social services as well as the Public administration department of Ministry of finance, Planning and economic development. The outputs of this process include the public investment programme, the medium expenditure framework paper and the national budget documents.

The public investment programme and the national budget are linked in that the development budget is a single current year extract from the current public investment programme. Identification of the broad demand profiles originates from the sector level through the sector wide groups at national level and local governments at district level. Plans at these two levels are prepared by the responsible departments during the second half of the financial year. These demand proposals are analyzed to generate project briefs for the development committee. The process is technical and centres on social, infrastructural and administrative perspectives upon which the development committee needs to be advised.
The decision to approve a demand profile is based on three main factors namely; (i) the availability of funds from development aid; (ii) the resource envelope that takes care of national macroeconomics; and (iii) guidelines reflecting technical and political considerations. For the approved profiles, government and aid agencies make agreements on funding issues and the sectors are further advised on sector wide funding projections for the subsequent years. Detailed budgets are prepared by the sector implementing agencies after projects approval by the development committee. On this basis, a three year rolling public investment programme is produced as a development plan. The resource envelop is estimated using historical data on tax and non-tax revenues, donor flows, expected loan and arrears payments with reference made to tax policy, aid policy, and monetary policy.

2.1.1 The Policy Framework

2.1.1.1 Development Planning in Uganda

The National Vision and the National Development Plan (NDP) guide development planning and resource allocation in Uganda. The mandate and jurisdiction for planning and resource allocation have provisions of the Constitution of the Republic of Uganda (1995). This mandate was operationalized by the enactment of the Budget Act (2000), a legislation that gives direction to budgeting. Under the budget act, the annual budgets are prepared following medium term projections made in the budget framework papers. The second provision, particularly on planning was operationalized by the enactment of the legislation on planning, the National Planning Authority Act of 2002. Under the NPA act, the National development plan guides all sectoral and local government level short and medium term level planning.
At policy level, all planning in the country is driven by the aspirations described in the national vision 2025, which is an overview of long term goals and aspirations achievable by the year 2025 and beyond. Ultimately, Ugandans desire to be prosperous in a harmonious nation and a beautiful country, encompassing the aspiration of a high quality of life based on a healthy and educated society. The above vision is realizable with eradication of mass poverty, ensuring rural transformation, and developing a society with a high quality of life. The series of the 3 year national poverty eradication action plans provided a planning framework on which to develop detailed sector strategies. Since 2010 the poverty reduction strategy is the NDP which is implemented over a five year period. At sector level, sector plans outline technical specifications of development and service priorities, as constrained by available resource allocations.

For service delivery, districts prepare medium term development and service delivery plans in line with decentralization policy to serve as implementation plans for sector strategies based on local priorities and needs. To guide planning at national and district levels, the medium term expenditure frameworks are rolling expenditure plans, setting out the medium term expenditure priorities and hard budget constraints against which sector plans can be developed and refined. In the district medium term expenditure framework, the medium term expenditure priorities and hard budget constraints are set against which district plans can be developed and refined.

On annual basis, national and district budgets are produced for the annual implementation of the three year plans to which donors, non-government organizations and the private sector contribute ideas and resources in a participatory manner. The whole process is
participatory in that it encourages sharing information and ideas in developing sector plans and budgets from bottom in the community upwards to the planning authority. Participation of districts in the planning and monitoring process, as well as participatory poverty assessments, provides essential feedback on progress towards achieving poverty eradication goals at community level.

2.1.1.2 Prioritizing Resource Allocation

Public resource allocation is executed under a number of guiding principles which are defined in the poverty reduction strategy as an overall development framework. These guiding principles include maintaining service delivery and meeting pension obligations; infrastructural programmes are continued and phased over the long-term; previously under-funded priority areas within each of the key poverty reduction themes or pillars get increased allocations; Areas that are not identified as needing increases or constant real value of resources are kept by finding cost savings wherever possible; Areas of waste in relation to mandated missions, those areas not well prioritized, and where crosscutting issues will bring about cost effectiveness of expenditure are cut back; and increases in unit costs resulting from pay reforms and minimization of service delivery cost and impact of future pay and pension liabilities. The above set of principles place much importance to the principles of poverty reduction. The principles of poverty reduction include: recognition by comprehensive strategies of the multidimensional nature of poverty; participation of civil society in the private sector make strategies needs driven; focusing on outcomes that benefit the poor should complement result oriented strategies; implementation becomes feasible fiscally and institutionally when prioritized; partnership orientation and strategies developed with close involvement of development partners.
from the bilateral, multilateral and nongovernmental fraternity; and long-term perspective for poverty reduction.

Because of the above principles, public expenditure is based on a six dimension criteria. The six dimensions are: the supply of goods and services which have the nature of public goods and which cannot be supplied in an optimal way by the public sector through the market; as highest priority, providing for human development and empowerment, in areas where there is a link with the defined strategic objectives of the poverty reduction strategy and with highest returns in terms of reducing income or the other dimensions poverty; providing for precise targets of outputs and realistic outcomes which have full activity cost values, and where the valuation of activities is realistic and based on government standard costs; providing resources with which the allocation of responsibilities for the activities reflect well defined mandates, make use of existing administrative structures, avoid duplication and waste, and are responsive to inter-sector issues; providing resources for proposals that take into account the direct spin off benefits for the poor especially those in the poorest parts of the country; and providing resources for those actions whose impact of future public sector costs are articulated and fully taken into account in the relevant sectors’ medium to long-term spending plans.

2.1.2 Implementation of the Processes

2.1.2.1 Planning and Budgeting

The resource allocation process comprises of three major steps. These are: estimation of the resource envelope and determination of sector resource ceilings; the production and approval of sector, district and national budget framework papers; the preparation of, and agreement on the indicative budget proposals; and finally the presentation and approval of
the budget. Table 2.1 provides the details of the activities and the stakeholders involved. The budget process begins with the budget call circulars which present to the line ministries medium term ceilings and guidelines for the preparation of detailed plans, and investment programmes. Sector programmes elaborate the goals and objectives in line with the overall planning framework and identifying cost effective strategies and interventions.

Sector working groups are constituted comprising of ministries, technical agencies, donors, and private sector partners with the purpose of giving the ministries in the preparation of the budget framework papers. The budget framework paper is the final version of the sector plans and investment programme. The final budget framework paper prepared by the sector working group and Ministry of finance determines benchmarks for the sector.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Output</th>
<th>Lead Agency</th>
<th>Participating Stakeholders</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Stakeholder consultation</td>
<td>1. Estimation of resources available</td>
<td>Macroeconomics and Budget Policy Departments of Ministry of Finance, Planning and Economic Development</td>
<td>o International Development partners (with reference to sector budget framework papers financing)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>o Line Ministries with respect to Budget proposals</td>
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<td></td>
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<td>o Parliamentary Committees with respect to preliminary budget proposals</td>
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</table>
Table 2.1: Budget Preparation and Resource Allocation

<table>
<thead>
<tr>
<th>2. First budget consultative workshop</th>
<th>2. Indicative Resource Envelop</th>
<th>Budget Policy Department of Ministry of Finance, Planning and Economic Development</th>
<th>○ Line Ministries ○ Sector Working Groups ○ Local Governments</th>
</tr>
</thead>
</table>

Source: MFED, 2003

The determination of benchmarks, reviews and assessments done by the sector wide group and the Ministry of Finance, Planning and Economic Development serve the purpose of guiding the consideration of upcoming policy initiatives and priorities between and within sectors with the use of logical frameworks. Policy analysis results into three outputs: clear definitions of the inputs and outcomes sought from various services, programmes and activities; relative financial costs of inputs and outputs in achieving desired outcomes; and the adjustments required reducing financial costs or enhancing effectiveness.
The budget strategy determines all the primary allocations and the financing from reallocations within the resources available to the sector. Financial implications and resource management optimization are considered, and the process ensures that the budget allocations for each activity are the minimum required for the activity to be carried out in a manner consistent with policy objectives and expected outcomes.

2.1.2.2 Development Process Outputs: Strategies

Development strategies, as major outputs of planning and budgeting, define the programmes for social and economic development, and resource outlays for implementing the strategies. The programmes for social and economic development include the rural, industrial, private, and financial sector services, infrastructure, social services as well as security and governance. The rural development strategy aims to expand agriculture output and agro-processing, and capacity development. Actions identified in this strategy include: increasing farm productivity for selected commodities, adding value to agriculture products, increasing household agriculture output, and ensuring stable market for products. This strategy encompasses providing support to farmers through associations, enhancing rural micro finance services, establishing community information system, enhancement of market access for agricultural produce, facilitating the delivery of agricultural inputs, enhancing agricultural productivity, agricultural industrial development, and supporting quality control and assurance.

Industrial development strategy, on the other hand, aims to enhance competitiveness and transformation of the export of low value and unprocessed goods using the establishment of mechanisms for technological development. Through the establishment of the innovation and industrialization fund, a research and development fund supports industry
led growth with emphasis on development and commercialization of suitable proto-types, as well as the processing of agricultural and other strategic products. Further, the establishment of the energy equity fund aimed at increasing the supply of electricity and energy for the development of modern manufacturing and services as well as stimulating rural development. In order to meet the energy demand adequately, the development strategy aimed to satisfy the base load with new developments in the hydropower sites, meet the peak load with emergency thermo power plant installation, ensuring stability of the power supply network with the development of renewable power sources to boost the main grid, and financing of power projects through public-private partnership as well as sole public development with debt financing and private sector management.

Private sector development strategy aims to support the private sector become a powerful engine of growth through increased productivity and profitability at firm level. It involves building competitiveness in the economy based on growth clusters, with objectives of promoting competition, improving efficiency, spurring innovation, encouraging inter-firm learning, establishing forward and backward linkages in production and improving the quality of small and medium sized firms.

Interventions in this sector include: infrastructure and financial services support, value addition, embracing globalization, improving the business environment focusing on reforms in business and land registries, labour productivity enhancing skills development, enhancing coordination and dialogue for private public partnership, promoting cluster approach in enhancing competitiveness of firms, and legal framework strengthening in favour of the private sector. The above development strategies were developed along the themes of the PEAP as shown in table 2.2.
Table 2.2: Themes of Poverty Eradication Strategy for Uganda

<table>
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<tbody>
<tr>
<td>1. Fast and sustainable economic growth and sustainable transformation</td>
<td>1. Economic Management</td>
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<td></td>
<td>○ The maintenance of macroeconomic stability</td>
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<td></td>
<td>○ Fiscal consolidation</td>
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<td></td>
<td>○ Boosting private investment</td>
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<td></td>
<td>○ Debt Sustainability</td>
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<tr>
<td>2. Increasing ability of the poor to increase household incomes</td>
<td>2. Production, Competitiveness and Incomes</td>
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<tr>
<td></td>
<td>○ The modernization of Agriculture</td>
</tr>
<tr>
<td></td>
<td>○ Preservation of natural resources base (soil and forests)</td>
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<tr>
<td></td>
<td>○ Infrastructure (roads, electricity and railways) and better maintenance</td>
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<tr>
<td></td>
<td>○ Enhancing private sector skills and business development</td>
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<tr>
<td></td>
<td>○ Ending rebel insurgency</td>
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<td></td>
<td>○ Ending cattle rustling</td>
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<td></td>
<td>○ Dealing with internal displacement</td>
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<td>4. Increased quality of life of the poor and human development</td>
<td>4. Governance</td>
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<td></td>
<td>○ Human rights</td>
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<tr>
<td></td>
<td>○ The development of a better legal system</td>
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<td></td>
<td>○ Transparency, accountability and the elimination of corruption</td>
</tr>
<tr>
<td>5. Human Development</td>
<td>○ Primary and secondary education</td>
</tr>
<tr>
<td></td>
<td>○ Improving health outcomes</td>
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<tr>
<td></td>
<td>○ Increasing people’s ability to plan the size of their families</td>
</tr>
<tr>
<td></td>
<td>○ Adult Literacy</td>
</tr>
</tbody>
</table>

Source: PEAP, 2002/3-2004/5, 2005/6-2007/8
In order to realize tangible development results, economic management resulting from reforms continue to be implemented making it possible to increase annual real growth of gross domestic product. These economic management measures include economic liberalization, decentralization, trade liberalization, privatization, and reforms in the civil service and financial sectors. Specifically, the desired outcomes of resource allocation within the framework of reducing poverty as stipulated in the second poverty eradication action plan entailed fast and sustainable economic growth and sustainable transformation of the economy; improving governance, accountability, and security; increasing ability of the poor to increase household incomes; and increased quality of life of the poor and human development a goals along major themes of poverty reduction. These goals were refocused in the third poverty reduction strategy so as to lead to specific outcomes, to the following themes or pillars: economic management; enhancing production, competitiveness and incomes; security, conflict resolution and disaster management; good governance; and human development. Resource allocation accordingly is intended to balance social and productive sector priorities.

With the ultimate macroeconomic desire for Uganda having been to have a self-sustaining, export led economy, with equitable distribution of benefits, a number of stability conditions were pursued for this to be achieved during the period of the PEAP (2005/6-2007/8). This was done by among other things: maintaining average annual inflation utmost 5%; reducing the fiscal deficit excluding grants by an average of 1% point of gross domestic product per annum; increasing domestic revenue by 0.5% of GDP per annum; limiting new external borrowing to 200 million United States Dollars per annum; and maintain foreign exchange reserves at a minimum of five months of import cover.
Figure 2.1: Percentage of Budget Resources Allocated by Function, 1998/9 – 2007/8

<table>
<thead>
<tr>
<th>Year</th>
<th>Public Administration</th>
<th>Security</th>
<th>Justice, Law and Order</th>
<th>Education</th>
<th>Health</th>
<th>Agriculture</th>
<th>Roads and Works</th>
<th>Water</th>
<th>Accountability</th>
<th>Economic Functions and Social Services</th>
<th>Interest Payments</th>
<th>Pensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998/99</td>
<td>20.7</td>
<td>19.9</td>
<td>7.2</td>
<td>26.9</td>
<td>6.5</td>
<td>1</td>
<td>6.2</td>
<td>1.2</td>
<td>0.6</td>
<td>2.7</td>
<td>7.1</td>
<td>-</td>
</tr>
<tr>
<td>1999/00</td>
<td>20.3</td>
<td>15.4</td>
<td>7.3</td>
<td>26.3</td>
<td>6.5</td>
<td>1.5</td>
<td>8.1</td>
<td>1.5</td>
<td>0.8</td>
<td>4.6</td>
<td>7.7</td>
<td>-</td>
</tr>
<tr>
<td>2000/01</td>
<td>20.2</td>
<td>13.9</td>
<td>6.5</td>
<td>24.9</td>
<td>7.4</td>
<td>1.5</td>
<td>8.5</td>
<td>2.4</td>
<td>1.1</td>
<td>5</td>
<td>8.5</td>
<td>-</td>
</tr>
<tr>
<td>2001/02</td>
<td>19.2</td>
<td>12.7</td>
<td>6.3</td>
<td>24.4</td>
<td>7.4</td>
<td>2.2</td>
<td>8.1</td>
<td>2.6</td>
<td>1.2</td>
<td>6.4</td>
<td>7.1</td>
<td>-</td>
</tr>
<tr>
<td>2002/03</td>
<td>16.4</td>
<td>13.1</td>
<td>6.9</td>
<td>24.8</td>
<td>10.5</td>
<td>2.3</td>
<td>8.1</td>
<td>2.4</td>
<td>1.3</td>
<td>7.6</td>
<td>7.1</td>
<td>-</td>
</tr>
<tr>
<td>2003/04</td>
<td>11.7</td>
<td>10.3</td>
<td>5</td>
<td>18.6</td>
<td>11.9</td>
<td>3.1</td>
<td>8.1</td>
<td>3.4</td>
<td>1.3</td>
<td>9.1</td>
<td>7.6</td>
<td>-</td>
</tr>
<tr>
<td>2004/05</td>
<td>12.5</td>
<td>11.0</td>
<td>5.2</td>
<td>18.3</td>
<td>8.0</td>
<td>3.4</td>
<td>8.1</td>
<td>3.3</td>
<td>1.3</td>
<td>9.3</td>
<td>7.7</td>
<td>-</td>
</tr>
<tr>
<td>2005/06</td>
<td>22.1</td>
<td>8.2</td>
<td>5.0</td>
<td>20.9</td>
<td>9.4</td>
<td>3.2</td>
<td>8.0</td>
<td>3.1</td>
<td>0.0</td>
<td>8.4</td>
<td>5.8</td>
<td>-</td>
</tr>
<tr>
<td>2006/07</td>
<td>28.2</td>
<td>7.4</td>
<td>5.9</td>
<td>24.1</td>
<td>12.1</td>
<td>3.6</td>
<td>9.4</td>
<td>3.1</td>
<td>0.0</td>
<td>8.7</td>
<td>0.3</td>
<td>-</td>
</tr>
<tr>
<td>2007/08</td>
<td>23.9</td>
<td>4.1</td>
<td>4.1</td>
<td>17.6</td>
<td>19.2</td>
<td>3.6</td>
<td>12.1</td>
<td>1.8</td>
<td>0.0</td>
<td>19.2</td>
<td>0.2</td>
<td>-</td>
</tr>
</tbody>
</table>

Source: Background to the Budget and Budget Speech 2002/03, Budget Framework Paper 2005/6-7/8, Background to the budget 2008/9, Statistical Abstract 2008
2.2 Economic Transformation

2.2.1 Status of Structural Transformation

Economic transformation is the joint occurrence of interrelated processes of alteration in the relative importance of economic sectors that accompany economic development. As indicated in chapter one, economic transformation seems not resulting from increasing productivity of the primary sectors, and the movement in labour is just a result of increase in the labour force, and the increasing output in industry and services is commanded by a small proportion of the labour force and entrepreneurs.

Thrust of the poverty eradication action plans (PEAP 2002/3-2004/5, 2005/6-2007/8) was on transforming the economy from a subsistence peasant economy to a prosperous modern industrial country. This vision guided the achievement of development objectives such as: ensuring fast and sustainable economic growth and sustainable transformation, and increase the ability of the poor to increase their household incomes during the period 2002-2005. In the period 2005-2008 these objectives were refined to cover economic management through maintenance of macroeconomic stability, fiscal consolidation, boosting private sector investment and debt sustainability on one hand, and on the other ensure increased production competitiveness and incomes. In order to achieve this objective, government sought to modernize agriculture, preserve the natural resources base, develop and maintain social infrastructure especially roads, electricity and railways, and compliment these with enhanced skills in the private sector coupled with business development. Further, the policy framework identified the necessity of improving the quality of life of the poor people and this was to be achieved by devoting resources on primary and secondary education, improving health, increasing people’s ability to plan their families as well as increase adult literacy.
2.2.2 Effect of Development Processes on Structural Transformation

The structure of Uganda’s output has changed over time as a result of the development strategies employed to guide resource allocation. Efforts that were made in the 1960s contributed to having in place about 940 industrial enterprises by 1971. By 1974 manufacturing contribution had risen from 12 percent to 15 percent of gross domestic product (Republic of Uganda, 2007). This can be compared to Africa’s performance as a whole, as shown in table 2.3, where the growth rate of manufacturing during the period 1963-1977 was 8.3 percent while the growth rate of GDP was 4.7 percent.

Table 2.3: Share of Industrial GDP, 1960-1977

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry</td>
<td>2</td>
<td>4.7</td>
<td>14.5</td>
<td>20</td>
<td>25.8</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>-</td>
<td>8.3</td>
<td>8.45</td>
<td>9.16</td>
<td>7.04</td>
</tr>
</tbody>
</table>

*Source: Republic of Uganda, 2007; World Bank Country Meta Data*

Growth in manufacturing GDP was a result of increased production in response to growing real demand. At that time agricultural productivity remained low while population growth was increasing. Demand was mainly of consumer goods demanded by a relatively small sector of the urban population. At that time industries failed to establish strong linkages within the sector and nor with the agricultural sector as the industrial raw materials were mainly imported and neither did they solve the problem of unemployment.

Uganda’s industrial sector started in the 1950s with the establishment of Uganda Development Corporation. The industries started then were protected and subsidized, and
policy focused on attracting foreign investment. The impetus of industrial development was not sustained because by the mid 1975 industrial output had fallen drastically to the extent that ten years later in 1984 growth of industrial output had dropped below 3 percent. Whereas the industrial policy embraced the East African countries, there was little attention given to human capital development. So no local entrepreneurial capabilities were promoted nor nurtured. Further, the policy further did not recognize that technology was an integral part of industrial development (Republic of Uganda, 2007).

The 1994-1999 industrialization policy framework designed as part of the economic recovery programme put emphasis on export sector based investment promotion, technology transfer, and optimum utilization of the country’s resources. There was a desired to have private sector led industrial development attained through swift transition from the public sector led industrialization. Government facilitated in achieving this by providing an environment for encouraging sustainable industrial establishment and development. Government supported the establishment of district promotion centres for promoting micro and small scale enterprise development; establishment of strategic consultative groups for increased dialogue between the government and the private sector on economic policy issues including fiscal measures and private-public partnerships in service delivery of especially utilities; enhancement of physical infrastructure such as electricity, water and roads; investment incentives for attracting foreign direct investment; and the simplification and introduction of contemporary legal and regulatory frameworks for industry and business; development and upgrading of industrial support institutions mainly the Uganda Bureau of Standards, the Uganda Industrial Research Institute, the Uganda National Council of Science and Technology, and the Uganda Investment
Authority. These initiatives are considered to have contributed to the growth of the industrial sector, whose annual rate of growth increased from 11.8 percent in 1992 to 17% in 1998. In the same period, the sector contribution to GDP increased from 10 percent in 1980s to 20 percent in 1997/8.

During the period 1997/8 – 2007/8, the PEAP was the major policy framework under which medium and long-term development was directed, having the ultimate goal of eradicating poverty. The conditions that the PEAP desired to change included; widespread unemployment, income poverty and inequality, food insecurity, inability to purchase or acquire the basic needs for sustainable livelihood, limited access to land, low enrolment and poor quality of education, poor health, and poor status of water and sanitation coverage.

In about 20 years, Uganda is expected to transform into a middle income country driven by a thriving and competitive industrial sector that is primarily private sector driven. This will be achieved through support to the promotion and development of resource based industries especially those having forward and backward linkages within the industrial sector and with other sectors. Rural communities are supportive of transforming the economy by participating in production of exports and generating incomes. This period saw the introduction of the medium term competitive strategy 2000-2005 and 2005-2009. Interventions under PEAP contributed to the decline of poverty from 56 percent in 1992/3 to 31 percent in 2006.

In this economic transformation, agriculture was the major focus sector since it was the biggest employer, given that most of the population were 86 percent rural based. In this
period, agriculture accounted for 30 percent of GDP. Agriculture sector output needed to be increased to meet food security needs, supply industrial raw materials as well as exports to generate income. Expenditure in the agriculture sector therefore has been directed at: improving or increasing agriculture research, and technology development, encouraging private sector investment in agriculture research and development; expanding agricultural advisory services throughout the country; and development of the livestock sub-sector, including the control of diseases and the introduction of new technologies to increase production.

The PEAP thus also served as a rural development strategy because it is considered to have impacted on the rural sector by benefiting the majority of the poor population through: improving their basic conditions of life; enhancing productivity; generating incomes; increasing demand for non-agricultural products and services thus creating a larger market for local industrial products and services. In the agriculture sector, the value chain approach is applied so as to add value to existing products and raw materials right from production, processing, preservation, packaging, marketing, distribution, and sales services. Further, the strategy ensures that Uganda’s production is competitive by: strengthening infrastructure, boosting the education system to provide for the work force, improving the financial system, and establishing a regulatory regime that ensures a level playing field. In Figure 2.2, the trends of Uganda’s Nominal Sector Output are shown since 1970 to 2007, reflecting the emergence of the services sector as the largest sector.
Figure 2.2: Trends of Uganda's Nominal Sector Output (US$ Current Prices)
Whereas the 2000-2005 medium term competitive strategy aimed at making institutions support private sector led growth, by focusing on creating an environment that would enable the private sector grow, the 2005-2009 strategy on the other hand focused on factors that had impeded the economic transformation of the economy. Such factors included: infrastructure and utilities; knowledge resources; the effectiveness of financial services; key macroeconomic initiatives, especially regarding stability, governance, and economic management; sector specific issues within the framework of cluster development for industry, especially in agro-fisheries processing, textile and garments, and mining; business regulation, especially land reform, competition law implementation, and minimizing business regulations and business red tape; investment and export promotion; and value addition and improving market positioning for the country’s products.

In Figure 2.4 it is shown that Uganda’s economic growth trends reflect periods where growth has been negative for all sectors. The periods when there was negative growth, are basically those areas when Uganda experienced wars, such as the second half of the 1970s, and the late 1980s when there were intensified insurgency in Northern Uganda. The growth rates indicate that the growth of agriculture sector has been closely aligned to the overall GDP growth rate since the 1960. Generally there has been more turbulence in growth of industry and services compared to agriculture. Recovery in growth rates also coincides with the implementation of sectoral policies, as already indicated above in the period 1994/5 industrial policy and the initiatives for private sector growth in the around 2004/5.
Figure 2.3: Trends in Sector Output Growth in Uganda, 1961 – 2009
2.3 Human Development

2.3.1 Status of Human Development

The importance of focusing resources on human development within the framework of economic growth is to increase the productivity of human capital or effective labour. According to the human development report 2007/2008, human development is a measure of well-being. It is measured by taking into account the joint impact on people’s wellbeing, of living a long and healthy life as measured by life expectancy, being educated as measured by adult literacy and enrolment at the primary, secondary and tertiary level, and having a decent standard of living as measured by purchasing power parity (PPP) income. Whereas human development can be estimated using the human development index, this index is not its comprehensive measure because it does not include other aspects of wellbeing as indicated gender or income inequality, respect for human rights and political freedoms (UNDP, 2008). The index however helps in understanding explaining human progress and the relationship between income and well-being. Uganda’s human development index was 0.505 in 2005, and 154th in world ranking, as shown in table 2.4.

Table 2.4: Uganda’s Human Development Index, 2005

<table>
<thead>
<tr>
<th>Indicator</th>
<th>HDI value</th>
<th>Life expectancy at birth (years)</th>
<th>Adult Literacy rate (% ages 15 and older)</th>
<th>Combined primary, secondary and tertiary gross enrolment ratio (%)</th>
<th>GDP per capita (PPP US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Status</td>
<td>0.505</td>
<td>49.7</td>
<td>66.8</td>
<td>63.0</td>
<td>1,454</td>
</tr>
<tr>
<td>World Rank</td>
<td>154</td>
<td>161</td>
<td>111</td>
<td>125</td>
<td>150</td>
</tr>
</tbody>
</table>

Source: UNDP, 2008

The human development index gives a more complete picture than income in the sense that while in some circumstances high income may be associated with low state
of wellbeing. UNDP (2008) for instance analyses the comparative situation of Uganda and Madagascar in 2005. It is shown that while Uganda had a better gross domestic income per capita in terms of purchasing power parity of US$ 1,420 above that of Madagascar which was US$ 880, Madagascar on the other hand had better human development status with HDI just above 0.533.

**Figure 2.4:** HDI Trends for Uganda in Comparison with other Countries and Regions

<table>
<thead>
<tr>
<th>Year</th>
<th>Uganda</th>
<th>Kenya</th>
<th>Tanzania, United Republic of</th>
<th>Rwanda</th>
<th>Burundi</th>
<th>Sub-Saharan Africa</th>
<th>Arab States</th>
<th>East Asia and the Pacific</th>
<th>South Asia</th>
<th>Latin America and the Caribbean</th>
<th>Central and Eastern Europe and the CIS</th>
<th>OECD</th>
<th>World</th>
</tr>
</thead>
<tbody>
<tr>
<td>1975</td>
<td>0.420</td>
<td>0.466</td>
<td>0.395</td>
<td>0.337</td>
<td>0.290</td>
<td>0.395</td>
<td>0.692</td>
<td>0.545</td>
<td>0.433</td>
<td>0.703</td>
<td>0.862</td>
<td>0.824</td>
<td>0.623</td>
</tr>
<tr>
<td>1980</td>
<td>0.434</td>
<td>0.514</td>
<td>0.431</td>
<td>0.385</td>
<td>0.318</td>
<td>0.448</td>
<td>0.711</td>
<td>0.579</td>
<td>0.612</td>
<td>0.730</td>
<td>0.862</td>
<td>0.846</td>
<td>0.647</td>
</tr>
<tr>
<td>1985</td>
<td>0.433</td>
<td>0.534</td>
<td>0.403</td>
<td>0.403</td>
<td>0.352</td>
<td>0.464</td>
<td>0.711</td>
<td>0.612</td>
<td>0.648</td>
<td>0.743</td>
<td>0.862</td>
<td>0.860</td>
<td>0.666</td>
</tr>
<tr>
<td>1990</td>
<td>0.433</td>
<td>0.556</td>
<td>0.340</td>
<td>0.340</td>
<td>0.366</td>
<td>0.466</td>
<td>0.711</td>
<td>0.648</td>
<td>0.648</td>
<td>0.757</td>
<td>0.862</td>
<td>0.877</td>
<td>0.688</td>
</tr>
<tr>
<td>1995</td>
<td>0.433</td>
<td>0.544</td>
<td>0.330</td>
<td>0.330</td>
<td>0.347</td>
<td>0.483</td>
<td>0.711</td>
<td>0.697</td>
<td>0.697</td>
<td>0.780</td>
<td>0.884</td>
<td>0.894</td>
<td>0.712</td>
</tr>
<tr>
<td>2005</td>
<td>0.505</td>
<td>0.521</td>
<td>0.419</td>
<td>0.452</td>
<td>0.413</td>
<td>0.511</td>
<td>0.767</td>
<td>0.733</td>
<td>0.733</td>
<td>0.818</td>
<td>0.893</td>
<td>0.924</td>
<td>0.756</td>
</tr>
</tbody>
</table>
UNDP (2008) indicates that of the components of the HDI, income and gross enrolment are somewhat responsive to short term policy changes and that is why it is important to examine changes in the human development index over time. For example, since the mid-1970s almost all regions have been progressively increasing their HDI score with the exception of sub-Saharan Africa, Uganda inclusive as seen in Figure 2.4. This stagnant trend since 1990 was associated with country economic reversals, and in particular, because of the negative effect of HIV/AIDS on life expectancy. Uganda’s human development performance was below the status of sub-Saharan Africa until 2005.

The status of poverty, measured in terms of the human poverty index for developing countries (HPI-1) reflects people’s ability to reach the threshold level in the same dimensions of human development. The HPI-1 looks beyond income deprivation and is multidimensional and is an alternative to the US$1 a day (PPP US$) poverty measure (UNDP, 2008).

In 2004, the HPI-1 value for Uganda was 34.7, ranking 72nd out of 108 developing countries for which the index was calculated by UNDP as shown in table 2.5. The index incorporates a measure of severe deprivation in health using estimates of the proportion of people who are not expected to survive age 40. Education is measured by the adult illiteracy rate.
Table 2.5: Selected Indicators of Human Poverty for Uganda

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Human Poverty Index (HPI-1) 2004</th>
<th>Probability of not surviving past age 40 (%) 2004</th>
<th>Adult illiteracy rate (%ages 15 and older) 2004</th>
<th>People without access to an improved water source (%) 2004</th>
<th>Children underweight for age (%ages 0-5) 2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Status</td>
<td>34.7</td>
<td>38.5</td>
<td>33.2</td>
<td>40</td>
<td>23</td>
</tr>
<tr>
<td>Rank in 108 Developing Countries</td>
<td>72</td>
<td>158</td>
<td>136</td>
<td>99</td>
<td>97</td>
</tr>
</tbody>
</table>

Source: UNDP, 2008

A decent standard of living is measured by the un-weighted average of people without access to an improved water source and the proportion of children under age 5 who are underweight for their age. Inequalities in achievement between women and men when incorporated in the HDI by adjusting for gender inequality.

So countries with greater gender disparity in basic human development have a lower country GDI relative to its HDI. In 2005, Uganda’s GDI value was 0.501 compared to the HDI value of 0.505, that is, 99.2% of HDI value. Table 2.6 shows more details pertaining to the GDI measure.

Table 2.6: The Gender Disparity Index for Uganda

<table>
<thead>
<tr>
<th>Indicator</th>
<th>GDI as % of HDI</th>
<th>Life Expectancy at Birth(years) 2004</th>
<th>Adult Literacy Rate (% ages 15 and older) 2004</th>
<th>Combined Primary, Secondary and Tertiary Gross Enrolment Ratio 2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Status</td>
<td>99.2%</td>
<td>102.2%</td>
<td>75.1%</td>
<td>97.0%</td>
</tr>
<tr>
<td>Rank out of 156 Countries</td>
<td>73</td>
<td>180</td>
<td>126</td>
<td>132</td>
</tr>
</tbody>
</table>

Source: UNDP, 2008
2.3.2 Effects of Development Processes on Human Development

The PEAP is considered to have led to significant contribution in the improvement of education and health conditions indicating achievement of human capital development. This is because there have been improvements in literacy from 65 percent in 1999/2000 to 70 percent in 2002/3; improved health service delivery; better safe water and sanitation coverage; reduction in HIV/AIDS prevalence to 6.2 percent, reduction in infant mortality rate to 76 per 1000 live births and maternal mortality ratio to 435 per 100,000 in 2006. Figure 2.5 shows the trends in selected human development indicators.
Figure 2.5: Trends of Selected Human Development Indicators (1960-2007)

Life Expectancy at Birth, Total (Years)
Adult Literacy Rate (Total)
Gross Tertiary Enrolment
Gross Secondary Enrolment
Gross Primary Enrolment
Poly. (Adult Literacy Rate (Total))
Poly. (Gross Secondary Enrolment)
Poly. (Life Expectancy at Birth, Total (Years))
Linear (Gross Primary Enrolment)
Linear (Gross Tertiary Enrolment)

Trend of Under 5 Mortality Ratio (1960-2007)

Under 5 Mortality Rate (per 1000)  Poly. (Under 5 Mortality Rate (per 1000))
It is evident that while there have been significant improvement in reducing mortality of children under the age of five life expectancy has not improved much. In education, total adult literacy and gross enrolment at primary level have improved significantly, but there have not been similar achievements in increasing gross secondary and tertiary education, yet these are important for increasing influencing individual social and private investment decision making behaviour including. This also impacts on health related consumption, including making reproductive health choices.

2.4 Persisting Constraints and Challenges

2.4.1 Income Inequality

Whereas Uganda has reduced poverty during the period of the PEAP, there is a challenge of rising income inequality (BTB, 2005/6). The incidence of poverty has been reducing since early 1992 (56%) to 2007 (31%) with fluctuations in between, yet inequality has been increasing, because of increasing poverty incidence in the rural areas. Even more serious to note is the increasing population growth rate, with Uganda being one of the countries with the fastest population growth rates in the world, at 3.2 percent per annum. This is resulting from a high fertility ratio of 6.7; with Uganda being the second highest in Sub-Saharan Africa in 2002. This high population growth rate means that there will continue to be increase in the growth of poor people despite the overall reduction in poverty. Few people are benefiting from economic growth therefore.

2.4.2 Low Labour Productivity

Uganda’s human development indicators despite improvement, still reflect inability to increase the productivity of households. Factors considered in this analysis regarding household productivity include mortality and morbidity, inadequate innovation in primary
sectors, inadequate systems for rewarding performance in the public sector, and inadequate civic appreciation of institutional roles, among others.

Maternal and infant mortality ratios are still high at 435 per 100,000 and 76 per 1000 live births respectively in 2006, thus requiring substantial investments in maternal and child survival, reproductive health and human capital development in general. High levels of mortality will continue to undermine efforts to sustain high economic growth. Whereas government has over time allocated a reasonable amount of resources in improving the health systems, the impact of a high fertility on mortality has not been considered a critical issue. This has contributed to inadequate focus on household mobilisation, especially in poor rural communities, for them to appreciate the link between their numbers of children, low income, low per capita basic needs, poor health, high mortality, inadequate time for household enterprise activities, low output per unit time per worker, and hence sustenance of low incomes. The resultant effect of this low productivity is the thinking among poor household members that government must consider private household needs to be public goods, which welfare state cannot be sustained by any government.

Transformation of the economic structure of Uganda is not a result of linkages between Agriculture and the other sectors. Changes in productivity in agriculture over time have not released labour to other sectors, because mobility of the people in agriculture remains low due to several reasons including limited skills, lack of capital to move with. People who would attempt to abandon agriculture because of higher returns in industry and services will most likely end up urban unemployed. Agriculture in Uganda still grows at a very low rate yet it is the major source of livelihood for majority of the people. The sector contributes 77% of employment and 71% of the working population engaged in subsistence agriculture
as their main occupation and 68% depending on it for their livelihood. With a growing population, a high proportion of it is destined to the agriculture sector yet the sector’s productivity is not increasing, yet output growth is the least of all sectors. Then the main challenge is the difficulty of escaping food insecurity and a high social protection burden. Its proportionate contribution to gross domestic product is declining because of the higher growth of other sectors of the economy such as telecommunications services and industry. What is more important to note is that investment decisions made by rural farmers is not necessarily depending on increased information to them via increased mobile communication. If Uganda’s historical growth is agriculture based, inability of the economic system to drive resources to sustain the agriculture base. This could be done by increasing the value of agriculture based industrial activity and a reward system for agriculture producers financed by service sector taxes on goods not consumed by the poor.

2.4.3 Corruption and Misuse of Resources in the Public Service

The quality of life of the population is still constrained by lack of access to services by a large proportion of the population, as a result of corruption in the Public Service. For instance by 2005, 38% of the households had no access to safe drinking water, and 97% of the households had no access to safe sources of cooking fuel and depended on firewood and charcoal. What is challenging is the local populace’s inability to appreciate their role in promoting the causes of lack of access to services, by rewarding cases of poor governance, such as corruption and bad leadership. Corruption is rewarded in Uganda’s communities by appreciating wealth accumulation without questioning the sources of wealth. Local people accept to be paid in exchange for votes, without encumbering future bad leadership. There are incidents where diligent servants in the public service who hold key offices but remain without wealth to show are disrespected by their communities. This therefore may
promote abuse of public offices by public servants, who will wish to reward themselves for they expect no social recognition for diligent service. Even the pension and social security systems are still weakly managed and do not guarantee a fair welfare after retirement because of the changing cost of living viz-avis welfare schemes that are poorly time discounted.

There are more challenges that relate to resource allocation and in this case, especially creation of efficiency in public resource use. By 2005, government acknowledged in the background to the budget that there was need address institutional issues relating to functions and expenditures of all the executive agencies and commissions as well as standardizing unit costs across government departments. The need to evaluate the appropriateness of allocations to particular sectors was evident in the budget review of 2004/5, thus created a basis for subsequent budget strategies for the subsequent financial years. The above challenges point to the need analyse their association with the resource allocation performance over the years, and also determine whether Uganda’s structural transformation can be accelerated using public policy to make rapid improvements in economic growth and human development.

2.4.4 Inadequate Competitiveness of the Manufacturing Firms

The challenges, to the private sector, are those issues that affect the competitiveness of the private sector firms. The factors outlined below are factors outside their control and that is why they are regarded as challenges, since the desire of Uganda is to have an economy that is private sector led. Uganda is least competitive in the East African Community, except for Burundi. The main factors contributing to Uganda’s low competitive index is the high cost of doing business as a result of weak economic governance, and inability to reduce
costs of private sector inputs such as credit finance, reliable social infrastructure for transport and industrial energy, high tariffs, low technology, inadequate skills, and poor incentive structure for local investors.

2.4.5 Vulnerability of the Services Sector

The services sector is still vulnerable to both domestic and foreign factor changes such as investor confidence among the foreign direct investors, climate change, volatile political situation in the continent, and slow pace of technology transfer and innovation. The services sector output faces the effect of high volatility of macroeconomic variables such as foreign exchange rates, inflation due to supply shocks triggered by political instability in countries of origin, and dependence on nature with limited control of it in favour of stable supply of tradable outputs in the agriculture sector.

2.4.6 High Rate of Population Growth and Poverty

The growth of the population of Uganda is not a problem per se, but rather it is the high growth rate that possesses a challenge to sustained growth and development. In a country which has a high income inequality, there is a high likelihood of a large population of poor people, who will not significantly contribute to sustaining the markets size and the growth of the services sector. Considering an example of the foreign direct investment and its relationship with rural poverty, the increase in the foreign investment in the last decade by the foreign telecommunication companies led to increase in the overall growth domestic product. These companies have provided cheap mobile phones to poor people, and their marketing strategies make it possible to enhance the ability of the poor to by talk time or air time. These strategies drain the poor of possible savings despite the fact that communication has information effects to the population. However knowing that Ugandan
poor people do not communicate mainly to gather business information, but in most cases to display their esteem levels, poverty may be sustained at macro level. These small amounts of money could constitute large savings at national level. Government does not seem to agree that investing in population management will increase the size of household savings, and household expenditure per person in form of consumption, which contributes to the market as well as savings due to avoided unnecessary expenditures due to ignorance, is good for social and economic transformation.

Whereas there is agreement about the potentially volatile situation due to high population growth rate, there is still no consensus on the approach to manage the population growth deliberately. Emphasis is on an implicit approach that addresses population growth rate through the impact of education on household reproductive choices, but does not prioritize issues of current demand for family planning, which is at 64% while met needs only 23%. The need to invest in fertility reduction has not been a recognised a key strategy for development. Consideration of the 41% unmet need for family planning is not recognised as priority for sustainable social and economic transformation.

2.4.7 Limited Independence in Implementing Local Community Priorities

Whereas decentralisation provides a policy framework and mechanisms for local communities to participate in identification and addressing local development problems, their capacities in implementing the corresponding strategies is limited. Local revenues in Uganda’s local governments constitutes only 5% of local government budgets, therefore operation and maintenance of local investments are challenged. Local governments have invested little in areas that would potentially be taxed to create new revenues for the local governments. Even the resistance from the poor community members on new taxes
aggravates the situation rendering the realization of accelerated economic transformation based on local initiatives far from reality. Local governments therefore have to depend on central government for grants that have little flexibility to respond to local development. The ability of local governments to negotiate access to local resources such as tourism resources including protected areas and mineral resources, as areas that can potentially contribute to local resources offers one area that can be focused on, as a source of revenue.

2.4.8 Unplanned fragmentation of Local Governance Structures

There has been an increase in the number of local governments created due to local demand for increased access to power to enable them decide their development priorities guided by decentralization. The benefits of decentralization are appreciated by the local communities, as they have increasingly participated in making decisions regarding their local development. However, the uncontrolled, creation of local government units from parish to district level is further stressing the ability of these local governments to provide services. This process is has led to an increase in the cost of administration as new jobs are created without new sources of revenue. Therefore the creation of new local governments if not properly planned will result into a reduction in the development resources, until government and communities realise that the optimal size of local governance unit has been surpassed. This moment should not be waited for, but rather have an acceptable criteria and plan for creating viable growth and development governance units in line with predetermined growth path of administrative expenditure. Many local governments lack the ability to attract skilled human resources, and local governments have almost half of approved structures filled and the most affected sectors include health and primary education.
2.4.9 The Supremacy of Donor Drive

Whereas Uganda government has over time reduced the proportion of its budget funded with official development assistance, donor aid syndrome will continue in the country. Many sectors that receive a big proportion of their budgets funded with donor resources such as health and education have a top down nature of drive that pursues donor objectives rather than national objectives. There is a tendency to align local development agenda to international development agenda. Departments often find ways of aligning their activities to donor activities, and this therefore makes the central government activities more oriented to donor priorities, rather than addressing pressing issues in district development plans. To some extent, many initiatives supported by donor agencies such as WHO in the case of HIV/AIDS, Malaria and TB have a narrow focus on these specific problems, rather than strengthen sector wide systems. This creates a challenge to the development and implementation of implement locally credible national plans for the country.
Chapter Three
LITERATURE REVIEW

This chapter presents reviews of literature relevant to the analysis of economic transformation and the linkages between economic growth, human development and public resource allocation. Application of the theoretical framework and studies conducting related analyses is considered, highlighting available empirical evidence on economic transformation and its link with public spending.

3.1 Human Capital and Development in the Growth Framework

Evidence shows that, additional years of education lead to increases in earnings (Behrman, 1990a, b, 1995; Behrman and Deolalikar, 1988; King and Hill, 1993; Psacharopolous, 1994; Schultz, 1988, 1993a, b; Strauss and Thomas, 1995), and the rate of return varies with the level of education. Other studies that provide evidence on the relationship between human capital and economic growth are: Agiomirgianakis, et al., (2002), Bas and Földvári (undated), Barro (1991), Mankiw, et al., (1992), Benos and Karagiannis (2008), Highum (2008)

The control of resources particularly budgetary funds determine the degree to which government and other development stakeholders impact on human development. The entire government budget is ultimately meant to serve human needs, whether of the individual or of society as a whole in terms of national defence, law enforcement, economic regulation, and others. The accumulation of human capital and the redistribution of income are key budgetary functions directly related to human development, and in these, expenditures on education, science, and healthcare, on the one hand, and social insurance and social
security, on the other hand are most important (UNDP, 2003). It is however indicated that analysis of the role and contribution of the government to human development shows that there is no direct relation between the size of the State (government) and the Human Development Index (HDI) for any given country. While the role of government is an important factor in providing for human development, its contribution is mediated by other factors, and the effects of its action are reflected by the prism of national specifics, historical and cultural traditions and social conditions.

The importance of analysing production sectors and their linkage with human development is amplified in the human development report for Kenya (UNDP, 2005). Considering that human development requires expanding people’s capabilities for living decent lives and enhancing their opportunities for economic, social and political empowerment, industrialization was considered crucial for human development. Industrialization acts as principal instrument for putting technical progress into use, permitting improvements in the way different factors of production are applied in the production of goods and services; industrial activities also offer unique scope for learning, improvement and transformation; industrialization entails empowering people to access productive resources by expanding human capabilities through education, skills development, and socio-cultural changes and in producing products that are vital for nutrition, health care, and other human needs to improve the quality of life. Accordingly for Kenya, industrialization has had significant bearings on human development indicators, particularly those related to wage employment, incomes, improved livelihoods, skill formation, entrepreneurship, gender parity, and links with agriculture and other sectors.

3.2 Government Spending and Economic Growth

There is overwhelming literature regarding the relationship between the role of government and economic growth. This literature is also extended to cover human development. Arrow
and Debreu (1954) indicate that the public sector produces goods and services that the market would not be able to offer because of forces of demand and supply. Production of these social outputs is based on specified production and demand parameters, which can be incorporated in real economy data when modelling. In the case of general equilibrium, the ultimate goal is to find a price vector at which excess demand is zero. When there is efficiency in allocation, all sectors are also in equilibrium and payments to resources of the same quality is the same and there are no differences between public and private sector offers for resources.

Studies that have found significant relationship between government spending and economic growth include though not limited to: Jorgenson (1961), Landau (1983; 1985), Ram (1986), Lindauer (1988), Jensen and Larsen (2004), Highum (2008), Alexiou (2009), Chobanov and Mladenova (2009), and Alam and Sultana (2010). In the particular cases of Jorgenson (1961) and Jensen and Larsen (2004), they present a unified analytical approach to obtaining the static, comparative static and dynamic equilibrium solutions of an n-sector economy and formulate sectoral production functions able to describe the technological possibilities available take into account labour capacities. In the above studies, the role of government in contributing to economic growth is positive, except in situations where spending is financed by non-lump-sum taxes.

Studies which indicate the incorporation of government into the models of endogenous growth include, though not limited to; Barro (1988; 1990), Rebelo (1990), Engen and Skinner (1992), and Gersom (1998). For example, Barro (1988) extended the models of endogenous growth to incorporate a government sector. Government services are considered to be an input to private production and this creates a positive link between government and growth. The expansion of government inputs facilitates a delay in the onset of decreasing returns to private capital, when both are private and public inputs are
expanded. This is on the assumption that initially, production exhibited constant returns to scale in private capital and public services. This is based on the endogenous growth concerns expressed by Romer (1986) that private returns to scale may be diminishing but social returns can be constant. In this case where private and social returns to investment diverge and decision choices made by private producers individually lead to sub-optimal rates of savings and economic growth, increasing social investment would have positive effect on private returns.

Rebelo (1987) also expressed concerns relating to the absence of externalities. In the absence of externalities privately determined choices of savings and growth are growth optimal. Rebel (1987) criticized the neoclassical model on grounds that it did not provide a suitable environment for studying effects of different policies on long run growth. He proposed of an alternative class of models, of endogenous growth, in which sustained growth arose from the existence of time stationary technologies and characterizes the policy implications of the entire class of endogenous models in the absence of an endogenous growth model that has been subjected to theoretical scrutiny and empirical testing. The advantage of endogenous models is that they permit analysis that facilitates deeper understanding of the factors responsible for economic growth and the influence of policy on those factors.

Cullis and Jones (1998) used the above framework and builds on the work of Barro and Salai Martin (1992) in their work on the development of the discipline of public choice and relate it to the voting theory, the demand for public goods, the theory of constitutions, and the theory of supply of public goods. In this consideration, Government specifies a set of final demands of society such that the sectoral gross outputs needed to yield them have to be known after determining the unit-level operation of the processes of each sector. At sectoral level, there are a number of inputs, in form of physical factors and effective labour
which are competed for as budget resources. In reality public expenditure is targeted at providing factors of production for instance as infrastructures to enhance growth, as well as factor augmenting inputs such as security and social justice which guarantee property rights in economic functioning. This framework has also been applied by Gerson (1998), Hurley (2000), and Nijkamp and Poot (2004). Gerson (1998) surveyed the theoretical and empirical literature between taxation, public expenditure and economic growth, finding that well targeted government expenditures on health, education, and infrastructure have a positive impact on growth. Gerson (1998) in his analysis indicates that government provision of education, and public health could increase the productivity of labour leading to an increase in the supply of effective labour without influencing the size of the labour force directly. At the same time, research and development or infrastructure, could lead to increases in the supply of effective capital, without influencing directly the size of the private capital stock, in agreement with Barro (1990).

3.3 Analysis of Multisector Output Growth

Barro (1990), Barro and Salai-martin (1992), Devarajan, et al., (1996) and Shanggen and Neetha Rao (2003) have undertaken multisector analysis of economic growth. In a similar way Pauly (2000) presents a macroeconomic framework that can be used to model small economy supply side in a neoclassical form that expresses output per fixed factor as a function of flexible factors of production as well as total factor productivity.

In a number of studies the issue of the causality between public sector spending and economic growth has been examined, with most applying the granger approach (Granger, 1969). In the study by Jalali-Naini and Kirimi (2003) budgetary rent seeking is introduced to an endogenous model of government and growth. It was shown that the effect of rent seeking is to reduce the rate of economic growth. Further, it is shown that introduction of
rent seeking to Barro (1990) model reduces the rate of per capita consumption growth, though it is still a positive constant growth rate.

Afonso, et al., (2006) measure and analyze expenditure efficiency of Portuguese local governments but apply a non-parametric technique for production frontier efficiency called the Free Disposal Hull (FDH). In that study they construct an index of municipal performance and then compute in-put output efficiency scores for the municipalities in order to estimate the extent to which resources are not productively used. In their study, it is found that the same output could be achieved with 39% fewer resources. The difference between their study and this proposal is that while the study is conducted at local government level, this one is conducted at national level and across sectors over time.

Afonso, et al., (2008) examined the role and efficiency of public spending policies in affecting income distribution from a cross-country perspective and they use a non-parametric Data Envelopment Analysis (DEA) approach. From their analysis, the direct link from the institutional framework to income distribution appeared more tenuous in regressions while the two step analysis pointed to a strong direct role with favourable institutional indicators significantly related with efficiency of social spending. Technology applied and skills available in the public sector and institutional factors are among the factors that determine expenditure efficiency, according to their findings. Education levels and education spending were used in their study as proxy variables for human capital endowment that should increase the productivity of the private sector and facilitate its monitoring, as institutional factors. Institutional variables provide evidence of the security of property rights and sound checks and balances that boost efficiency in public spending. The proxy variables for institutions include: independent arbitration departments, red tape, shadow economy, and regulation quality. In the proposed study education spending and literacy will be used as efficiency factors in addition to labour and capital in each sector.
In explaining cross-period differences in fiscal positions, some studies have focused upon the procedures that lead to the formulation, approval and implementation of the budget. Alesina, et al., (1999) found that fiscal institutional capacity play an important role in influencing fiscal outcomes. They confirm for instance that the stringency of balanced budget laws influences fiscal outcomes.

McGee, et al., (2005) explores ways of enhancing efficiency of government budget and fiscal policy and tackles the problem from two aspects of the issue, namely from the spending side and from the collection (tax) side. They conclude that from the spending side, one must strive for efficiency by finding ways to cut costs so that government revenues can stretch farther. From the collection side, efficiency should not necessarily be the goal such that collecting taxes should be made more difficult rather than less if the goal is to increase overall economic welfare. However, this view may not apply to resource scarce country as in Sub Sahara Africa where tax efficiency is also an objective to raise more revenue for provision of services. In the proposed study focus will be placed on where the role of government can be redefined in delivering services to particular sectors with the assumption that increases in local financing currently being observed will continue.

Country experience in SSA indicates that policy improvements help in generating substantial growth. For instance in Ghana in the 1980s policy changes led to the availability of resources to the public sector which was invested in capital projects (Aryeetey, et. al., 2004). In Ghana, it is noted that a steady improvement in total factor productivity has not accompanied the growth from capital injection. Total factor productivity is related to reliability of donor funding, focus of policies and institutional strength. The proposed study will focus on the role of policies and institutional strength
since donor funding is expected to continue declining in proportionate terms of budget financing.

### 3.4 Economic Transformation and Resource Allocation

The seminal contribution of Lewis (1954) and Fei and Ranis (1964) are significant in the genesis of models of development processes overtime in terms of structural transformation (Gemmell, et al., (undated)). Most studies have concentrated on modelling agriculture and manufacturing and little is done on services sector.

A model of the development process overtime provides an analytical tool for investigating the growth of GDP in aggregate terms on one hand, and at sectoral level on the other. Using the model, the role played by the components of GDP such as industry, agriculture and services can then be analysed, as is the case in this study. Relevant to this analysis are Kaldor’s laws (Kaldor, 1966). Kaldor’s first law was that there is a close relationship between the growth of manufacturing output and the growth of GDP. Kaldor was interested highlighting the role played by the manufacturing sector as an engine of growth. If it is true that manufacturing is the engine of growth, then when manufacturing sector output is increasing there are high growth rates of the overall economy. The overall growth of the economy is therefore associated with the growth rate of not only manufacturing (or industry in a broader sense) but also services and agriculture.

While evidence of modelling structural transformation include Feder (1986) and Dowrick and Gemmell (1991), alternative models by Gemmell (1982), Bhagwati (1984) and Dowrick (1990) hypothesize possible interactions between agriculture, manufacturing and services during the development process. These studies do not reveal whether there are differences in interrelationship behaviour when manufacturing is replaced with industrial
sector, except Hwa (1989) and this study would like to find such evidence with data on Uganda.

Lewis (1954) indicates that agricultural development yields positive contributions to the expanding manufacturing activities through both demand and supply side links. It is thus hypothesized that faster agricultural GDP growth caused faster growth in industrial sector GDP (Hwa, 1989). It is indicated that where there are foreign exchange rate constraints as a domestic source of input goods to the agricultural sector can solve the problem of foreign exchange shortage.

Fuchs (1968), Blades, et al., (1974), Gemmell (1982), and Bhagwati (1984) show that service activities such as distribution and retailing contribute to both agriculture and manufacturing especially at intermediate level. At final use level, services can be both compliments and or substitutes in demand for agricultural and manufacturing products (Gemmell, et al., (undated)).

Whereas there are arguments for mutually reinforcing sectoral growth, Gemmell, et al., (undated) points to the likelihood that economies at or close to their production possibility frontier sectoral competition for resources may mutually inhibit growth. An exogenous expansion in one sector may be mutually reinforcing or inhibiting for other sectors depending on sector factor usage and the tradability of different sectors’ outputs. Thus the expansion of agriculture, manufacturing or services could impact positively or negatively on the output of either of the other two sectors especially where sectors compete for inputs in all forms. Negative effects are likely to appear in the short run when aggregate resources are relatively fixed, and any surplus resources may not be readily mobilized. However, in the long run factor accumulation and the easier mobilization of resources make simultaneous expansion in the output of several sectors. The implications of for sectoral
productivity arising from effects of inter-sectoral linkages depend on the spill over effects from one factor to another as productivity changes with sector growth.

In analysing and explaining budget performance, some studies have looked at efficiency, percentage allocation to sectors, functions and items while others have merely looked at determinants of overall expenditure. Studies such as, Farell (1957), Santiago and Gaobo (2005), Afonso, et al., (2006), Greene (2003), and Esfahani (1999) look at estimating efficiency and application of broad models to specific country data.

While analysing and comparing sectoral growth in Côte d’Ivoire, Ghana, and Zimbabwe since 1965, Blunch and Verner (1999) estimate and quantify the economic size of the sectors, defining the economic size of a sector by its output. In this model, the residual of a statistical regression model captures the additional factors likely to affect sectoral output and these include production of that sector as well as that of the other sectors.

Dominique (1998) reviews the approaches by which performance of public spending can be assessed. While benefit incidence and behavioural approaches are identified here, the study recommends an approach that incorporates behavioural responses into incidence studies. In this review, it is asserted that while benefit incidence methodology assumes that the benefit derived by consumers can be approximated by the cost to government of providing the service. Accordingly it is possible to determine whether public spending is a good way to transfer benefits to preferred sections of the population compared to other public spending components. The problems in this method are that first, it interprets public spending in terms of monetary transfer equivalent but do not reveal the impacts such as improvement in status such as increased spending on education will lead to improved literacy.
Second, some public goods and services are not identified with individual users, nor do they estimate the unit cost of provision, for example infrastructure projects. Third, indirect benefits, which are ignored in the method, may be of considerable consequence to the distributional outcomes and to why one policy dominates the other, such as the case of significance of subsidies to tertiary education on the wellbeing and livelihood of the poor. Lastly, average incidence at one point in time is a misleading indicator of the distribution of the gains from public spending. This is why marginal benefits should be applied in assessing public policy reform. OECD (2003) outlines how the issues of public policy reform are addressed in resource reallocations. A review of the OECD suggestions will be done to enrich the understanding of resource reallocation.

Laitner (2000) presented a model in which a country’s measured average propensity to save endogenously rises when its economy industrializes. Basing on Engels’s law in which it is predicted that low income countries have a large expenditure share for agriculture products and farmland will constitute a significant share of national wealth. The two sector model with agriculture and manufacturing sectors suggests an explanation for the historical time series evidence that investment rises with national income. Regression outcomes indicate that a higher average propensity to save (APS) will lead to a higher level of income per capita. Heterogeneity of exogenous preferences leads to international differences in APSs and in turn to long run differences in standards of living. The model assumes to consumable products; agriculture and manufactured goods, where the producing the former requires land while the latter uses reproducible capital. When exogenous technological progress raises incomes over time, the importance of agricultural consumption and demand therefore shifts to manufactured goods. Then the portfolio importance of the primary factors for agriculture (land) relative to those for manufacturing (reproducible capital) diminishes and the national income and products account saving rate can rise.
Gemmell et al., (undated) investigated linkages between agricultural, manufacturing and services sectors using time series data for Malaysia. They found that expansion of manufacturing GDP was associated with reduced agricultural output in the short-run but associated with agricultural expansion in the long run. Services GDP growth was inimical to agricultural GDP growth both in the short and long run. Both Manufacturing and services GDP were found to be weakly exogenous in causing changes in agricultural GDP but not vice-versa. Increases in manufacturing and services both impacted positively on agricultural productivity in the long run as higher productivity techniques in manufacturing tend to spill over to agriculture. Data for Malaysia indicated that the relationships between sectoral allocation of GDP and per capita income, trade orientation and country size have wide differences. For example, higher income per capita tended to be associated with a lower share of GDP in Agriculture and a higher share in manufacturing and services. This finding is important for Uganda’s development policy and its empirical validity using Uganda’s data will provide more evidence on the phenomena.

3.5 Human Development, Economic Growth and Public Policy

The Role of Public Policy in considering the link between human development and economic growth is critical. The lack of a universally accepted theory of optimal expenditure policy contributes to the inability of bureaucracies to prescribe well-defined rules for expenditure allocation, and hence absence of a universal solution to the basic budget problem (Fozard, 2001). Similarly, there is no single theory describing the transformation process and that is why there is a general description of what has been referred to as stylized facts to characterize the transformation process (Breisinger and Diao, 2008). However, the year 1994 marked a transition in the approach to the conceptual framework for analysing resource allocation, when it was proposed that development agencies should earmark 20 per cent of aid flows and 20 per cent of government budgets to
basic social services, thus a human development 20:20 concept. Later, heavily indebted poor countries (HIPC) initiatives emphasized public spending on health and education as key to human development and poverty reduction (UNDP, 1996). According to World Bank (2002) and Williamson and Canagarajah (2003) roads, agriculture and water and sanitation are likely to yield higher returns for employment and income creation than primary health care and education. This also provides insight into why the Poverty Action Fund have been broadened, as a pro-poor program, so that budget allocations give more inclusive focus on programs that may allow greater poverty reduction.

Paternostro S., et al., (2005) presents a framework analysing the relationship between public policy, growth and poverty. Their framework takes account of the dynamics of poverty reduction and is based on the considerations of trade-offs between expenditure policy choices as an aspect of the broader policy choices facing a government given its development strategy. A strategy can best be implemented when the roles of the public and the private sector are well defined with minimum implicitness in the weights of each other’s role. In order to implement the strategy objectives, policy instruments suitable for stimulating the economy are used and these may be categorized into three: expenditure policy, tax policy and regulatory policy which include public private partnership arrangements. Whereas the regulatory policy framework establishes the rules of the game and the economic environment for the private sector as well as the public sector, Tax policy raises the necessary resources for public programs.

The way the resources are raised matters for growth, equity and poverty reduction. Expenditure policy on the other hand, is used to influence policy objectives and works through the management of the level and composition of expenditure. Resource allocation is a choice between “social” expenditure and “infrastructure” expenditure (physical capital)
with the objective of maximizing the standard of living. In reallocating resources between social and infrastructure to maximize the standard of living, the choice depends on the total welfare effects working through both basic needs and income mechanisms. In this framework, government allocates resources between social, infrastructure and other expenditure based on their trade off of their direct and indirect impact on income and an income inequality assumed to be function of basic needs achievement, social expenditure, infrastructure expenditure and other expenditure.

The purpose of allocating resources is to improve social development and poverty reduction indicators as contained in development strategies. With human development, there is need to set multiple objectives of improving social indicators and reducing income poverty. Based on availability of data, a composite human development indicator will facilitate the analysis of trade-offs; otherwise, multiple indicators are still appropriate in a representative framework.

Studies by Narayan and Smyth (2004), Francis and Sunday (2006), and Naeem, et al., (2008) have particularly used cointegration and error correction approaches in analysing long run growth effects of human development, and have significant similarities with this study.

3.6 Conclusions
Evidence has been found in the literature to show that human development is positively associated with human capital and though not identically similar have been used interchangeably as a proxy of each other. There is also further evidence that government spending facilitates the building of stock of human capital by focusing on human development indicators. In studying the role of government, it is not the size that matters, but rather the focusing of the expenditure does. There is also evidence of attachment of
importance to production sector activities in order to develop human capital, such as industry, as was the case in Kenya.

Models for associating government expenditure, human development, human capital and economic growth have been developed and those that consider the relationships in an endogenous manner are found to be more efficient. Endogenous models have the power to capture the effect of government spending on preventing a decrease in returns to private factors and factor productivity growth.

Evidence has been found regarding the modelling of structural transformation in agriculture and industry but not the services sector. No evidence has been found in which the analysis of economic transformation is extended to the analysis of linkages with human capital and public spending in a single framework. Evidence of applying such framework that analyzes structural transformation across the three economic sectors and linking them to public spending and human capital development is lacking for Uganda. Due to lack of such evidence in Uganda, it is still difficult to explain whether the low momentum associated with agriculture output growth compared to growth in output in industry and services is a short run phenomenon, as it happened in Malaysia, for instance.

Therefore the contribution of this research work is in developing a model of endogenous growth suitable for characterizing the behaviour of inter-sectoral behaviour in Uganda. Further contribution is in the application of this model in providing an empirical analysis of the country’s ability to create efficiency gains in public resource use; adequate provision in public spending for human capital and its development; and the acceleration the country’s economic transformation through the known sectoral output linkages with human development. This study contributes to providing further understanding of the existing
linkages and facilitates the process for identifying evidence based remedies for growth and development.
Chapter Four

THEORETICAL FRAMEWORK

This chapter presents the theory on which the study is based and the specific study hypotheses. This review has considered mainly the endogenous growth framework which is adopted in this study because of its advantage in the ability to integrate government spending and human development in the models. This review ends with a look at the framework for analysing and testing hypotheses regarding the validity of the frameworks when applied to real data situations, as is done in this study.

4.1 Overview of Economic Growth Frameworks

Economic growth as a process through which productivity, living standards and output increase (De-Long, 2002), is needed because human needs continuously grow and even get more diverse over time. Valeriu, et al., (2006) indicate that acceleration of growth can be achieved by improving capital endowment, qualitative and quantitative growth of the labour force, technological development and a better combination of these production factors. Accordingly, initial conditions and growth promoting economic policies work through their impact on (i) available level of technology that multiplies the efficiency of labour, and (ii) on the capital intensity of the economy. Better technology leads to a higher level of efficiency of labour because the skills and knowledge of the labour force, the ability of the labour force to handle modern machine technologies, and the efficiency with which the economy’s business and markets function. The capital intensity of the economy means the amount of capital goods available for use to the average worker, such as buildings, freeways, machine tools, and computers. Capital intensity is determined by (i) the investment effort made in the economy and (ii) the investment requirements of the economy. The share of total production that is saved and invested in order to increase the
capital stock will be responsible for increasing capital intensity and productivity of workers.
Changes in the underlying technology and preferences map into differences in growth rates.

Other conceptual underpinnings of economic growth relate to the quality of economic growth. The larger and socio-geographically inclusive growth is, the higher is its quality. This is ensured by reducing the inequality of income and poverty incidence through increasing the income of the poor and improving the population’s health and education.

High Quality Economic Growth takes into account the depletion of natural resources sustainability so as not to undermine the economic prosperity of the future generations. It further ensures that a certain amount of income is reinvested in maintaining or extending the productive basis for future growth, and also leads to advanced level, high quality economic growth leads to economic development of the nation. It should have a feature of major structural change process involving upgrading of infrastructure and resources shifting among agriculture, manufacturing and services, a process called economic transformation.

There are four main economic growth models commonly used in empirical studies. The first two, the Harrod-Domar model (Harrod, 1948; Domar, 1947) and the Solow growth model (Solow, 1956; Solow 1970) are neoclassical models. The Solow model is the epitome of neoclassical theory. The other two are endogenous growth models, namely; the model with constant returns to physical capital (Romer, 1986) and a model with human capital (Uzawa, 1965; and Lucas, 1988).

In the neoclassical growth framework, the central determinant of economic growth is physical capital. For instance the Solow growth model developed by Robert Solow which is used to study issues of growth, changes in income, standards of living, patterns across countries and implications of differences over time. The model is used to identify equilibrium, as a point of balance and state, of the system toward which the model
converges over time, and explains productivity changes. The major conclusion of the model is that the accumulation of physical capital cannot account for either the vast growth in output per person overtime, or the vast geographic differences in output per person. In the model, output is primarily determined by a combination of accumulated capital. Accumulated capital is dependent on the savings rate, exogenous variables such as technology and other sources such as externalities. Technology is exogenous or endogenous depending on the circumstances. The saving rate is considered to be an exogenous constant in the model as a determinant of capital accumulation, though modifications can be made on the model where savings are not fixed.

These neoclassical models however have limitations stemming from the reliance on exogenous changes in technology and labour or population. Human capital accumulation and government activities as alternative sources of long run growth are not adequately analysed in neoclassical models (Baffoe-Bonnie, 2003). This is why the section that follows considers the alternative endogenous growth framework, which is given emphasis in the rest of the study.

4.2 Endogenous Growth Framework

Endogenous growth models generate long term growth by displaying constant or increasing returns in the factors that can be accumulated. Barro (1990) indicates that private and social returns to investment may diverge so that decentralized choices lead to sub-optimal rates of saving and economic growth. Alternatively lack of externalities may make the privately determined choices of savings and growth Pareto optimal due to constant returns to private capital, in both human and non-human form. An example of the endogenous growth models with constant returns to capital is the one in which an infinite-lived representative household maximizes overall utility with a given growth rate of consumption at each point in time and the net marginal product of capital is constant. In this case,
production takes the form of the Ak –model in which output per worker is proportional to capital per worker.

Endogenous models explain how the changes that occur to have an economy move from any arbitrary starting point in terms of the physical to human capital ratio, to a steady state rate. All factors put together will display constant returns to scale, and the production function will yield a constant net marginal product of capital, and the analysis of this effect requires extending the neoclassical models, as was done by Lucas (1988), to introduce both physical and human capital. The models aim to optimise a constrained utility function of the household and focuses on the relationship existing between the growth rate of consumption, the net marginal product of capital and the constant rate of time preference.

Endogenous growth models consider public spending by linking it with the economy’s long-term growth rate (Devarajan, et al., 1996). Further, technological progress is explained by economic forces, with technological progress positively related to the accumulation of human knowledge. Below are two basic cases of endogenous growth theorisation namely Uzawa and Lucas Models.

4.2.1 The Uzawa Model

Uzawa (1965) formulated a model of economic growth in which advancement in the state of technological knowledge is achieved only by engaging scarce resources in some positive quantities, and in analysing the pattern of allocation of scarce resources that result in an optimum growth. The main objective here is to find and characterize the time path of the optimum economy given the social welfare criterion, in terms of the discounted sum of consumption per capita. The procedures followed here involve building on the aggregative model of economic growth by Solow (1957) and Swan.
The state of technological knowledge that exists at any moment is summarized by the aggregate production: $Y(t) = F[K(t), A(t)L_p(t)]$, in which output is a function of capital ($K(t)$) and effective labour ($A(t)L_p(t)$). It is assumed that all changes in technological knowledge are embodied in labour and the improvement in labour efficiency does not depend upon the amount of capital employed. The education sector is responsible for the activities which result in improvement in labour efficiency, $A(t)$, and the impact of these activities is diffused over the whole economy. The rate of improvement of labour efficiency is determined by the ratio of labour employed in the education sector over the total labour force, $L(t)$. The rate of capital accumulation is determined by the quantity of annual output to be set aside for investment.

The time path of the economy is uniquely determined when the allocation of labour between the education and productive sectors, and the division of the annual output between consumption and investment at any time is specified. Uzawa found that; for any rate of discount, there existed a uniquely balanced ratio of capital to labour in terms of the efficiency unit. If the initial value of capital-labour ratio in the efficiency unit is known, then the optimal growth is achieved by allocating labour and annual output such that the rate of increase in labour efficiency equals the rate of increase in the capital-labour ratio. When the initial capital-labour ratio in the efficiency unit is greater than the balanced ratio, all annual output is consumed until balance is attained. Similarly, when the initial capital-labour ratio in the efficiency unit is less than the balanced ratio, all annual output is invested until the balanced ratio is attained. Following the above theorisation, Lucas (1988), Romer (1986; 1990), Aschauer (1989), Rivera-Batiz and Romer (1991), King and Levine (1994), Nirvikar and Hung (1996), and Zhang (2002) have modelled growth effects of endogenous technical change, particularly effects of knowledge and productivity changes.
In the next section the model developed by Lucas (1988) is reviewed, as a key model that has inspired most of the empirical studies of endogenous growth.

4.2.2 The Lucas Model

The original Lucas model (Lucas 1988) assumes that; (i) the economy is closed with competitive markets, (ii) agents in the economy are identical and rational, (iii) there is constant returns technology, (iv) the population of the economy is \( N(t) \) persons or equivalently man-hours devoted to production and grows at an exogenous rate, \( \lambda \), (v) real per capita consumption is a stream \( c(t) \) of units of a single good with \( t \) being non-negative. It further assumes that the technology function in which output growth is generated has yield constant returns-to-scale production. Output is obtained from the utilization of technology, physical capital, the time spent by labour on work, the stock of labour-force, and the stock of human capital.

The model builds on the theory of economic growth developed by Robert Solow and Edward Denison to analyse economic development with respect to the importance of: (i) physical capital accumulation and technological change, (ii) human capital accumulation through schooling, and (iii) specialized human capital accumulation through learning by doing. Technology is the capital elasticity of output. Human capital is the stock of knowledge that has been transmitted from technological and scientific discoveries such as textbooks, scholarly journals, websites, into human brains via studying.

Capital accumulation is a function of net savings, while the accumulation of human capital is a function of the distribution of time available to labour for work and other non-work. In order to produce perpetual economic growth, there must be a combination of factors that can be accumulated indefinitely without diminishing returns. Among the ways to increase the amount of human capital is through more years of schooling, and more time spent
healthy by the working population, and by so doing knowledge can be accumulated indefinitely in the overall economy.

The primary objective of the model is to maximize satisfaction derived from a stream of consumption preferences subject to technological progress and human capital development. In a constrained optimisation function, the Hamiltonian is obtained by summing up the current period utility function and the rate of increase of capital. The production function is given by equation 4.1 and production per capita is devoted to consumption c(t) and capital accumulation as in equation 4.2.

\[ Y = A(t)K(t)^{\beta}N(t)^{1-\beta}; \quad 0<\beta<1 \]  
\[ Y = N(t)c(t) + \dot{K}(t) \]  

(4.1)  
(4.2)

In equation 4.2, Y is output, K(t) is the total capital stock; \( \dot{K}(t) \) is rate of change of capital stock; A(t) is the level of technology; and the rate of technical change is expressed as \( \frac{\dot{A}}{A} \) exogenously given as \( \mu \).

According to Lucas, the allocation of resources in the economy to pursue desired consumption levels is constrained by the initial values of capital, the technology, and the path taken by capital. The paths taken by technology and population are selected exogenously. Optimal allocations are obtained from the constrained consumption function, the current value Hamiltonian H, which is then maximized with subject to technology enshrined in the production function. When the maximum is achieved with respect to consumption, goods are allocated at each time point to be equally valuable, on the margin, used either as consumption or investment. At the margin the rate of growth of capital, the price of the rate of increase of capital, and that of consumption is constant.
The rate of growth of per capita consumption on a balanced growth path is negatively proportional to the rate of change in the cost of increasing capital. So along the balanced path, the marginal product of capital is a constant value. At balanced growth path, the rate of capital change is constant, such that per capita units of consumption and capital grow at a common rate. It is derived from the above that at the balanced growth path, the further observed that the consumption – capital ratio which is also equivalent to the constant savings rate can be derived. All in all, it follows that along a balanced path, magnitudes of the rate of growth per capita are proportional to the given rate of technological change. The share of labour is inversely related to the constant of proportionality. If there is low time preference and degree of risk aversion, then accumulation of savings is induced hence a higher savings and higher output will result. In order to increase growth, certain parameters need to be changed to alter growth rates. Such parameters are related to technological change and human capital, in form of a person’s general skill level, which are complimentary engines of growth. By influencing the way individuals allocate their time over various activities affects their productivity.

Human capital levels and the current time allocation are aspects of technology which affect current production and human capital accumulation respectively. At any one time, there is an effective labour force, given the number of workers, their skill levels, and the time allocated to current production.

Suppose that there are N workers with skill level h, denoted by N(h), then the total units of work force are expressed as the sum of the continuous function of generating workers. If each worker devotes a fraction of his work time denoted by u(h) to current production, and the remaining 1-u(h) to human capital accumulation, then effective work force in production is a summation, of the products of the augmented function derived by multiplying the proportionate time worked with the number of workers of a particular skill,
along the skill axis. In this way the skill weighted hours of the human resource that is devoted to production can be estimated as the effective workforce, \( N^e \).

\[
N^e = \int_{h=0}^{\infty} u(h) \times N(h) \times hdh.
\] (4.3)

The production function is now \( F(K, N^e) \), the wage per hour for the worker of skill \( h \) is \( F_N(K, N^e)h \) and total earnings are \( F_N(K, N^e)h \) multiplied with \( u(h) \). Human capital has both internal and external effects. Internal effects are the individual’s human capital effects on own productivity. The level of skill or human capital contributes to the productivity of all factors of production. External effects the person’s average level of skill is not a result of own human capital accumulation decisions. Assuming that all workers are identical in the economy, with skill level \( h \), and the time allocation is \( u \), then effective work force is \( N^e = uhN \), and the average skill level \( h_a \) is \( h \). The production function therefore describing the technology of producing goods is provided in equation 4.4, in which \( h_a(t)^\gamma \) is the external effect of human capital and the technology \( A \) is constant.

\[
Y = A(t)K(t)^\beta \times [u(t)\times h(t) \times N(t)]^{1-\beta} \times h_a(t)^\gamma.
\] (4.4)

The effort, \( G \), devoted to the accumulation of human capital, \( 1-u(t) \), is linked to its rate of change \( h(t) \). If human capital grows at a rate \( \dot{h}(t) \) based on the capital levels already attained and the effort devoted to acquiring more, \( G \), then;

\[
\dot{h}(t) = h(t)\gamma \times G(1-u(t))
\] (4.5)

Government expenditure on education, private acquisition of education, and depreciation of human capital over time, is considered to be the main form in which human capital
evolution effort is manifested. If there are diminishing returns to the accumulation of human capital then \( \zeta < 1 \), in which case, human capital cannot serve as an engine of growth as an alternative to the technology term \( A(t) \). Since \( u(h) \), the time devoted to current production is none negative, then;

\[
\frac{\dot{h}(t)}{h(t)} \leq h(t)^{\zeta - 1} G(1); \quad \frac{\dot{h}(t)}{h(t)} \to 0 \text{ as } h(t) \to +\infty
\] (4.6)

By focusing on sustained per-capita income growth resulting from only endogenous growth from human capital development, when \( \gamma = 0 \) and \( U(c) = c \), then, \( h(t)^{\zeta} G(1-u(t)) \) from equation 4.5 is linear in \( u(t) \) with \( \zeta = 1 \). Assume that lifetime is finite such that the return to increments falls with time. Further assuming that \( G \) is linear, then;

\[
\dot{h}(t) = h(t)\delta[1-u(t)].
\] (4.6)

If all effort is devoted to human capital accumulation, \( h(t) \) grows at its maximal rate \( \delta \).

If the external effect, \( h_a(t) \) in equation 4.4 exists, the optimal growth path does not coincide with the competitive equilibrium path. Obtaining the optimal path requires choosing the values of \( K(t) \), \( h(t) \), \( H_a(t) \), \( c(t) \) and \( u(t) \) that maximize the utility derived from consumption \( c(t) \), subject to the production function and the constraint \( h(t) = h_a(t) \) for all \( t \). The current value Hamiltonian for this optimal problem is presented as 4.7, where \( \theta_1(t) \) and \( \theta_2(t) \) are the prices used to value increments to physical and human capital respectively, and \( 1-\beta \) is the the share of labour in the use of primary factors.

\[
H(K, h, \theta_1, \theta_2, c, u, t) = \frac{N}{1-\sigma}(c^{1-\sigma} - 1) + \theta_1[AK^\beta(uNh)^{1-\beta} h^\gamma - N_c + \theta_2[\partial h(1-u)].
\] (4.7)
Consumption \([c(t)]\) the time devoted to production \([u(t)]\) are the decision variables that have to be selected to maximize \(H\). The efficient rate of human capital growth as well as the equilibrium growth rate can be found by estimating the growth paths of consumption and capital accumulation and should not exceed the maximum feasible rate \(\delta\). The growth rate in human capital increases with the effectiveness of investment in human capital \(\delta\) and declines with increases in the discount rate, \(\rho\).

In the above framework it is illustrated how human capital development and physical capital are theoretically integrated in a welfare function. The major focus in this study is to address the link between the said factors and further quantifying the role of government expenditure in accumulating physical and human capital in order to increase output.

4.2.3 The Effect of Government Spending

From the framework by Lucas (1988) above, where the production is expressed as \(Y = AK^{\beta}(uNh)^{1-\beta}h^{\gamma} - N_{\phi} + \theta_2[\delta h(1-u)]\), Barro (1988) also develops a similar formulation, but emphasizing the role of government. Consider, \(y\) to be output per worker; \(k\) to be capital per worker representing a producer’s quantity of capital also corresponding to the amount of aggregate capital per capita; and \(g\) is the per capita quantity of government purchases of goods and services. Then output per capita can be expressed as a function of \(k\) and \(g\) using a Cobb-Douglass formulation as follows.

\[
y = f(k, g) = Ak^{(1-a)}g^a
\]  
\[(4.8)\]

Since government expenditure is financed contemporaneously by income tax determined with a tax rate \(\tau\), and then government expenditure can be expressed as equation 4.9.

\[
g = \tau[Ak^{(1-a)}g^a] = k(\tau A)^{a-1}
\]  
\[(4.9)\]
\[ y = k A^{\frac{1}{1-a}} \tau^{a/(1-a)} \] (4.10)

From 4.10, the marginal product of capital is given as \( f_k \); where

\[ f_k = A(1-\alpha)(g/k)^{\alpha} \] (4.11)

Changes in the producer’s quantity of capital and output do not lead to any changes in the amount of public services available to him. Accordingly, for a given expenditure (or tax) ratio \( \tau \), output per capita is proportional to capital available per person. An increase in the expenditure ratio means an increase in the relative amount of public input and an increase in the coefficient that connects per capita output and capital (Barro 1988). From equations 4.10 and 4.11 by using the ratio of public input to the capital per capita and re-formulating the marginal product of capital per worker, an increase in expenditure ratio, \( \tau \), implies an upward shift in the marginal product of capital, \( f_k \). A rise in expenditure ratio raised the marginal product of capital thereby raising the growth rate in production constrained consumption of goods and services, thus impacting on welfare.

\[ f_k = (1-\alpha) A^{\frac{1}{1-a}} \tau^{a/(1-a)} \] (4.12)

Assume representative household seeking to maximize its utility (welfare) by consuming goods and services, using a technology constrained utility function. Where government expenditures finance not only production function inputs but consumption services enter the household consumption function, then maximization of utility can be shown to correspond to the maximization of growth rate of consumption (Barro, 1988). Government can choose a constant expenditure ratio and dictate there after the household choices for consumption over time. It also means that setting consumption choices for households over time would be possible to find expenditure ratios consistent with the desired consumption. Consumption choices in this case may relate to the desired human development or welfare
indicators. Where public services are non-rival for the users total government purchases rather than the amount per person matters for each individual in determining the desirable scale of governmental activity.

In view of the above discussion, this study makes a choice of variables for government expenditure, at sector level that contributes to accumulating human as well as physical capital, namely expenditures on health, expenditure on education, expenditure on agriculture, and expenditure on transport and communications.

4.2.4 The Role of Human Development

The frameworks provided in the above two sections is further put into perspective and schematised by Rannis and Stewart (2001) when examining the interdependence between economic growth and human development. The concept of human capital above is here addressed in a broader sense of human development illustrating the changes in per capita income and its two-way relationship with the basic societal objective of human development. Using regressions in a study conducted across various Latin American countries over the period 1960-92, rejected the commonly held view that ensuring increases in economic growth automatically leads to advances in human development. Instead, they find that human development has to occur prior to or simultaneous with improvements in economic growth, if a country is to reach a virtuous cycle of growth and human development improvement. In their framework, consider human capital to be a narrow definition of human development which consists of the health and education of a country’s people. The link between human development and economic growth can be seen by looking at the how economic growth provides resources for sustained human development on one hand, and how human development warrants improvements in the quality of the labour force needed for economic growth.
Accordingly, to Rannis and Stewart (2001), this relationship has implications that should be considered in both policy and analysis. Whereas there have been analyses at cross country level of the linkages and implications, there is still limited consideration of these linkages at national level over long periods. There is need to identify the linkages between economic growth and human development at national level, and further analyse their implications to policy aimed at achieving sustained progress in both human development and economic growth.

Human development is a result of the implementation of the Human Development Improvement Function or effectiveness of expenditure, which is facilitated by allocation of resources by households, government and civil society. This effectiveness is affected by
the efficiency of the process of social prioritization and the making of choices and both household and society levels. For instance, at household level, good choices on child spacing leads to higher expenditures per child born alive and improves child and maternal survival rates. At national level, allocation of expenditures on girls education improves their long-term behaviour towards own reproductive life and improves capabilities needed for child care and nutrition.

Human development affects the economy through enhancing people’s capabilities and consequently their creativity and productivity. Human development means that people are healthier, nourished and educated and therefore can contribute more to economic growth because they are more productive as workers, and can use improved technology need for increased output and exports.

4.2.5 Multisector Growth

In a multi sector framework, the basic model for analysing the effect of public inputs on output growth considers extension of dual sector model, say to \( \phi \)-sectors. Consider the technology in the Lucas’ model, particularly the constraint in equation 4.7, and consider the output to be generated by three sectors, that is, \( \phi = 3 \).

\[
Y = AK^\alpha (uNh)^{1-\alpha} h^\gamma - N_e + \theta_1[\delta h(1-u)].
\]  

(4.7)

Therefore the 3-sector economy production function describes a non-negative smooth concave homogenous production function with constant returns to scale in labour and capital. We therefore generalise the model in equation 4.7 and consider that; \( Y_\phi(t) \) denote output of Sector \( \phi \) in year \( t \); while \( A_\phi(t) \), \( K_\phi(t) \), \( H_\phi(t) \) and \( G_\phi(t) \) are composite factors of technology, total capital stock, human capital in form of human development indicators,
and government expenditure respectively; while $\zeta$ and $\beta$ are distributive factors, and the asteric $*$ is a multiplication symbol, such that

$$Y(t) = \sum_{\phi=1}^{1} A_{\phi}(t) * K_{\phi}(t)^{\beta} * H_{\phi}(t)^{1-\beta} * G_{\phi}(t)^{\zeta}$$  \hspace{1cm} (4.13)

Sector production is analysed using equation 4.13 to indicate how resources are appropriated or allocated to $\phi$ sectors in some period $t$, and a model of this nature is developed also by Pauly (2000) as stated implicitly in equation 4.14, and in a specific form in equation 4.15, and borrows from the framework by Barro (1988) and Rebelo (1987). Pauly (2000) models the small economy supply side in a neoclassical form expressing output per fixed factor as a function of flexible factors of production as well as total factor productivity, but uses government expenditure as the dependent variable while the other factors are independent variables.

$$SS_{\phi,t} = g (\text{GEPGDP}_{t-1}, \text{GDPP}_{t-1}, SA_t, Z_{\phi,t}),$$  \hspace{1cm} (4.14)

where, $SS_{\phi,t}$ is the share of the $\phi$-th sector in total government expenditure, $\text{GEPGDP}_{t-1}$ is the one period lag of per capita GDP, $SA_t$ is structural adjustment, and $Z_{\phi,t}$ is factors that may affect government spending in the sector.

$$Y = A_0 X^{\alpha} Z^{\beta} M^{\delta} e^{\text{TFP}}$$  \hspace{1cm} (4.15)

Where, $Y$ is the Sector Output per fixed factor or value added; $X$, $Z$, and $M$ are fully utilised factors of production; $e^{\text{TFP}}$ represents factors determining total productivity of the sector; and $\alpha$, $\beta$, and $\delta$ are coefficients of the factors of production.

In order to estimate the coefficients of the model in equation 4.15, a log-linear model can fitted with specific input and output quantities of the factors defined in the model. From
both equations 4.14 and 4.15, the steady state growth rate of output depends on the ratio of
government expenditure to output and the tax rate as in equation 4.16.

\[ y(t) = \alpha + \beta y(t-1) + \gamma \tau(t) + \sum \kappa g(t) + \varepsilon(t) \]  

Where, \( t \) is time in years, \( y(t) \) is growth rate of real trend – GDP at time \( t \), \( \tau(t) \) is the ratio of
total government revenue to nominal GDP in logs at time \( t \) as a proxy for government size, 
\( g(t) \) is the ratio of functional government expenditure (education, health, agriculture,
general government, and others; and \( \varepsilon(t) \) is the error term.

### 4.2.6 Economic Transformation

Consider a three sector model where output is generated from agriculture, industry and
services. The formulation of this relationship is provided in the equation 4.17 below.

\[ y(t) = \omega_i + \varphi_i (m_i - a_i - s_i) \]  

Where, \( m_i \) is the growth of manufacturing GDP; \( a_i \) is the growth rate of agriculture GDP;
and \( s_i \) is the growth of services GDP. The relationship in equation 4.17 means that the
impact of the growth in one sector on the growth in the productivity of the economy can be
identified. And the analysis can be extended to finding out whether the expansion of sector
output and employment do actually lead to transfer of labour from low productivity sectors,
in form of disguised unemployment, to higher productivity sectors, especially industry as
assumed. Further it is possible to find out whether there exist static and dynamic increasing
returns in the sectors to explain the relationship between sector growth and productivity in
the economy. Static returns in this case exist where there are economies of scale internal to
the firm while dynamic returns exist where increasing productivity is derived from learning
by doing, induced technological change, and external economies in particular.
The second of Kaldor’s laws states that there exist a relation between output growth and productivity growth in a sector. This is also called Vedoorn’s Law. Based on this law, productivity growth can be attributed to output growth in a sector. From a static point of view (as a result of internal economies of scale), and considering the already presented output model in equation 4.15, such that if \( Y = A_0X^\alpha Z^\beta M^\delta e^{\text{TFP}} \) which is equal to \( E\omega K^{\Omega} \), then equation 4.18 also holds.

\[
p = \left( \frac{\Omega}{\omega} \right) \omega + \left( \frac{\omega - 1}{\omega} \right) y
\]

In equation 4.18, \( p \) is factor productivity; \( \omega \) is the rate of growth of capital stock; and \( y \) is the output growth. Accordingly, given the definitions in equation (4.17), factor productivity can be expressed as a function of sector output as in equation (4.18).

\[
p = \left( \frac{\Omega}{\omega} \right) \omega + \left( \frac{\omega - 1}{\omega} \right) \left[ \omega_i + \varphi_i \left( m_i - a_i - s_i \right) \right]
\]

When \( e \) is the rate of growth of employment in a sector, such as industry, then

\[
p = (m_i - a_i - s_i) - e
\]

Therefore, since \( \Phi_{1i} + \Phi_{2i} \left[ m_i - a_i - s_i \right] \)

\[
e = \left( m_i - a_i - s_i \right) - \Phi_{1i} - \Phi_{2i} \left[ m_i - a_i - s_i \right]
\]

The returns to scale can be obtained from equation (4.20) as \( (1/ (1 - \Phi_{2i})) \). This formulation can therefore be used to investigate the role public policy can play in accelerating sector
output growth through increased productivity and employment, as variables of endogeneity in output determination.

When using time series data, care has to be taken to ensure that stable forms of the factors are used in the modelling to avoid estimating spurious or false relationships. With the use of vector auto regression (VAR), co-integration and error correction mechanism, it is possible to avoid the above problem in the estimation. The study uses co-integration and error correction mechanism in analysing short and long-term aspects of the model.

4.3 Interdependence in Short and Long run Relationships

An econometric framework of co-integration based on Engle and Granger (1987), allows for testing economic hypotheses regarding possible sectoral interdependencies by testing parameter restrictions. This extension of the classic dual economy model of agriculture and industry to include services found that at least one statistically significant long run sectoral relationship existed in each period. This indicated the existence of a large degree of interdependence in long-run sectoral growth. On the basis of these results, it is important to improve the understanding of inter-sectoral dynamics to facilitate policy implementation aimed at increasing national economic growth. This particular study is important to the current study because its methodological approach will be utilized.

Sector outputs are results of various structural relationships which can be modelled statistically with sufficient generality to accommodate a variety of reduced form relationships. Imposing apriori assumptions of exogeneity on the variables is avoided under the vector autoregressive framework. This is because it allows the data to determine the precise model specification.
Testing hypotheses is undertaken in a framework where the estimates of the long run relationships between variables in a VAR model estimated in a vector error-correction (VECM) form are obtained using the method of reduced rank regression. Taking equation (4.15) above, as sector output $y_t$, of the form in equation (4.21) has an equilibrium correcting form such as that in equation (4.22).

\[
y_t = \Pi_1 y_{t-1} + \Pi_2 y_{t-2} + \ldots + \Pi_k y_{t-k} + \mu + \epsilon_t \quad (4.21)
\]

\[
\Delta y_t = \Gamma_1 \Delta y_{t-1} + \ldots + \Gamma_{k-1} \Delta y_{t-k+1} + \Pi y_{t-k} + \mu + \epsilon_t; \quad \epsilon \sim n-i-d(0, \Omega) \quad (4.22)
\]

where,

$t = 1, \ldots, T$;

$y_t = (n \times 1)$ vector of endogenous variables that are linear functions of past values $y_i$;

$\mu = (n \times 1)$ vector of constants such that $\epsilon_t$ an $(n \times 1)$ vector of independently distributed disturbances of zero mean and diagonal covariance matrix $\Omega$. $\mu$ can be considered to be deterministic taking into account short-run shocks.

The dynamic effects of the system are captured by $\Gamma$, where, $\Gamma = \Sigma_{(i=1, \ldots,k-1)}(\Pi_i - I)$; and the long run relationships are expressed as, $\Pi = \Sigma_{(i=1, \ldots,k)}(\Pi_i - I)$. The long run relationships are enduring inter-sectoral linkages that bind sectors together in the process of economic development. The growth of one sector reflects the size and state of others with which it interacts. The coefficients of $\Pi$ reflect the extent to which resource competition or technological spillovers between sectors induce lasting effects. From Johansen (1988) the rank of the steady state coefficient matrix $\Pi$, $r$ gives the number of linearly independent combinations of $y_t$ that are integrated of order zero. If $r < n$, then there exist $r$ I(0) linear combinations of the $n$ I(1) variables in the system. Where the variables of $y_t$ cointegrate, $\Pi$
is expressed as a decomposition comprising a matrix of cointegrating vectors $\beta$ and a matrix of equilibrium correcting coefficients, $\alpha$, from equation (4.40) where $\hat{\Pi} = \alpha \beta'$, so that;

$$
\Delta y_t = \alpha \beta' y_{t-k} + \sum_{i=1, \ldots, k-1} \Gamma_i \Delta y_{t-i} + \mu + \epsilon_t
$$

(4.23)

Empirically, the rank of $\Pi$ is the number of long run relationships and is determined using the trace and maximal Eigen-value test statistics. Locating a single cointegrating vector, so that $r=1$, implies that the series integrated of degree one and the elements of $\beta$ quantify the unique long run relationship between variables in the system and the elements of $\alpha$ capture the deviations from the equilibrium, $\beta' y_{t-k}$, describing short run behaviour. The $\Gamma$ coefficients in equation (4.23) estimate the short run (or impact) effect of shocks to $\Delta y_t$ and thereby allow the short run and the long run responses to differ.

Testing for temporal precedence, the system based approach allows the assumptions of exogeneity of the explanatory variables to be tested empirically through parameter restrictions. If weak exogeneity exists, variables do not respond to disequilibrium in the system in which they are part and where it exists for $(n-1)$ the complexity of the modelling exercise is reduced to the use of single equation methods. For a VAR model in which components cointegrate, weak exogeneity implies granger non causality and the result may signal whether the adjustment mechanisms between sectors are uni-directional or multi-directional. Noting that over parametisation is inherent in system based approaches finite sample corrections of the test statistics have to be presented. Where the exact sample distributions are unknown, the adjustments for sample size become necessary approximations to the true critical values.

In the empirical estimations, use the logarithms of the sectoral GDPs in the three sectors of agriculture ($a_t$), industry ($m_t$) and services ($s_t$) as the dependent variables, and then estimate
the sectoral labour productivity in the three sectors. Introduce an intercept dummy for time to accommodate policy changes in the period under review. In order to test for the order of integration of the series and cointegration, start by estimating the VAR, then estimate the VAR (2) model of the three variables; $a_t$, $m_t$ and $s_t$. Thereafter check for system based tests for residual autocorrelation, normality, heteroskedasticity, and over parametisation to check any departures from the stated assumptions. Then test hypotheses for nullity of the matrix of estimated coefficients, using the F-statistic and p-value. The nullity of the number of cointegrating coefficients can then be tested using the Cheung and Lai (1993) finite sample correction. The statistics will indicate rejection of the null hypothesis of no cointegration vectors in favour of two or more if the critical value of 10 percent is on the upper side. Strong evidence of cointegration in the estimated equation of the equilibrium correcting coefficients, leads to inferring the existence of a single cointegrating vector between sector GDPs. With the three variables in the system, and one cointegrating vector, there are $(n-r) = 2$ unit roots implying that all the variables are I(1) process in the same way of confirming conventionally univariate tests of non-stationarity.
Chapter Five

METHODS AND PROCEDURES

This chapter is a detailed presentation of the selected methods and procedures that were followed by the study in collecting, processing, analysing and presentation of findings in line with the stated objectives. It presents the analytical models, the selected variables, model specification, scope of the study, analysis of linkages, and diagnostic tests on the models developed. In section 5.1 the econometric model is specified. The model analyses cointegrating interdependence in sectoral output. Section 5.2 presents the procedures for measuring output interdependence in the long run, while section 5.3 presents diagnostic tests on the models.

5.1 Econometric Model Specification

5.1.1 Definition and Measurement of Variables

Based on the theoretical framework developed by Rebelo (1987), Lucas (1988), Barro (1988), and applied by Pauly (2000) among others, this study specifies a model along the lines described in equations; 4.13 and 4.15 for identifying the production function structure. Further this study benefits from equation 4.16 in using loglinear functions at sector level and equation 4.22 in conversion of the relationships in the multivariate error correction form. The methods are also in line with Rannis and Stewart (2001) on the framework for economic growth and Human development.

Using the general model in equation 4.13 and then transforming it into log linear equations for each sector are specified. Equations 5.1 to 5.3 are general to the agriculture, industry and services sector outputs based on the variables outlined in table 5.1.
Data for the estimation of the model functions in each sector was collected on the following variables from the sources provided in table 5.1. The selection of particular variables for as independent variables in the model for sector output is based on prior theoretical knowledge of the association, and availability of data. It is also assumed that each of the variables is potentially endogenous, and that is how they are treated in the error correction models explained below.

**Agriculture:** Agriculture sector gross domestic product (YA), labour employed in agriculture sector (LA); under five mortality rate (U5MR) as an indicator of health of the population and human development; literacy level (LI) as an indicator of human development and the ability of the population to access and use available information in making production decisions; expenditure on roads and transport infrastructure (RX), as an indicator of the level of infrastructure development and rural accessibility; and the quantity of farm fertilizers (F), as a direct input in agriculture.

Labour employed in agriculture sector (LA): Uganda’s agriculture is heavily dependent on the hand hoe, and therefore labour is a key input that facilitates the generation of agriculture output. The increase in labour is expected to generate higher output. Growth in the sector output can result from both increases in labour quantity as well as increase in the quality of labour by changing labour efficiency. Under-five-mortality rate (U5MR) is an indicator of health of the population and human development. This factor has mixed results. If under five mortality affects agriculture output by diverting resources from agriculture to providing health care for the children, especially the labour of mothers. The positive effects can arise from the effect that child mortality has on fertility and the growth of the population. Since labour is a proportion of the population, this implies that increase in under-five mortality
over long periods can lead to increase in labour size. Literacy level (LI) is an indicator of human development and the ability of the population to access and use available information in making production decisions. The higher the literacy rate the higher the productivity of labour in agriculture and services sectors. This is because literate labour responds positively to new information and innovations in agriculture.

Expenditure on roads and transport infrastructure (RX), as an indicator of the level of infrastructure development and rural accessibility is a form of physical capital. Physical capital is needed to link production areas with markets and therefore a favourable factor to agriculture output growth. This expenditure leads to an increase in the lagged increase in the stick of physical capital and the movement of human capital in and out of the production areas. The quantity of farm fertilizers (F), is a direct input in agriculture. Increase in the utilisation of fertilisers leads to increase in farm yields.

Therefore, the general model for agriculture sector is specified as in equation 5.1.

\[ YA = \beta \cdot LA_t^{a_{1}} \cdot U5MR_t^{a_{2}} \cdot F_t^{a_{3}} \cdot LI_t^{a_{4}} \cdot RX_t^{a_{5}} \cdot AGEXP_t^{a_{6}} \]  

(5.1)

**Industry:** Industrial sector output (YI), gross secondary enrolment (GSE) as an indicator of the size of labour base employable in industry, education expenditure (EDX) as an indicator for quality of labour, Interest rates of financial institutions (IR) as an indicator of the availability of finance for investment; Agricultural output (YA), as an indicator for availability of raw materials since Uganda’s industrial sector is agricultural based; and Electricity sold domestically to Ugandans (EL), as a direct input for industries. Agriculture expenditure endogenously affects industry output through its influence on agriculture output growth.
Gross secondary enrolment (GSE) is an indicator of the size of labour base employable in industry. Potential workers in industry require skills relevant to the specific industry. Labourers who have attained secondary education are easier to train than those who have not attained secondary education. A proportion of those enrolled for secondary education proceed to enrol for tertiary training that is relevant for industrial labour. General secondary education in this particular case substituted for technical graduates, whose data is not readily available.

Education expenditure (EDX) is an indicator for quality of labour and government effort. Government expenditure is the effort government exerts towards the improvement of the quality of human capital. The higher the expenditure on education, the higher is industrial output. A proportion of the government expenditure goes to funding secondary and tertiary education, which is important for industrial skills development.

Interest rates of credit from financial institutions (IR) are an indicator of the availability of finance for investment. Lower interest rates encourage more investment, while high variability can affect the situation of expectations and discourage investment.

Agricultural output (YA), as an indicator for availability of raw materials since Uganda’s industrial sector is agricultural based. It is expected that growth of agriculture output leads to increase in industrial raw materials and there growth in industrial output. Agriculture expenditure endogenously affects industry output through its influence on agriculture output growth. Expenditures on agriculture inputs is paid for industrial output. For
instance, processed inputs for agriculture promote industrial activity if increasingly used in agriculture.

Electricity sold domestically to Ugandans (EL) is a direct input for industries. The increase in electricity supply makes energy available to run industries. Stability of the availability of electricity is necessary for keeping the costs for running industries stable. The supply further facilitates the attraction of more investment into the sector.

The general model for industry sector is specified as in 5.2

\[
Y_t = \lambda^*_{GSE} GSE_t^{\delta_1} * EDX_t^{\delta_2} * IR_t^{\delta_3} * EL_t^{\delta_4} * YA_t^{\delta_5}
\]

(5.2)

**Services:** Services sector gross domestic output (YS); Interest rates of financial institutions (IR) as an indicator of the availability of finance for investment; literacy level (LI) as an indicator of ability of the population to use available information and human development; Exchange Rate of the Uganda Shilling to the United States dollar (ER); public expenditures on health (HX) and education (EDX) as indicators of effort and investment into human capital development; and transport and communication expenditure (RX).

Interest rates on financial products facilitate exchange. If the interest rates are low, then investment in to the services sector is high. A stable economic environment that is characterised by stable interest rates creates certainty, which is essential for smooth trading and other service sector activities.

Concerning literacy level (LI) of the population, it positively influences business transacting and therefore a positive condition for the growth of services sector. Ability to
read market information and interpreting it effectively will spur effective decision-making and therefore encourage growth.

Exchange Rates are important for services sector more than other sectors because Uganda has an open economy transacts business with the rest of the world through the services sector. Rapid changes in the exchange rates are negative to the growth of the services sector especially if there are foreign currencies loans are a sizeable proportion of the loan portfolio. Therefore, a low speed to exchange rate variations is positive for services sector output growth.

Public expenditures on health (HX) and Public expenditures on education (EDX) are indicators of effort and investment into human capital development. Goods and services procured for the health sector and education sector transacted by the services sector has margins that take a sizeable proportion of the input costs of health and education. Even wages in the health and education sector benefit the services sector. Further, these expenditures facilitate the process of keeping the human capital for services sector healthy, skilled, and therefore contributing more hours of work. Therefore increased expenditure on health and education leads to increase in the services sector.

Transport and communication expenditure (RX) facilitate in reducing the cost of doing business and therefore creates a favourable environment for increased rates of return on investment in the services sector. Therefore, expenditure on infrastructure leads to increase in services sector growth over time.

The general model for services sector is specified as in equation 5.3.
\[ Y_S = \gamma \cdot IR_t^{\mu_1} \cdot LI_t^{\mu_2} \cdot ER_t^{\mu_3} \cdot HX_t^{\mu_4} \cdot EDX_t^{\mu_5} \cdot RX_t^{\mu_6} \]  \hspace{1cm} (5.3)

The model therefore considers gross domestic product as the sum of the 3 sector outputs from Agriculture, Industry and Services. GDP is generally modelled as specified in equation 5.1, and practically taking the general form in equation 5.4. The variables have different contributions to sector technology \([A_i(t)]\), sector capital stock \([K_i(t)]\), human development \([H_i(t)]\), and government expenditure \([G_i(t)]\).

\[
GDP(t) = \sum_{i=1}^{3} Y_i(t) = YA(LA, F, RX, LI, AX, U5MR,) + YI(YI, GSE, EDX, IR, YA, EL) + \\
YS(IR, LI, ER, HX, EDX, RX) \hspace{1cm} (5.4)
\]

Based on equation 5.4, a multisector model expresses each of the sector output growth as dependent on the other sectors’ output growth in line with the framework in equation 4.7 to generate equation (5.5).

\[
YA = f(YI, YS, LA, F, RX, LI, AX, U5MR, GSE, EDX, IR, EL, ER, HX) \hspace{1cm} (5.5)
\]

The sources of data used in the study are presented in table 5.1.
Table 5.1 Sources of Data for Model Variables

<table>
<thead>
<tr>
<th>Model Variable</th>
<th>Source(s) of Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Labour employed in agriculture sector (LA) – (‘000s of people)</td>
<td>FAO estimate, Manual Estimation, Country data reported by International Organizations where the country is a member (Semi-official) - WTO, EU, UNSD, etc. and Official data reported on FAO Questionnaires from countries</td>
</tr>
<tr>
<td>3. The quantity (tons) of farm Fertilizers (F)</td>
<td>Africa Development indicators 2004 &amp; 2006; WB 2007; Word Development reports; HDR, Table 5.1 BGTB 2002; Ministry of Education (AfDB report);</td>
</tr>
<tr>
<td>5. Gross secondary enrolment (GSE) – rate</td>
<td>Bank of Uganda Annual Reports</td>
</tr>
<tr>
<td>6. Literacy level (LI) - ratio</td>
<td>Bank of Uganda Annual Report, 2001/2; Source for 2004-2007 is from ERA</td>
</tr>
<tr>
<td>8. Public expenditure on health (HX)</td>
<td></td>
</tr>
<tr>
<td>9. Transport and communication expenditure (RX)</td>
<td></td>
</tr>
<tr>
<td>10. Expenditure on roads and transport infrastructure (RX),</td>
<td></td>
</tr>
<tr>
<td>NB: All monetary values are in US Dollars</td>
<td></td>
</tr>
<tr>
<td>11. Interest (lending) rates of financial institutions (IR)</td>
<td></td>
</tr>
<tr>
<td>12. Electricity sold domestically to Ugandans (EL), (million Kwh)</td>
<td></td>
</tr>
<tr>
<td>13. Exchange rate of the shilling to the United states dollar (ER);</td>
<td></td>
</tr>
</tbody>
</table>
5.1.2 Data Processing

The data collected from various sources was processed to put them in a form required for the specified models. Some of the data was obtained as proportions, and was converted into absolute values using the values of the denominators. Such data transformed from proportions to absolute values included Education expenditure (EDX), Public expenditure on health (HX), and Transport and communication expenditure (RX). This was done by using the data on the proportion of total public expenditure as a proportion of gross domestic product. Different sources provided these variables as a proportion of GDP or expenditure. In order to facilitate the analysis using a linear model, all variables were transformed to their logarithm values, for them to be fitted in log-linear production functions as the model required. There were variables with missing data in the series whose values are usually established through national surveys conducted after about two years.

Table 5.2: Estimation of Missing values

<table>
<thead>
<tr>
<th>Variable</th>
<th>Trend Equation</th>
<th>Trend Type of Best fit</th>
</tr>
</thead>
<tbody>
<tr>
<td>The quantity (tons) of farm fertilizers (F)</td>
<td>$0.0098x^3 - 0.727x^4 + 17.96x^3 - 131.35x^2 - 737.08x + 9308.2; R^2 = 0.8925$</td>
<td>Polynomial</td>
</tr>
<tr>
<td>Agriculture Expenditure</td>
<td>$1E-06x^5 - 0.0002x^4 + 0.0115x^3 - 0.1881x^2 + 0.6845x + 6.0295; R^2 = 0.8247$</td>
<td>Polynomial</td>
</tr>
<tr>
<td>Under five mortality rate (U5MR)</td>
<td>$0.0114x^2 - 2.3647x + 222.3; R^2 = 0.991$</td>
<td>Polynomial</td>
</tr>
<tr>
<td>Adult Literacy</td>
<td>$-0.0075x^2 + 1.2903x + 24.386; R^2 = 0.977$</td>
<td>Polynomial</td>
</tr>
<tr>
<td>Labour employed in agriculture sector (LA)</td>
<td>$4519e^{0.02535x}; R^2 = 0.9975$</td>
<td>Exponential</td>
</tr>
<tr>
<td>Gross secondary enrolment (GSE)</td>
<td>$0.0115x^2 - 0.1683x + 3.8565; R^2 = 0.932$</td>
<td>Polynomial</td>
</tr>
</tbody>
</table>
The estimation method of interpolated values was based on the behaviour of the trend as analysed and estimated using Microsoft Excel software and taking the model with the highest R-square, as shown in Table 5.2. Missing values were estimated for the quantity (tons) of farm fertilizers, agriculture expenditure, under five mortality rates, adult literacy, labour employed in agriculture sector, and gross secondary enrolment, using the equations generated from the existing data. Other than labour which is a part of a population that grows in an exponential manner, the rest of the series with missing data are subsets of populations that whose growth pattern can be obtained from the data itself without recourse to theoretical behaviour. It was therefore found that these series present themselves with a trend of the best fit being a polynomial.

5.2 Co-integration and Vector Error Correction Mechanism

5.2.1 Justification of Methods

This study chose co-integration and error correction to analyse short-term and long-term relationships in line with objective three of the study. This was also intended to avoid spurious regressions while using time series data. The procedure therefore undertakes tests on all variables to assess whether they have stationary time-series properties, as an indicator useful in avoiding spurious results. In line with Granger (1983) and Granger and Weiss (1983), where a combination of two variables is integrated to order 1 the two variables in the combination are integrated to the same order, the study establishes the degree of integration for combinations of variables in the production model. Given the need to establish and analyse short run changes and long run dynamics, the error correction model is constructed following the procedures used by Phillips (1954), Sargan (1964), Davidson et al, (1978) and Bong and Harrison (1992), to take into account these changes through levels of adjustment. The intention is to observe, using the error correction model, the
adjustments that occur to the steady state targets. This is done by including in the short-term dynamics a measure of how much out of equilibrium the variables were at the start of the period.

Tests for cointegration are conducted to find evidence that the series are co-integrated and can therefore be represented by an error correction model in either a 2-step or 3 step estimation procedures. First, estimation of the levels of integration of the variables is done and hypotheses for co-integration are tested. This is followed in the second stage, with variation of the lags to observe whether cointegration exists. In the third stage, calculation of new adjusted coefficients and standard t-statistics is done from the parameter estimates of the first stage (long run) estimation and a set of standard errors. EViews software is used to carry out the econometric estimations following the procedures described in the sections that follow. Three tests were conducted for hypothesis testing on the parameters: Durbin-Watson, Dicker-Fuller and the Augmented Dickey-Fuller. With the three steps, all long run co-integration relationships present in the data with the short run properties simultaneously to adjust for a set of new coefficients and the t-statistics. The procedure of the multivariate co-integration model estimation, on which the study is based, facilitates the simulation of policy oriented macroeconomic development scenarios by analysing the relationships between resource redistribution across social and production sectors. The study chose the single equation estimation as superior to the two stage method because the method allowed the long run solution to be estimated in a model which incorporates dynamics and was not likely to be biased.
5.2.2 Testing for Stationary Errors and Order of Integration

For each of the variables above, checking whether they have stationary errors was necessary, by undertaking a unit root test. The variables found to be having stationary errors were then used in the cointegration models. In testing the unit root test, it was intended to test the hypothesis that for a time series \( y_t \), where \( y \) represents any of the variables already stated above, the null, \( H_0: y_t = y_{t-1} + \eta + \epsilon_t \) against the alternative, \( H_a: y_t = \mu + \delta T + \rho y_{t-1} + \epsilon_t \), which is a trend-stationary time series. The criteria used to decide whether each of the series was stationary or not was basically the ADF test and is based on the equation: 

\[
\Delta y_t = \mu + \delta T + (\rho-1) y_{t-1} + \sum_{k=1}^{\rho} \beta_k \Delta y_{t-k} + \epsilon_t.
\]

The lagged values of \( \Delta y \) are incorporated into the ordinary least squares estimation to correct for possible serial correlation. EViews software already had the above equations incorporated and was used to conduct these tests.

In this case, we tested the hypothesis that \( H_0: (\rho-1) = 0 \) against \( (\rho-1) < 0 \). The procedure includes deciding on three options that: (i) there is an intercept, \( \mu \); (ii) both intercept, \( \mu \) and trend, \( \delta T \) (iii) there is a trend, \( \delta T \). This is followed by deciding on the number of lags, \( p \) to include in the model. In deciding the lag length, the fact that too few lags will leave autocorrelation in the errors and distort the test, while too many lags could reduce the power of the test. The test statistic is calculated by EViews, so making decision based on the ADF test was somewhat straight forward. The hypothesis that the series has a unit root is accepted when the ADF test statistic is greater than the 1\%, 5\% and 10\% critical values. By differencing and detrending, the ADF test statistic for the difference is provided by EViews, on the basis of which to decide following the criteria above.
5.2.3 Test Procedure for Co-integration of Variables

A stationary linear combination is called the cointegrating equation and may be interpreted as a long-run equilibrium relationship between the variables. In order to test whether the variables are cointegrated, conduct cointegration tests for variables using the Johansen Cointegration Test. The test was undertaken to find out whether a linear combination of any two or more of the series in 5.1.1 could be stationary. The test was conducted for the variables in groups, hence multivariate, based on the sector functions that were to be estimated. The variables for agriculture sector are tested together, and similarly for industry and services sector. This is followed by deciding on the lag length of the test by looking at the value of the log-likelihood, AIC and SIC. The study therefore selected a lag length of 1 to 1 and ensured that the estimation period did not change so much to lose degrees of freedom. This facilitated the study in getting an indication on the number of integrating equations. The number of integrating equations is supposed to be at-most equal to the number of endogenous variables minus one. Whereas the above process is guided by EViews software, the inbuilt procedure is equivalent to taking one independent variable at a time together with the dependent variable and related as in equation 5.7. The purpose of the relationship in equation 5.6 is to verify whether there is cointegration, and if the variables are not cointegrated, the error term \( u_t \) would not be stationary.

\[
\ln (YA)_t = \alpha_1 \ln (LA) + u_t \quad (5.6)
\]

If the relationship between \( \ln(YA)_t \) and \( \ln(LA) \) is cointegrated, then the estimates of the relationship in equation 5.7 are very accurate and converge to their true values rapidly. To test for co-integration for the relationship in equation 5.7 the formulation in equation 5.11 was used for all the independent variables in equation 5.8. EViews programme was then used to conduct the cointegration test using all the identified independent variables for each
sector production function following the error correction mechanism (ECM). If there are \( z \) endogenous variables, each of which has one unit root, there can be from zero to \( z-1 \) linearly independent, cointegrating relations. When there are \( z \) separate integrated elements driving the series, levels of the series do not appear in the VAR in this case. The study thus establishes the number of cointegrating equations such that if there is one cointegrating equation in the system, then a single linear combination of the levels of the endogenous series should be added to each equation in the VAR and when multiplied by a coefficient for an equation, the resulting term is an error correction term. If there are additional cointegrating equations, each contributes an additional error correction term involving a different linear combination of the levels of the series. If there are exactly \( z \) cointegrating relations, none of the series has a unit root, and the VAR may be specified in terms of the levels of all of the series. In some cases, the individual unit root tests will show that some of the series are integrated, but the Johansen tests show that the cointegrating rank is \( k \). This contradiction may be the result of specification error. If all the variables all together show cointegration, as will be investigated using equation 5.10, there will be application of equation 5.6, to check whether the residuals are stationary also.

\[
\ln (Y_A)_t = \hat{\alpha}_0 + \hat{\alpha}_1 \ln (L_A) + \hat{u}_t; \quad (a_{01} = e^{0})
\]  

(5.7)

where, \( \hat{\alpha}_0, \hat{\alpha}_1 \) are OLS estimates of \( \alpha_0 \) and \( \alpha_1 \); and \( \hat{u} \) are the OLS residuals. In order to testing whether OLS residuals are stationary using the ADF tests the regression in equation 5.9 was run.

\[
\Delta \hat{u}_t = \psi \Delta \hat{u}_{t-1} + \phi_1 \Delta \hat{u}_{t-2} + \phi_2 \Delta \hat{u}_{t-3} + \cdots + \phi_k \Delta \hat{u}_{t-k} + \varepsilon_t
\]  

(5.8)

where \( \varepsilon_t \) is a random error. The null hypothesis (H_0) in this test is that \( \psi = 0 \), in which case, the OLS residuals would be considered non stationary, and the relationship between \( \ln(Y_A) \)
and $\ln(LA_t)$ would not be cointegrated. The alternative hypothesis was that $H_1: \psi < 0$ meaning that the OLS residuals were stationary and the relationship between $\ln(YA)$ and $\ln(LA_t)$ was cointegrated. The test statistic $\frac{\hat{\psi}}{\hat{\sigma}_\psi}$, where $\hat{\psi}$ was the estimate of $\psi$ in the regression and $\sigma_\psi$ was the estimate of the standard error, was used. Since the residuals were generated by the regression, the ADF tests of their stationarity are different from ADF tests of whether a variable is stationary. In the programme used, the OLS estimator chose the values of the parameters that minimized the sum of the squared residuals and tended to choose parameter values that gave stationary errors that had the lowest variance. The critical values therefore used would be those that were negative other than those used for the ADF tests for stationarity of a variable.

The second test conducted was the Cointegrating Regression Durbin Watson (CRDW) test. If the residuals were non-stationary, DW would tend to zero in the limit as the sample size increased. Low values of DW were taken as evidence that co-integration existed.

### 5.2.4 Procedure for Specification of Error Correction Model

After rejecting the null hypothesis that the residuals were non-stationary in equations 5.8 and 5.9 a general model is estimated for the dependent variable parametised in an error correction form which incorporated the estimated disequilibrium errors of the first step above. The error correction model was formulated in the form presented in equation 5.10. In equation 5.10 only one independent variable is included, but a multivariate ECM involves including all independent variables (Engle-Yoo, 1991)

$$\Delta \ln(YA)_t = u + \rho_1 \Delta \ln(YA)_{t-1} + \rho_2 \Delta \ln(LA)_t + \rho_3 \Delta \ln(LA)_{t-1} + \rho_4 \hat{u}_{t-1} + \varepsilon_t$$  \hspace{1cm} (5.9)
In equation 5.9, ln(LA_t) represented all the other independent variables in the three sectors, and the ln(YA) represented the dependent variables in the three sectors. The single equation dynamic model of the error correction form was estimated with the lagged values of the independent and dependent variables included in the formulation of the equation above by substituting for the lagged error term as indicated in equation 5.10.

\[
\Delta \ln(YA) = u + \rho_1 \Delta \ln(YA)_{t-1} + \rho_2 \Delta \ln(LA) + \rho_3 \Delta \ln(LA)_{t-1} + \rho_4 \ln(YA)_{t-1} + \rho_5 \ln(LA)_{t-1} + \epsilon_i
\]  

(5.10)

Information about the long run relationship between \( \ln(YA) \) and \( \ln(LA) \) was obtained from the terms \( u, \rho_4 \ln(YA)_{t-1} \) and \( \rho_5 \ln(LA)_{t-1} \). To show that these variables contained the information about the long run relationship the dynamic model in the error correction form was solved for the implied long run equilibrium. This implied that in the long run, equation (5.11) holds.

\[ u + \rho_4 \ln(YA) + \rho_5 \ln(LA) = 0, \text{ such that } \ln(YA) = \frac{-u}{\rho_4} - \frac{\rho_5}{\rho_4} \ln(LA) \]  

(5.11)

The parameter estimates of the equilibrium relationship could be estimated using OLS estimates of \( u, \rho_4 \) and \( \rho_5 \) from the ECM formulation.

5.3 Measuring Sectoral Output Interdependence and Long-run Returns to Scale

Take sector outputs to be results of various structural relationships which can be modelled statistically with sufficient generality to accommodate a variety of reduced form relationships. Imposing apriori assumptions of exogeneity on the variables was avoided
under the vector autoregressive framework. This is because it allowed the data to
determine the precise model specification. Estimates of the long run relationships between
variables in a VAR model estimated in a vector error-correction (VECM) form were
obtained using the method of reduced rank regression using the EViews programme.
Equation (5.6) above, considered as sector output $y_t$, of the form in equation (4.22) the
dynamic effects of the system and the long run relationships were estimated.

From the results of the model, using EViews programme, the rank of $\Pi$ which is the
number of long run relationships was determined using the trace and maximal Eigen value
test statistics. Locating a single cointegrating vector, so that $r=1$, implies that the series
integrated to degree one and the elements of $\beta$ quantify the unique long run relationship
between variables in the system and the elements of $\alpha$ capture the deviations from the
equilibrium, $\beta' y_{t-k}$, describing short run behaviour. The coefficients of the short run
variables estimate the short run (or impact) effect of shocks to $\Delta y_t$ and thereby allow the
short run and the long run responses to differ.

The study tested for temporal precedence, where the system based approach allowed the
assumptions of exogeneity of the explanatory variables to be tested empirically through
parameter restrictions. Conclusions were based on the alternative that if weak exogeneity
existed, variables did not respond to disequilibrium in the system in which they were part
and where it existed for $(n-1)$ the complexity of the modelling exercise would be reduced to
the use of single equation methods. The nature of exogeneity (weak or strong) was used to
tell whether there was, in the model where the components were cointegrated, granger
causality. The result of this test provided a signal on whether the adjustment mechanisms
between sectors were unidirectional or multi-directional. Narayan and Smyth (2004)
describe how granger causality tests are constructed where there is cointegration, and EViews generates the test statistics automatically.

In the estimations, the study used the logarithms of the sectoral GDPs in the three sectors of agriculture \((a_t)\), industry \((m_t)\) and services \((s_t)\) as the dependent variables, and then estimated the sectoral factor productivity in the three sectors.

In order to test for the order of integration of the series and cointegration, first, the VAR was estimated, followed by estimation of the VAR (2) model of the three variables; \(a_t\), \(m_t\) and \(s_t\). This was followed by checking for residual autocorrelation, normality, heteroskedasticity, and over parametisation to check any departures from the stated assumptions.

The procedure then tested the hypotheses for nullity of the matrix of estimated coefficients, using the F-statistic and p-value. The nullity of the number of cointegrating coefficients was tested using the Cheung and Lai (1993) finite sample correction. The statistics provided a basis for rejection of the null hypothesis of no cointegration vectors in favour of two or more when the critical value of 10 percent was on the upper side. Strong evidence of cointegration in the estimated equation of the equilibrium correcting coefficients, made the study make inference on the existence of a single cointegrating vector between sector GDPs. With the three variables in the system, and one cointegrating vector, there are \((n-r) = 2\) unit roots implying that all the variables are I(1) process in the same way of confirming conventionally univariate tests of non-stationarity.
5.3.1 Short and Long-term Relationships

Following the definitions of the variables in table 5.1, estimation of the cointegration relationship is done. In estimating the equations, it is considered that the series do not have deterministic trends and the cointegrating equations have intercepts. Thus the models for agriculture, industrial and services outputs (YA) were estimated in equations 5.1 to 5.3. Therefore the linear logarithmic forms of these equations are provided as in equations 5.12, 5.13 and 5.14

In linear logarithmic form the equation for agriculture sector is estimated as,

\[ LNYA = e^\beta + \alpha_1 LNLA + \alpha_2 LNUSMR + \alpha_3 LNLN + \alpha_4 LNRX + \alpha_5 LNF \]  \hspace{1cm} (5.12)

The model for industry sector output (YI) in linear logarithmic form the equation is estimated as,

\[ LNYI = e^{\lambda} + \delta_1 LNGSE_t + \delta_2 L NedX_t + \delta_3 L NIR_t + \delta_4 LNEL_t + \delta_5 LNYA_t \]  \hspace{1cm} (5.13)

Lastly, services output model in linear logarithmic form the equation is estimated as,

\[ LNYS = e^\gamma + \mu_1 LNIR_t + \mu_2 LNLN_t + \mu_3 LNER_t + \mu_4 LNLHER + \mu_5 LNHX_t + \mu_6 L NedX_t + \mu_7 LNRX_t \]  \hspace{1cm} (5.14)

Based on the above model functions, the vector error correction model is estimated so as to separate the short-term and long-term models from the data. Appendix 1 in the appendix provides a summary of the parameters that were estimated by the model.
5.4 Diagnostic Tests

Based on stationary variables in the VECM models for the three production sectors, diagnostic tests were undertaken to make sure that the regressions fulfil the conditions for classical regression analysis. The tests that were conducted for each sector included: the autoregressive conditional heteroskedasticity Lagrange Multiplier (ARCH LM) for heteroskedasticity, Jarque-Bera for normality and for serial correlation conduct the Lung Box Q tests. Since the study uses lagged variables, the above tests are preferred to the Durbin Watson statistic. These tests are conducted on the four models estimated in the study. The procedures followed in these tests are provided in the sections that follow.

5.4.1 The Lagrange Multiplier test for Autoregressive Conditional Heteroskedasticity

The Lagrange Multiplier (ARCH LM) test was conducted, to demonstrate that the there is no auto regressive conditional heteroskedasticity in the residuals, $\mu_t$. We find out whether the series are not related to the recent residuals, so as to be sure that efficiency of the model estimated is not compromised. Basically the hypothesis that there is no autoregressive conditional heteroskedasticity in the residuals is tested, and the test statistic is estimated from the regression of the squared residuals on a constant and squares of its lagged values up to order q as presented in equation 5.15:

$$\mu^2_t = \beta_0 + \beta_1\mu^2_{t-1} + \beta_2\mu^2_{t-2} + \ldots + \beta_q\mu^2_{t-q} + \nu_t$$  \hspace{1cm} (5.15)

The study used the Obs*R-squared statistic, which is computed as the number of observations times $R^2$ from the test regression, and the F-statistic test for the joint
significance of all lagged squared residuals. The LM test statistic is asymptotically
distributed $\chi^2 (q)$ under general conditions.

5.4.2 Breusch-Godrey Test for Autocorrelation

To test for autocorrelation should allow for nonstochastic regressors, such as the lagged
values of the regressand and the higher order autoregressive schemes, as well as moving
averages of white noise error terms (Gujarati, 2004). In order to do this, we consuct the
Breusch-Godfrey test which is also called the LM test. In this test, we assume the error
term $\mu_t$ follows the $q$-th order autoregressive scheme such that; $\mu_t = \beta_1 \mu_{t-1} + \beta_2 \mu_{t-2} + \ldots + \beta_q \mu_{t-q} + v_t$; where $v_t$ is the white noise errotr term.

Then the null hypothesis is $H_0: \beta_1 = \beta_2 = \ldots = \beta_q = 0$. This test indicates that there is no serial
correlation of any order. The test is based on the Lagrange multiplier principle and if the
sample is large, BG or LT test is such that $(n-q)*\text{R-square}$ follows a chi-square distribution
with $q$ degrees of freedom. The decision criteria are that if $(n-q)*\text{R-square}$ exceeds the
critical chi square value at the chosen level of significance rejected the null hypothesis.

5.4.3 Jarque-Bera test for Normality

To test whether the series were normally distributed, the Jarque-Bera test statistic was used
to measure the difference of the skewness and kurtosis of the series with those from the
normal distribution. Under the null hypothesis of a normal distribution, the Jarque-Bera
statistic is distributed as a chi square with 2 degrees of freedom. The procedure in EViews
is that after estimating the equation, view residual tests, then select white
heteroskedasticity. The result will give the test statistic and the probability that the statistic
exceeds (in absolute value) the observed value under the null hypothesis. Reject the null hypothesis that the residuals are normally distributed if the value of the probability is small, otherwise accept.

5.4.4 Ljung Box Q test for serial correlation

This Q-statistic, at lag k, is used to statistic for the null hypothesis that there is no autocorrelation up to order k. The Q-statistic is asymptotically distributed with degrees of freedom equal to the number of autocorrelations when the series is not based upon the results of autoregressive integrated moving average estimation (ARIMA). The purpose of this test is that if the series represents the residuals from ARIMA estimation, we adjust the appropriate degrees of freedom to represent the number of autocorrelations less the number of autoregressive (AR) and moving average (MA) terms previously estimated. The statistic is used to test whether the series is white noise, and we chose the order of lag to use for the test taking into consideration that too small lags make the test not detect serial correlation at high-order lags, yet too large lags reduce the power of the as the significant correlation at one lag could be diluted by insignificant correlations at other lags. We used 16 lags which is about half of the observations. If there is no serial correlation in the residuals, the autocorrelations and partial autocorrelations at all lags should be nearly zero, and all Q-statistics should be insignificant with large p-values.

Based on the methods and procedures presented above, the findings and their discussion are presented in the next chapter.
Chapter Six

ANALYSIS, DISCUSSION AND INTERPRETATION OF RESULTS

In this chapter, the findings on the linkages between indicators for production sector output, government spending and human development using a model of endogenous dynamic growth are presented. Presented are the characteristics of the data particularly the stationary variable properties, the order of integration, and cointegration. The parameter coefficients of the vector error correction mechanism (VECM) model also presented separately for the estimated short and long-term impacts of the variables. Evidence of conformity of the model with the conditions for classical regression analysis is presented to prove minimisation of misspecification, heteroskedasticity, the functional distribution of the series, and serial correlation. There is evidence that the model is statistically sound for use in explaining the linkages under investigation, and provides forecasts over a period of 10 years using standard deviation and variance decompositions.

6.1 Verification of Key Assumptions

6.1.1 Stationarity of Time Series

The results of unit root tests conducted on the variables in the model are provided in table 6.1. Gross secondary enrolment, labour employed in agriculture, literacy rate, under-five mortality ratio, electricity sold in Uganda, agriculture output and industrial output were found to have stationary roots at levels of significance ranging from one to ten per cent. In order to make the rest of the variables stationary differencing was done on gross domestic product, agriculture expenditure, expenditure on education, exchange rates, fertilizer, public expenditure on health, interest rates, public expenditure on transport and communication, and service sector income.
Table 6.1: ADF Unit Root Test on Variables (one lag)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Test Statistic at Level</th>
<th>First Difference</th>
<th>Integration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No Intercept</td>
<td>Intercept</td>
<td>Trend and Intercept</td>
</tr>
<tr>
<td>LNGDP</td>
<td>0.954038</td>
<td>-1.003732</td>
<td>-3.066558</td>
</tr>
<tr>
<td>LNAX</td>
<td>0.341907</td>
<td>-1.140042</td>
<td>-1.256973</td>
</tr>
<tr>
<td>LNEDX</td>
<td>0.838714</td>
<td>-0.764802</td>
<td>-3.188852</td>
</tr>
<tr>
<td>LNER</td>
<td>0.883488</td>
<td>-1.469055</td>
<td>-2.795025</td>
</tr>
<tr>
<td>LNGSE</td>
<td>3.713308</td>
<td>0.179566</td>
<td>-5.891409***</td>
</tr>
<tr>
<td>LNHX</td>
<td>0.958533</td>
<td>-0.328034</td>
<td>-2.768577</td>
</tr>
<tr>
<td>LNIR</td>
<td>0.343720</td>
<td>-1.879281</td>
<td>-1.497736</td>
</tr>
<tr>
<td>LNLGA</td>
<td>7.189370</td>
<td>-0.437026</td>
<td>-5.244233***</td>
</tr>
<tr>
<td>LNLI</td>
<td>3.777482</td>
<td>-1.706996</td>
<td>-3.834058**</td>
</tr>
<tr>
<td>LNIRX</td>
<td>1.236906</td>
<td>-0.807738</td>
<td>-2.728971</td>
</tr>
<tr>
<td>LNU5MR</td>
<td>-4.927110**</td>
<td>-0.421494</td>
<td>-3.929333***</td>
</tr>
<tr>
<td>LNEL</td>
<td>1.079898</td>
<td>-0.319866</td>
<td>-3.452056*</td>
</tr>
<tr>
<td>LNYA</td>
<td>0.215161</td>
<td>-2.790883*</td>
<td>-3.166283</td>
</tr>
<tr>
<td>LNYI</td>
<td>1.278452</td>
<td>-0.470215</td>
<td>-3.316068*</td>
</tr>
<tr>
<td>LNYS</td>
<td>1.852430</td>
<td>-0.621294</td>
<td>-2.449443</td>
</tr>
</tbody>
</table>

---

1 LN = \log ( ) = \text{natural log ( )}

2 "*", "**", and "***" refer to 10%, 5% and 1% level of significance respectively, comparing critical t-statistics as computed by MacKinnon. These results were obtained using EViews 3.1 software.
For variables that are differenced, the letter D is used in the variable syntax, such as in D(LNYA) to refer to the first difference of LNYA. Where variables such as D(LNYA,2) are used, the numeral 2 after the variable in brackets refers to the second order difference of LNYA. So D(LNYA) refers to the change in LNYA which also refers to the output growth in agriculture, while D(LNYA, 2) refers to the change in D(LNYA) which is a form of acceleration in the rate of change. Where the symbol delta (Δ) is used in place of D, a restatement would be as follows: First difference, that is, D(LNYA) is Δ(LNYA), and Second order difference is D(LNYA,2) is presented as Δ Δ (LNYA) or Δ²(LNYA).

For purposes of presenting the variables in the form used and matching the syntax language of EViews programme letter D is used instead of delta in the analysis as well as presentation of results. The interpretation adopted for the first order difference is the absolute growth in the values (and not the growth rate), while the second order difference means the absolute acceleration in the values of the variables.

In each of sectors, the main focus is on assessing the impact of public input variables (economic policy represented by exchange rates and interest rates; and social sector resources allocated) and human development (represented by literacy and mortality) on the sector output and vice versa. Considering sector output and the determinant factors above, short-term relationships are expressed in error correction form to show that the cointegrated model is also dynamic. Significant parameter estimates of the VECM for Uganda’s output at sector level help to identify the important areas for the respective sectors, and give indication of whether expenditure in social sector is important for the production sector in Uganda based on available information.
6.1.2 Results of Co-integration Tests and Cointegrating Relationships

6.1.2.1 Agriculture Sector

Results for the Johansen Cointegration Test indicate that it is possible to form stationary linear combinations of the stationary variables. The series used in the test were: the difference of agriculture output, labour employed in agriculture, under 5 mortality ratios, literacy rate, the difference in public expenditure on roads and transport, and the difference of fertilizer used. The series were converted to their natural logarithms before differencing. The test assumption was that a linear deterministic trend existed in the data. 30 of the 33 observations were included with the 1 to 1 lag interval, while 29 were included with the 1 to 2 lag interval. Following the normalization of coefficients for two cointegrating equations, the log likelihood value was 231.0908, but this value increases to 316.5818 when the lags were changed from 1 to 1, to 1 to 2 lags interval and three cointegrating equations.

Table 6.2: Johansen Cointegrating Test

a) Lags interval: 1 to 1 (30 observations)

<table>
<thead>
<tr>
<th>Series: ΔLNYA, LNLA, LNU5MR, LNLI, ΔLNRX, ΔLNF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eigen value</td>
</tr>
<tr>
<td>-------------</td>
</tr>
<tr>
<td>0.831499</td>
</tr>
<tr>
<td>0.677855</td>
</tr>
<tr>
<td>0.375990</td>
</tr>
<tr>
<td>0.367974</td>
</tr>
<tr>
<td>0.198436</td>
</tr>
<tr>
<td>0.027903</td>
</tr>
</tbody>
</table>

Notes: *(**) denotes rejection of the hypothesis at 5%(1%) significance level
L.R. test indicates 2 cointegrating equation(s) at 5% significance level
Log likelihood 231.0908
b) Lags interval: 1 to 2 (29 observations)

<table>
<thead>
<tr>
<th>Eigen value</th>
<th>Likelihood Ratio</th>
<th>5 Percent Critical Value</th>
<th>1 Percent Critical Value</th>
<th>Hypothesized No. of CE(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.893415</td>
<td>155.5228</td>
<td>94.15</td>
<td>103.18</td>
<td>None **</td>
</tr>
<tr>
<td>0.712205</td>
<td>90.59715</td>
<td>68.52</td>
<td>76.07</td>
<td>At most 1 **</td>
</tr>
<tr>
<td>0.677566</td>
<td>54.47745</td>
<td>47.21</td>
<td>54.46</td>
<td>At most 2 **</td>
</tr>
<tr>
<td>0.408306</td>
<td>21.65361</td>
<td>29.68</td>
<td>35.65</td>
<td>At most 3</td>
</tr>
<tr>
<td>0.159669</td>
<td>6.435390</td>
<td>15.41</td>
<td>20.04</td>
<td>At most 4</td>
</tr>
<tr>
<td>0.046819</td>
<td>1.390566</td>
<td>3.76</td>
<td>6.65</td>
<td>At most 5</td>
</tr>
</tbody>
</table>

Notes: *(**) denotes rejection of the hypothesis at 5%(1%) significance level

L.R. test indicates 3 cointegrating equation(s) at 5% significance level

Log likelihood 316.5818

The variables for each sector (agriculture, industry and services) are tested together.

For agriculture sector, a lag length of 1 to 1 is selected to make sure the estimation period, which determined the number of observations, did not change so much to lose degrees of freedom. In each case, an indication that there was one integrating equation as indicated in table 6.2 is got. Following the determination of the number of cointegrating equations, the hypothesized relationship was estimated and the results as presented in Appendix 3 were not significant, but were re-estimated as shown in section 6.2.

**Figure 6.1: Actual, Fitted and Residual of Agriculture Relationship**
The results for the model are presented section 6.2. Pair wise Granger causality tests on the series indicate that all the regressors actually determine the regressed series.

### 6.1.2.2 Industrial Sector

In the industry sector, the Johansen cointegration test indicates that there are 2 cointegrating equations at 5% significance level. Like Agriculture, we set the lag interval at 1 to 1, and the observations included are 30. The likelihood ratio of 42.58 is less than the critical values of 47.21 at 5% and 54.46 at 1% on the third round, and therefore the null is accepted indicating that there are two cointegrating equations as seen in table 6.3.

<table>
<thead>
<tr>
<th>Eigen value</th>
<th>Likelihood Ratio</th>
<th>5 Percent Critical Value</th>
<th>1 Percent Critical Value</th>
<th>Hypothesized No. of CE(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.749363</td>
<td>115.3154</td>
<td>94.15</td>
<td>103.18</td>
<td>None **</td>
</tr>
<tr>
<td>0.646862</td>
<td>73.80293</td>
<td>68.52</td>
<td>76.07</td>
<td>At most 1 *</td>
</tr>
<tr>
<td>0.552192</td>
<td>42.57606</td>
<td>47.21</td>
<td>54.46</td>
<td>At most 2</td>
</tr>
<tr>
<td>0.281078</td>
<td>18.47433</td>
<td>29.68</td>
<td>35.65</td>
<td>At most 3</td>
</tr>
<tr>
<td>0.244307</td>
<td>8.574249</td>
<td>15.41</td>
<td>20.04</td>
<td>At most 4</td>
</tr>
<tr>
<td>0.005673</td>
<td>0.170666</td>
<td>3.76</td>
<td>6.65</td>
<td>At most 5</td>
</tr>
</tbody>
</table>

**Notes:** **(*)** denotes rejection of the hypothesis at 5%(1%) significance level. L.R. test indicates 2 cointegrating equation(s) at 5% significance level

Unit root tests on the industry model residuals generated ADF Test Statistic of -3.693757, which showed that the series are actually stationary and purely white noise, as can be seen in figure 6.2.
Therefore the model of the long run relationship is based on the parameter coefficients estimated given in the Appendix 4. Most of these coefficients were not statistically significant and the re-estimates presented in section 6.2 below were on that basis.

### 6.1.2.3 Services Sector

The services sector has two cointegrating equations according to the Johansen cointegration test. There is therefore long-run relationship between services sector output and the regressors, namely; interest rates, adult literacy, real exchange rates, and public expenditures in health, education and transport and communications, as shown in table 6.4.
Table 6.4: Johansen Cointegration test and Number of Cointegrating Equations

Included observations: 30

Test assumption: Linear deterministic trend in the data
Series: ΔLNYS,ΔLNIR, LNLI,ΔLNER,ΔLNHX,ΔNEDX,ΔNRX
Lags interval: 1 to 1

<table>
<thead>
<tr>
<th>Eigen value</th>
<th>Likelihood Ratio</th>
<th>5 Percent Critical Value</th>
<th>1 Percent Critical Value</th>
<th>Hypothesized No. of CE(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.926072</td>
<td>194.6631</td>
<td>124.24</td>
<td>133.57</td>
<td>None **</td>
</tr>
<tr>
<td>0.753475</td>
<td>116.5232</td>
<td>94.15</td>
<td>103.18</td>
<td>At most 1 **</td>
</tr>
<tr>
<td>0.670883</td>
<td>74.51447</td>
<td>68.52</td>
<td>76.07</td>
<td>At most 2 *</td>
</tr>
</tbody>
</table>

[Cut..]

Notes: *(***) denotes rejection of the hypothesis at 5%(1%) significance level
L.R. test indicates 3 cointegrating equation(s) at 5% significance level

Therefore based on the integration levels in table 6.4, we estimated a long-term relationship details are in Appendix 5. Figure 6.3 presents the graph of the trends of the actual, fitted and the residuals of the services.

Figure 6.3: Actual, Fitted and Residual of Service Cointegrating Relationship
6.1.2.4 Multi-sector

In a similar manner to the respective sectors, we assume a linear deterministic trend in the data, and use 1 to 1 Lags interval. The test could not allow 1 to 2 lags intervals because of the limited number of observations for the variables. All variables for the sectoral output models are all included in the Multisector model, that is; LNYA, LNYI, ΔLNYS, LNLI, LNU5MR, ΔLNEDX, ΔLNAX, ΔLNHX and ΔLNRX which bring together sector output growth (LNYA, LNYI and ΔLNYS), human development (LNLI and LNU5MR), and public resources allocation (ΔLNEDX, ΔLNAX, ΔLNHX and ΔLNRX). Table 6.5 shows the results of Johansen’s cointegration test results on the number of cointegrating equations. There are three cointegrating equations at 1% significance level and four equations at 5% significance level.

Table 6.5: Results of Johansen’s Cointegration Test All Sectors

<table>
<thead>
<tr>
<th>Eigen value</th>
<th>Likelihood Ratio</th>
<th>5 Percent Critical Value</th>
<th>1 Percent Critical Value</th>
<th>Hypothesized No. of CE(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.936413</td>
<td>284.5352</td>
<td>192.89</td>
<td>205.95</td>
<td>None **</td>
</tr>
<tr>
<td>0.868025</td>
<td>201.8746</td>
<td>156.00</td>
<td>168.36</td>
<td>At most 1 **</td>
</tr>
<tr>
<td>0.752916</td>
<td>141.1203</td>
<td>124.24</td>
<td>133.57</td>
<td>At most 2 **</td>
</tr>
<tr>
<td>0.679461</td>
<td>99.17941</td>
<td>94.15</td>
<td>103.18</td>
<td>At most 3 *</td>
</tr>
<tr>
<td>0.552409</td>
<td>65.04692</td>
<td>68.52</td>
<td>76.07</td>
<td>At most 4</td>
</tr>
</tbody>
</table>

Notes: **(*) denotes rejection of the hypothesis at 5%(1%) significance level
L.R. test indicates 4 cointegrating equation(s) at 5% significance level

6.2 Analysis of Short and Long-term Relationships

The objectives of the study are assessed in this section. Our main interest is to find out whether Sector Output Growth, Government Spending and Human Development are related in a Dynamic Growth Model; and whether the short-run and long-run inter-sectoral linkages existing between production sector output growth and
expenditures in education and health, can be analysed using the data for Uganda. This is what the section presents. In contrast with most of the studies reviewed, where analysis is done at aggregate level, this study analyses the economic growth at sectoral level.

6.2.1 Establishment and Interpretation of Long-term Relationships

As already established, that there are cointegrated relationships for the three sector outputs and their proposed regressors, and there is need to adjust the models for better specification. The models are now analysed to separate the long term from short run parameters using the vector error correction mechanism. In estimating the VAR-VEC, it is considered that the series do not have deterministic trends but the cointegrating equations have intercepts. Thus the sector models for agriculture output (YA), industry sector output (YI) and services output (YS) as presented above called for re-specification to generate better coefficients, and including single lags, to get a better understanding of both the short run and long term relationships. Diagnostic tests for heteroskedasticity, serial correlation and normality follow in the section 6.2.2 that follows.

Agriculture: On specifying the long-term model for agriculture, the data fits well in a ML-ARCH model, with ARCH (1) and GARCH (1), component arch, and the standard deviation is included as the ARCH–M term. Further we select the heteroskedasticity consistent covariance, and Marquardt optimization algorithm. The starting coefficient values are those of the OLS/TSLS in an iterative process of 100 maximum iterations and convergence of 0.001. The results obtained following the
above procedure are presented in table 6.6. There are no more specification errors as seen from the specification parameters.

Table 6.6: Results of the Cointegrating Relationship of Agriculture Model

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>z-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>SQR(GARCH)</td>
<td>2.277654</td>
<td>0.338356</td>
<td>6.731532</td>
<td>0.0000</td>
</tr>
<tr>
<td>ΔLNRX</td>
<td>0.120831</td>
<td>0.014611</td>
<td>8.269879</td>
<td>0.0000</td>
</tr>
<tr>
<td>ΔLNAX</td>
<td>0.168910</td>
<td>0.023888</td>
<td>7.070835</td>
<td>0.0000</td>
</tr>
<tr>
<td>LNYA(-1)</td>
<td>0.944291</td>
<td>0.010847</td>
<td>87.05266</td>
<td>0.0000</td>
</tr>
<tr>
<td>LNU5MR</td>
<td>0.166038</td>
<td>0.041830</td>
<td>3.969370</td>
<td>0.0001</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.822158</td>
<td>Mean dependent var</td>
<td>21.40182</td>
<td></td>
</tr>
<tr>
<td>Adjusted R-squared</td>
<td>0.749404</td>
<td>S.D. dependent var</td>
<td>0.358946</td>
<td></td>
</tr>
<tr>
<td>S.E. of regression</td>
<td>0.179687</td>
<td>Akaike info criterion</td>
<td>-0.702565</td>
<td></td>
</tr>
<tr>
<td>Sum squared resid</td>
<td>0.710320</td>
<td>Schwarz criterion</td>
<td>-0.244523</td>
<td></td>
</tr>
<tr>
<td>Log likelihood</td>
<td>21.24104</td>
<td>F-statistic</td>
<td>11.30057</td>
<td></td>
</tr>
<tr>
<td>Durbin-Watson stat</td>
<td>1.708468</td>
<td>Prob(F-statistic)</td>
<td>0.000002</td>
<td></td>
</tr>
</tbody>
</table>

These results indicate that current agriculture output in the country is dependent on the current level of human development (U5MR). The effect of a one unit change in underfive mortality on current agriculture output is a rise to the power of 1.18. At the same time, 2.6 is the power to which the one year lagged agriculture output will be raised to get its effect of a unit change in current agriculture output. The effect on current agriculture output from a unit change in the differences of roads and agriculture expenditures will be a rise in these factors to the power of 1.12 and 1.18 respectively.

These findings thus suggest that changes in human development will lead to growth effects on agriculture output. Further, lagged values of the sector output, and the changes in expenditure on road and communication as well as changes in expenditure on agriculture itself affect positively agriculture output. This is not conclusive about
influencing output growth, but is further analyzed by examining the nature of adjustment over the longrun in section 6.2.3.

Whereas it is evident that agriculture output is positively related with change in public expenditures on roads and on agriculture, this does not necessarily mean that, that changing the budget for agriculture by increasing the growth rate of agriculture expenditure will lead to growth in the agriculture output. It is however important to interpret the sign of underfive mortality with care. We could explain this by looking at the speed of reduction in mortality rate if increasing then this would correspond to higher output growth in agriculture. This indicated that the faster we improve the quality of human capital the better for agriculture output. Another explanation for the relationship between mortality and output growth as provided by Brenner (2005) is that rapid economic growth is occasionally associated with increased mortality rates estimated in annual changes. Brener (2005) indicated that the volatility of rapid economic growth as it departs from its major trend, had a very short-term effect to increase mortality and explained this as resulting from the adaptation to new technology and the adjustment of the formerly unemployed to new jobs, social status and organisational structures.

**Industry:** Industry sector equation is re-estimated as EGARCH model and the coefficient details are provided in table 6.7. The results indicate a trend model with no specification errors. Current industrial output is dependent on changes in: interest rates, agriculture output, life expectancy, exchange rates as well as lagged values of exchange rates. It is also dependent on the lagged values of: its own output, electricity sold in the country, lagged values of education expenditure, as well as lagged values of agriculture output. It is observed that a one-unit change in the growth
of agriculture output has the potential to raise the output of industry sector by the power of 3.5. This power is 1.3 for one year lagged value of agriculture output. This is derived by converting the coefficient value from logarithms by taking their exponential values. This is true given that Uganda’s Food processing alone accounts for 40 percent of total manufacturing (Republic of Uganda, 2010a).

Improvement in life expectancy showed a positive effect on industrial output and this is because of the effect of life expectancy on industrial labour. Increasing the change in life expectancy by one year has the potential to raise industrial output up to the power of 7.2. If life expectancy is high, then the ability of industries to retain skilled labour is high. Life expectancy is associated also with a positive economic environment that is positive to the attraction of foreign direct investment into the country.

**Table 6.7: Results of the Cointegrating Relationship for Industry Model**

The Dependent Variable is LNYI; Method: ML – ARCH; Sample (adjusted): 1977 2007; Included 31 observations after adjusting endpoints; Convergence achieved after 86 iterations; and Bollerslev-Wooldrige robust standard errors & covariance.

<table>
<thead>
<tr>
<th>Regressors</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>z-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ΔLNIR</td>
<td>0.197641</td>
<td>0.013978</td>
<td>14.13931</td>
<td>0.0000</td>
</tr>
<tr>
<td>ΔLNYA</td>
<td>1.258198</td>
<td>0.014857</td>
<td>84.68914</td>
<td>0.0000</td>
</tr>
<tr>
<td>LNYI(-1)</td>
<td>0.509332</td>
<td>0.023343</td>
<td>21.81969</td>
<td>0.0000</td>
</tr>
<tr>
<td>ΔLNLIFEEXP</td>
<td>1.971515</td>
<td>0.271439</td>
<td>7.263193</td>
<td>0.0000</td>
</tr>
<tr>
<td>LNEL</td>
<td>0.078715</td>
<td>0.035617</td>
<td>2.210027</td>
<td>0.0271</td>
</tr>
<tr>
<td>LNEDX(-1)</td>
<td>0.093645</td>
<td>0.020210</td>
<td>4.633668</td>
<td>0.0000</td>
</tr>
<tr>
<td>ΔLNER</td>
<td>0.070821</td>
<td>0.020620</td>
<td>3.434660</td>
<td>0.0006</td>
</tr>
<tr>
<td>LNYA(-1)</td>
<td>0.259692</td>
<td>0.028756</td>
<td>9.030878</td>
<td>0.0000</td>
</tr>
<tr>
<td>ΔLNER(-1)</td>
<td>0.730492</td>
<td>0.022413</td>
<td>32.59180</td>
<td>0.0000</td>
</tr>
<tr>
<td>C</td>
<td>1.584692</td>
<td>0.354271</td>
<td>4.473105</td>
<td>0.0000</td>
</tr>
<tr>
<td>ΔTREND</td>
<td>0.031041</td>
<td>0.002726</td>
<td>11.38893</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

R-squared: 0.974309 Mean dependent var: 20.14663
Adjusted R-squared: 0.951829 S.D. dependent var: 1.042343
S.E. of regression: 0.228772 Akaike info criterion: -0.703198
Sum squared resid: 0.837385 Schwarz criterion: -0.009333
Log likelihood: 25.89957 F-statistic: 43.34169
Durbin-Watson stat: 1.940880 Prob(F-statistic): 0.000000
Lagged industrial output showed positive effect on current industrial sector output to the power of 1.7, and the power of a unit change in education expenditure is 1.1. The unit changes in current and one-year lagged exchange rates are 1.1 and 2.1 respectively, indicating that the effect of the latter is double the effect of the former.

**Services:** Services Sector output is estimated with the output growth ($\Delta LNYS$) as the dependent variable. The model is estimated as EGARCH with the estimated equation being a maximum likelihood – ARCH function with the sample adjusted to 1976-2007. Convergence was achieved after 57 iterations and Bollerslev - Wooldrige robust standard errors and covariance is generated. The results in table 6.8 are heteroskedasticity consistent, and its estimation followed the Marquardt optimization algorithm. The results in table 6.8 show that other than changes in the exchange rates and the constant, changes in other factors, namely interest rates, literacy rates, public expenditure on education and expenditure on roads and communications lead to a positive relationship beyond the power of 1.0 in services sector output growth.

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>z-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>GARCH</td>
<td>9.954515</td>
<td>2.662467</td>
<td>3.738831</td>
<td>0.0002</td>
</tr>
<tr>
<td>D(LNIR)</td>
<td>0.080323</td>
<td>0.025647</td>
<td>3.131909</td>
<td>0.0017</td>
</tr>
<tr>
<td>D(LNL)</td>
<td>2.266242</td>
<td>0.192004</td>
<td>11.80308</td>
<td>0.0000</td>
</tr>
<tr>
<td>D(LNER)</td>
<td>-0.376656</td>
<td>0.056721</td>
<td>-6.640509</td>
<td>0.0000</td>
</tr>
<tr>
<td>D(LNEDX)</td>
<td>0.225403</td>
<td>0.025208</td>
<td>8.941626</td>
<td>0.0000</td>
</tr>
<tr>
<td>D(LNRX)</td>
<td>0.180137</td>
<td>0.022646</td>
<td>7.954449</td>
<td>0.0000</td>
</tr>
<tr>
<td>C</td>
<td>-0.115187</td>
<td>0.014387</td>
<td>-8.006269</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

R-squared       | 0.812381    | Mean dependent var | 0.078859 |
Adjusted R-squared | 0.723038 | S.D. dependent var | 0.253581 |
S.E. of regression | 0.133452 | Akaike info criterion | -1.220962 |
Sum squared resid | 0.374001 | Schwarz criterion | -0.717115 |
Log likelihood   | 30.53539    | F-statistic       | 9.092869  |
Durbin-Watson stat | 1.919170 | Prob(F-statistic) | 0.000013 |
Therefore, changes in services sector output growth are dependent on changes in rate of change of interest rates, the rate of change in exchange rates, the rates of growth of expenditures in education and roads and communication. A unit change in the current literacy rate has the effect to the power of 9.6 on the growth of services sector output. This indicates how services sector output growth is positively related to human development given the positive relationship found with change in literacy variable. Regarding macroeconomic stability, a unit increase in exchange rate (depreciation) has a negative effect on the growth of services sector output which reduces growth to the power of 0.7. Concerning the relationship between sector output growth and human development, education expenditure is significant but it serves also for the effect of public spending. A unit change in the growth of education expenditure translates into a rise in the growth of services sector output growth to the power of 1.3.

**Cross-sectoral linkages:** Using maximum likelihood estimation (ML – ARCH), the long run cointegration relationship of Multisector model is estimated. Table 6.9 presents details of the results. The dependent variable is agriculture output, and including lagged variables up to three years, convergence is achieved after 66 iterations.

<table>
<thead>
<tr>
<th>Table 6.9: Multisector Equation Coefficient Estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Independent Variable:</strong> LNYA</td>
</tr>
<tr>
<td><strong>Regressor</strong></td>
</tr>
<tr>
<td>LNYI</td>
</tr>
<tr>
<td>ΔLNEDX</td>
</tr>
<tr>
<td>ΔLNHX(-2)</td>
</tr>
<tr>
<td>ΔLNRX(-3)</td>
</tr>
<tr>
<td>LNYA(-1)</td>
</tr>
<tr>
<td>ΔLNHI(-1)</td>
</tr>
<tr>
<td>ΔLNYS(-1)</td>
</tr>
<tr>
<td>LNI(-1)</td>
</tr>
<tr>
<td>LNU5MR(-1)</td>
</tr>
<tr>
<td>ΔLNAX(-2)</td>
</tr>
</tbody>
</table>

**R-squared:** 0.941604
**Adjusted R-squared:** 0.897807
**S.E. of regression:** 0.120303
**Sum squared resid:** 0.231565
**Log likelihood:** 36.97776
**Durbin-Watson stat:** 2.065002

**Mean dependent var:** 21.40515
**S.D. dependent var:** 0.376328
**Akaike info criterion:** -1.653638
**Schwarz criterion:** -1.040713
**F-statistic:** 21.49932
**Prob(F-statistic):** 0.000000

**Note:** Bollerslev-Wooldrige robust standard errors & covariance
Most important in this relationship is the relationship between the growth rates between agriculture, industry and services. By taking anti-logarithms of the values, it shows that current industrial output and its lagged growth values lead to changes in agriculture output to the power of 1.40 and 0.81 respectively. This means that when the factors are increased, the returns in form of changes in agriculture output is 40 percent higher than the change in current industrial output, while as a result of the lagged values it is less by 19 percent.

These model results indicate that agriculture output is dependent on: industrial output and industrial output growth; the rate of growth in lagged values of services sector output. This relationship is consistent Kaldor’s first law on economic transformation (Kaldor, 1966) explored in section 2.3, and particularly equation 2.43. Factors of public expenditure important in this relationship are; rate of growth in current education expenditure, rate of growth in health expenditures lagged over two years, rate of growth in expenditure in roads and communication lagged over three years, and rate of growth in expenditure on agriculture lagged over two years. Other factors important in this relationship are changes in growth of education expenditure, and rates of growth in lagged values of: health expenditure, and roads expenditure. Expenditures in education and health contribute to human development. The other significant factor of human development in the model is the improvement in under-five mortality lagged over one year. The model also includes lagged values of industrial as well as agriculture output. These findings are comparable with the findings of Akram (2008) that health indicators have a long run impact on economic growth; and further suggesting that impact of health is only a long run phenomenon and in the short-run there is no significant relationship exists between health variables and economic growth.
In the last section, the long run relationship re-estimated from the error correction mechanism is presented, comparing the coefficients. The study emphasizes the fact that estimation of the equations of sector output, without linking it with other sector outputs is important in the sense that it analyses vertical linkage as opposed to horizontal cross-sector linkage. The Multisector relationship analyses the horizontal linkages.

6.2.2 Diagnostic Checks on the Long Run Relationships

For the ECM models of the three production sectors, results of diagnostic tests undertaken on the conditions for classical regression analysis. Particularly, the results for heteroskedasticity, serial correlation, and normality are presented in the sub-sections following.

6.2.2.1 Heteroskedasticity

The Lagrange Multiplier (ARCH LM) test demonstrates that there is no autoregressive conditional heteroskedasticity in the residuals, \( \mu_t \). The test on the models of agriculture, services, and industry generated Obs*R-squared statistics as shown in table 6.10(a) and were not significant. The F-statistics estimated from the model are shown in table 6.10(b) and were all not significant hence indicating that there was no joint significance of all lagged squared residuals.

<table>
<thead>
<tr>
<th>Model</th>
<th>Obs*R²</th>
<th>Probability</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>0.010846</td>
<td>0.917053</td>
<td>No more ARCH remains in residuals</td>
</tr>
<tr>
<td>Industry</td>
<td>0.218842</td>
<td>0.639924</td>
<td>No more ARCH remains in residuals</td>
</tr>
<tr>
<td>Services</td>
<td>0.243853</td>
<td>0.621437</td>
<td>No more ARCH remains in residuals</td>
</tr>
<tr>
<td>Multisector</td>
<td>0.908377</td>
<td>0.340545</td>
<td>No more ARCH remains in residuals</td>
</tr>
</tbody>
</table>
b) F-statistic

<table>
<thead>
<tr>
<th>Model</th>
<th>F-statistic</th>
<th>Probability</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>0.010150</td>
<td>0.920443</td>
<td>No joint significance of all lagged squared residuals.</td>
</tr>
<tr>
<td>Industry</td>
<td>0.205753</td>
<td>0.653613</td>
<td>No joint significance of all lagged squared residuals.</td>
</tr>
<tr>
<td>Services</td>
<td>0.229929</td>
<td>0.635173</td>
<td>No joint significance of all lagged squared residuals.</td>
</tr>
<tr>
<td>Multisector</td>
<td>0.871775</td>
<td>0.359055</td>
<td>No joint significance of all lagged squared residuals.</td>
</tr>
</tbody>
</table>

Therefore, no series are related to the recent residuals, and the efficiency of the models estimated is not compromised. The hypothesis that there is no autoregressive conditional heteroskedasticity in the residuals is accepted.

6.2.2.2 Breusch-Godrey Test for Autocorrelation

Because of the fear to rely on Durbin - Watson d test of autocorrelation, the Serial Correlation LM test produced the results in table 6.11, and we conclude that there is no autocorrelation.

<table>
<thead>
<tr>
<th>Model</th>
<th>Obs*R²</th>
<th>Probability – Chi-Square (1)</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>2.657860</td>
<td>0.1030</td>
<td>No serial correlation of any order</td>
</tr>
<tr>
<td>Industry</td>
<td>0.289028</td>
<td>0.5908</td>
<td>No serial correlation of any order</td>
</tr>
<tr>
<td>Services</td>
<td>1.195359</td>
<td>0.2743</td>
<td>No serial correlation of any order</td>
</tr>
<tr>
<td>Multisector</td>
<td>0.000785</td>
<td>0.9776</td>
<td>No serial correlation of any order</td>
</tr>
</tbody>
</table>
6.2.2.3 Ljung Box Q-Statistic test for Serial Correlation

The Q-statistic at lag 16 tested for the null hypothesis that there is no autocorrelation up to order 16. The results presented in table 6.12 indicate that the autocorrelations and partial autocorrelations at all lags are nearly zero, and all Q-statistics insignificant with large p-values, as indicated in the table below. There is therefore no serial correlation in the residuals.

Table 6.12: Ljung Box Q-Statistic Serial Correlation in Estimated Models

<table>
<thead>
<tr>
<th>Model</th>
<th>Included Observations</th>
<th>Maximum lag</th>
<th>Q-statistic</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agric</td>
<td>32</td>
<td>16</td>
<td>9.0355</td>
<td>0.912</td>
</tr>
<tr>
<td>Industry</td>
<td>31</td>
<td>16</td>
<td>17.010</td>
<td>0.385</td>
</tr>
<tr>
<td>Services</td>
<td>32</td>
<td>16</td>
<td>14.735</td>
<td>0.544</td>
</tr>
<tr>
<td>Multisector</td>
<td>29</td>
<td>12</td>
<td>6.5189</td>
<td>0.888</td>
</tr>
</tbody>
</table>

6.2.2.4 Normality Tests on Residuals

Plots of the kernel density for the estimated distribution of the series indicate that there is normality in the residual series, in that there is distribution around their mean. Measuring the difference of the skewness and kurtosis of the series under the Jarque-Bera test statistic, it is indicated that for all the three sectors, none had low-test statistic values. The values of the statistic for agriculture, industry and services are respectively: 0.268141, 1.884807 and 2.310440; while the p-values were: 0.874528, 0.389690 and 0.314988. These confirm that the residual are normally distributed.

6.2.3 The Vector Error Correction Mechanism – Johansen Approach

Based on the above model proposition, we then estimate vector error correction models to separate the short-term and long-term models from the data. The ECM models equations are presented in the sub-sections that follow for each sector, and
match the presentation in appendices 2, 3 and 6. The long run relationships estimated represent the enduring inter-sectoral linkages that bind sectors together in the process of economic development, to show how sector growth in agriculture is affected by the size and state of industry and services. The coefficients in the long run relationship reflect the extent to which resource competition or technological spillovers between agriculture and the other sectors, industry and services induce lasting effects.

6.2.3.1 Agriculture Sector

Error Correction considers 1 to 1 lag intervals for the series for the changes in agriculture output growth (ΔLNYA), growth in agriculture labour (LNLA), reduction in under five mortality (LNU5MR), increase in literacy rates (LNLI), changes in expenditure on roads and communication/transport (ΔLNRX), and changes in the growth of fertilizer use (ΔLNF). The model assumes a linear trend in data and with intercept and no trend. The sample is adjusted to 1978-2007 thus including 30 observations after adjusting endpoints, and the results are presented in Appendix 10 appended. With two cointegrating equations, the adjustment coefficients of the first and second cointegrating equations in the first equation of the VEC are \( \Phi_1 = -0.213495 \) and \( \Phi_9 = 1.061670 \). Further, the adjustment coefficients of the first and second cointegrating equations in the second equation of the VEC are \( \theta_1 = -0.000513 \) and \( \theta_9 = -0.0384711 \).

The significance of the coefficients however shows that the first cointegrating equation can best be specified with the right hand side having ΔLNYA(-1), LNU5MR(-1), LNLI(-1), and ΔLNF(-1) in first cointegrating equation, and LNLA(-1), LNU5MR(-1), LNLI(-1), ΔLNRX(-1), ΑΔLN(-1) in the second long run equation. \( \Delta(LNYA \ (-1), \ 2) \) is the only significant variable for the short run dynamics. The adjustment coefficients show that whereas the first equation is negative and therefore
gives an indication of the system reverting to the equilibrium when there is a shock, the second adjustment coefficient is positive, as provided in appendix 3-5.

The second equation of the vector error correction in the agriculture sector is specified with the difference of growth in agriculture labour as the dependent variable. The model provides evidence of convergence to the steady state when there are shocks given that the two adjustment variables are negative but not significant. This equation however does not have significant adjustment coefficients and therefore the changes in agriculture labour are solely dependent on a short run effects of $\Delta \text{LNLA} (-1), \Delta \text{LNU5MR} (-1), \Delta \text{LNLI} (-1)$ and $\Delta (\text{LNF}(-1),2)$.

The results indicate that current growth in the supply of labour is increased by the level of lagged acceleration and not growth of its supply; lagged changes in the value of underfive maternal mortality; lagged changes in literacy; and lagged acceleration in fertilizer use. The one-year lag in labour growth leads to a fall in current labour supply growth. A similar relationship is observed with literacy. This means that changes in literacy in the past leads to a fall in labour supply in subsequent periods. Perhaps this may be true that literate labour has a tendency to abandon agriculture as productivity in agriculture increase. In the case of Uganda, they may tend to move to services since there is also an increase services output with increase in literacy. In regard to mortality, when there is high underfive mortality in the current year, there is a tendency to spend more on health and this may have effect on lower mortality in the subsequent year and hence lead to positive growth in agriculture output. If not lagged, mortality should lead to a decline in growth of labour supplied because of the effect on diverting resources and family labour to the provision of care.
6.2.3.2 Services Sector

In analysing short and long-term impact of regressors on services output, Error Correction considers 1 to 1 lag intervals for the series ΔLNYS, ΔLNIR, LNLI, ΔLNER, ΔLNHX, ΔLNEDX, and ΔLNRX. Further, assuming linear trend in data and with intercept but no trend, the sample is adjusted to 1978-2007 thus including 30 observations after adjusting endpoints, and the results are presented in Appendix 11. The series have three cointegrating equations, and the adjustment coefficients of the first, second and third cointegrating equations in the first equation of the VEC are $\infty_1 = -2.160584$, $\infty_{10} = 0.818120$, and $\infty_{19} = -0.086067$. The adjustment coefficients of the first, second and third cointegrating equations in the second equation of the VEC are $\varsigma_1 = 0.754694$, $\varsigma_{10} = -0.605812$ and $\varsigma_{19} = -0.249814$. For the third equation, the adjustment coefficients of the first, second and third cointegrating equations are respectively; $\mu_1 = -0.073272$, $\mu_{10} = 0.036168$ and $\mu_{19} = 0.021619$. The fitted service sector output ECM equation therefore indicates that there is reverting to equilibrium when there are shocks. In the fitted model, the level of significance tests indicate that some of the coefficients are not significant up to 25 percent.

The model shows that health and education expenditures are important variables in explaining accelerated changes in service sector output in the short run. In the long run, acceleration of service sector output changes takes on the long run values through the negative adjustment on one year lagged differences of; services output, exchange rates, and expenditures on health education, and transport and communications. The long run positive adjustment, which is on the same variables, with the exclusion of services output but with an additional variable of interest rates, is smaller in magnitude, thus explaining how eventually the system adjusts to the equilibrium in the long run.
6.2.3.3 Industrial Sector

The industry sector ECM is estimated using the series for: LNYI, LNGSE, ΔLNEDX, ΔLNIR, LNEL, and LNYA. The sample was adjusted to 1978-2007 thus including 30 observations are after adjusting endpoints. The coefficient parameters estimated for the two cointegrating equations are detailed in Appendix 12. The adjustment coefficients of the first and second cointegrating equations in the first equation of the VEC are $q_1 = -0.453897$ and $q_9 = 1.707052$. The adjustment coefficients of the first and second cointegrating equations in the second equation of the VEC are $\ell_1 = 0.079810$ and $\ell_9 =-0.150462$. The fitted industrial sector output ECM equation is therefore specified and indicates that changes in the industrial sector output growth reverts to the equilibrium in the long run. The most important variables in explaining short-term changes in industrial output based on this model are one year lagged values of: gross secondary enrolment, education expenditure and electricity supply. Gross secondary enrolment and education expenditure have a negative impact on the change in industrial output in logarithmic terms, and this means that these variables have a very small though significant effect on industrial output changes. This could be because of the long period it takes for education expenditure and enrolment in secondary education to translate into direct inputs for the industrial sector.

6.2.3.4 Multi-sector ECM model

Since great importance in the case of Uganda has been attached to transformation from agriculture, to industry, and to services and raising concern over whether these dynamics are important for increasing income of the majority of Ugandans employed in agriculture, we now analyse the sector linkages. The variables already presented above, namely agriculture output, industrial output, change in services output, literacy, under-five mortality, change in education expenditure, change in agriculture expenditure, and change in road expenditure are used in the analysis. Results indicate
that there exist econometric links between the sectors based on the vector error
correction model, with four cointegrating equations, able to explain the first four
endogenous variables in the model. 30 observations were included after adjusting
endpoints. Besides including sector outputs in the model, we included other variables
that could help in explaining the individual sector outputs.

Considering sector output and the determinant factors above, short-term relationships
were expressed in error correction form to show that the cointegrated model is also
dynamic. The adjustment coefficients for the four cointegrating equations in the first
equation are: $\varepsilon_1 = -0.373608$, $\varepsilon_{12} = 0.346743$, $\varepsilon_{23} = -0.502230$ and $\varepsilon_{34} = 0.700307$.

For the second equation they are: $\Upsilon_1 = -0.148247$, $\Upsilon_{12} = -0.011315$, $\Upsilon_{23} = -1.238883$
and $\Upsilon_{34} = 2.111821$; for the third equation they are: $\upsilon_1 = -0.661576$, $\upsilon_{12} = 0.277902$,
$\upsilon_{23} = -1.407521$ and $\upsilon_{34} = 5.969349$ while for the fourth equation they are; $\nu_1 = 0.050087$, $\nu_{12} = -0.047972$, $\nu_{23} = -0.051996$ and $\nu_{34} = -0.191821$. Appendix 13
provides details. This validates the assumption that a long run relationship exists
where a long run value of the dependent variable exists based on the information of
the dependent variables. In addition, a short run movement from the equilibrium
whenever it happens in the three sectors, such disequilibrium is captured in the
equilibrium error (error term), the adjustment coefficients. The short-term behaviour
and the long run value are tied together by the error terms. Therefore, reconciling the
short-term behaviour with its long run behaviour is possible through the error
correction mechanism.

Based on the significance of the parameter estimates of the ECM for Uganda’s output
in the multisector model, the three sectors are linked and thus identifying the
important areas for the respective sectors. Further, there is evidence to support the
importance of social sector expenditure to the production sector in Uganda. However,
the fourth adjustment coefficient was not significant. The model indicates that the linkage between agriculture, industry and services sectors has a long-term explanation and is less explained by short-run variations. Using agriculture sector, we link it with the rest of the sectors by the magnitude of the long run adjustment coefficients in the following manner. 37.4 percent of the adjustment in current agriculture output is explained by the value of one year lagged output growth in the same sector, 34.7 percent by the value of one year lagged output growth in industrial sector, and 50.2 percent by the change in the value of one year lagged output growth acceleration in the services sector. The second difference of one year lagged values of education expenditure was the only short-term explanatory variable significant in the model, with a small effect on agriculture output changes.

These findings on the significance of the indicators of human development are similar to findings in Pakistan by Naeem, et al., (2008) who determined the relationship between health and economic growth by investigating the impacts of different health indicators on economic growth using similar analytical methods. Their findings indicated that (i) per capita GDP is positively influenced by health indicators in the long run and health indicators cause per capita GDP. In the short run the health indicators fail to put significant impact on per capita GDP; (ii) health indicators have a long run impact on economic growth; and (iii) the impact of health is only a long run phenomenon and in the short run, there is no significant relationship exists between health variables and economic growth. However, note that while in Pakistan it was aggregate GDP used, the Ugandan case has used sector level output.

Concerning the importance of public expenditure, the findings are similar to those obtained by Alam and Sultana (2010) who examined the long run relationship
between social expenditures and economic growth in Asian developing countries. Note that their work only differs from this one by conducting a panel cointegration analysis of the sample countries. Particularly, the long run impact of expenditures in social sector such as education health and social security or welfare along with fiscal deficit or surplus on economic growth in a case study of ten countries including Bangladesh, India, Indonesia, Korea, Malaysia, Pakistan, Philippine, Singapore, Sri Lanka, and Thailand was analysed. They concluded that there existed long run dynamic relationship among expenditures on education, health and social security welfare along with fiscal deficit or surplus on economic growth for all cases of sample countries. Expenditures in the social sector thus could affect economic growth. Social expenditures were found to enhance productivity by providing infrastructure, education, health and harmonizing private and social interests. As a policy recommendation, they called for the promotion of faster economic growth by influencing expenditure composition, particularly sustainable fiscal adjustment made by reducing unproductive expenditures while protecting expenditures in social sector.

6.3 Discussion of Results: Inter-Sectoral Links between Economic Growth, Human Development and public Spending

The analysis in each of three sectors, has focused on finding evidence that there exist links between allocated social sector resources (allocated in health, education, agriculture, and transport and communication) with human development on one hand. On the other hand similar links exist between the changing state of human development (as represented by under-five mortality ratio and adult literacy) and output growth (in agriculture, industry and services sector). Using granger causality tests, evidence has been found to show direction of causality that underpins sector
output growth, with emphasis on the role of human development and public resource allocation. Interpreting the coefficients of the ECM is not necessary when most of the variables enter the model in different form (Chiekweiro, 2007), and accordingly where interpretation is provided in this section necessary care is taken on the form of the variables.

6.3.1 Agriculture Sector

There is dual causality between agriculture output growth and all its regressors except fertilizers, whose null hypothesis that a change in the growth of agriculture output does not granger-cause a change in the growth of fertilizer applications is accepted as we see in Appendix 14. This may be because there are few farmers in Uganda who actually use fertilizer. Yet we know that fertilizer use would increase agriculture output and sector growth. The hypotheses that reduction in child mortality ratio and improvement in adult literacy do not cause changes in the growth of agriculture output are rejected. Therefore, human development causes growth in agriculture output. This is inline with the existing theory, where the quality of human capital in agriculture is a major factor in increasing output in the sector. Good health of the labourers means that they can devote maximum hours to production since Uganda’s agriculture is still labour intensive. Another important aspect of these causality tests is the fact that changes in the growth of public expenditure on transport and communication are a cause of and also are caused by changes in agriculture output growth. Increased expenditure on roads helps to maintain the status of motorability of the roads as well as opening of new access routes in high potential agriculture areas. Roads especially feeder roads
increase accessibility of farming communities to markets and hence reduce the costs of marketing as well as cost of inputs.

By rejecting the hypothesis that under-five mortality does not granger-cause agriculture output is a finding that is supports the need to prioritize the reduction of infant and child mortality, and improving the quality of human capital in general as a precondition for increased incomes from agriculture. This concurs with the 2007/08 Human Development Report for Uganda (UNDP, 2008) which indicated that of the components of the HDI, only income and gross enrolment are responsive to short-term policy changes. The report called for the need to examine changes in the human development index over time; monitoring the effect of child mortality on income is an important element of the short-term policy issues.

Human development is essential for human capital development. Therefore, the finding of human development indicators leading to increased agriculture output growth is in line with previous findings on the link between human capital and economic growth. Such studies include Lucas (1988), Romer (1990), Barrow (1991), Agiomirgianakis, et al., (2002), Narayan and Smyth (2004), and Akram, et al., (2008) as already explained in the literature.

6.3.2 Services Sector

The series of regressors for services sector also show dual causality except for exchange rate, health expenditure, and education expenditure. The null hypotheses that changes in service sector output growth does not granger-cause changes in exchange rates fluctuations; that changes in growth of health expenditure does not
granger-cause changes in service sector output growth; and that changes in growth of education expenditure does not granger-cause changes in service sector output growth are accepted. Details of the findings are in appendix 15. As services sector takes over the lead in the size of Uganda’s output, changes in growth of adult literacy rate stands out to be a cause of changes in growth of service sector output. Considering that Barro (1991) in examining the role of human development on economic growth from cross country evidence found that while primary and secondary enrolment rates had a positive growth effect, that was not always true for adult literacy rates. This indicates the importance of literacy across production sub-sectors. This may indicate the relative importance of inputs (such as expenditure) and outputs or outcomes (such as literacy rates) in explaining output across sectors over time. For instance, whereas expenditure on education helps to create a more efficient way to do business, it does not impact on services immediately the way it happens if we considered the effect of the current level of literacy on doing business. Other important causes are changes in the lending rates, real exchange rate depreciation, as well as changes in expenditure on transport and communications.

6.3.3 Industrial Sector VAR Model

In the industrial sector, the hypotheses that growth of gross secondary education and growth in agriculture output do not cause growth in industrial output are accepted (Appendix16 provides more details). It should however be noted that agriculture output not causing growth in industrial output could be resulting from the fact that the value of output is determined by other factors other than those related to primary inputs of the activity. It is a known fact that Uganda has a number of industries that are dependent on agriculture inputs. In situations where the industries import inputs
of agriculture nature when there are shortages in local agriculture production can be a factor explaining lack of causality.

So important for industry output growth are the changes in growth of public expenditure, and growth in electricity sold domestically. Causality runs from electricity growth to industrial output growth but not the other way round.

Industrial growth will probably cause increased education expenditure and gross secondary education because of the role industry plays in contributing to tax revenue to government, availing cheaper education materials and therefore increased capacity of government to support secondary education. Further, industrial growth facilitates the development of infrastructure for education, and in general, for human development.

The failure to find significant links between industrial output growth and growth of gross secondary education as well as growth in agriculture output have implications for Uganda’s development policy. So important for industry output growth are the changes in growth of public expenditure, and growth in electricity sold domestically. Causality runs from electricity growth to industrial output growth but not the other way round.

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the development of infrastructure for education, and in general, for human development.

6.3.4 Multi-sector ECM model

The multisector linkage existing across the three sectors is of important concern for understanding the process of economic transformation and the implications for human development and public resource allocation policy. The finding that changes in the growth of services output result from growth in industry alone and there is no causality from agriculture output growth can be explained. In the first case, theoretically the price differentials existing between traded agriculture output and industrial output are high. Secondly, some of the agriculture outputs once processed may be included as estimates of industry output. Third, there is a widening gap between the traded output of agriculture and the services output indicates obscures the contribution from agriculture to services growths.

Whereas agriculture does not seem to cause significant growth in industry and services, it on the other hand benefits from growth in other sectors. This only demonstrates the weak link existing, which needs to be strengthened particularly of farmers have benefit from industrial development and services sector growth. Given the benefits that agriculture gets from industry and services sectors, facilitating the growth of processing of agriculture output near the producing farmers might reduce the gap in prices at the farm and the industrial market. This could increase ability of the agriculture sector to move together with the rest of the sectors and increase statistical significance of the causality from agriculture to industry. As long as much of Uganda’s agriculture output is for subsistence and does not therefore
constitute a significant contribution to services sector output through trading, nor industry through processing, the causal link will remain statistically weak. In this case one can also argue that much of agriculture products traded locally are imported, for instance rice and wheat. It is also known that much of industrial input is imported, and is non-agricultural, besides carrying high value in nominal terms. Secondly, it may be because the benefits from services and industry into agriculture are in small non-optimal quantities. So the benefits into agriculture are more of short-term rather than long-term. Because of this, the growth in the agriculture sector is affected by instabilities from industry and services, than these instabilities affect their own industry and service sectors.

Could this be a reason why poverty is still high in the population despite high rates of gross domestic product? The answer is partly yes, because majority of the population is employed in the agriculture sector. But also partly because most of agriculture is not commercialized, it is mainly subsistence, and yet the other sectors namely industry and services are highly monetized and commercialized.

6.4 Impulse Response Analysis: Variance Decomposition

As opposed to Impulse response functions, which trace the effects of a shock to an endogenous variable on the variables in the VAR, we use variance decomposition to illustrate and decompose variations in the endogenous variable into component shocks to the endogenous variables in the VAR. This provides information about the relative importance of each random innovation to the variables in the VAR. In this particular case, for agriculture sector, we look at ΔNYA, LNLA, LNUMR, LNI, ΔNRX and ΔNF. Besides estimating separate variance decomposition for each endogenous
variable, we estimate also the forecast error of the variable for each forecast horizon that result from the variation in current and future values of the innovations to each endogenous variable in the VAR.

**Forecasts in Agriculture Sector**

100 percentage of the variance due to each innovation in one period ahead is a result of the innovation in ΔLNYA. In the fifth year, out of every 100 percent variation that result from innovations in the endogenous variables, 97.8 percent is explained by innovations in ΔLNYA itself, 0.81 percent from innovations in ΔLNRX, 0.5 percent from ΔLF innovations, 0.4 percent from innovations in LNU5MR. At the end of 10 year period, innovations in ΔLNYA will yield 97.6 percent variation, while the rest of the variation is explained by innovations in LNL (0.35 percent), LNU5MR (0.48 percent), LNL (0.05 percent), ΔLNRX (0.91 percent) and ΔLF (0.60 percent). It is noted that over the whole period of forecasting, the variation caused by innovations in the quantity of agriculture labour is declining.

**Forecasts in Industrial Sector**

In 10 years, out of 100 percent variation in industrial output, 51 percent will be from its own innovations, 13.4 percent from innovations in secondary education, 1.3 percent from education expenditure innovations, 12.9 percent from macroeconomic management specifically innovations in interest rate management, 19.4 percent from innovations in electricity supply, while innovations in agriculture output will explain 1.7 percent of the variations. This is an indication of how important economic management, secondary education and energy supply are important for industrial development in the country.
**Forecasts in Services Sector**

Whereas innovations in services sector output explain close to 70 percent of its own variations by the year 2017, economic management through innovations in interest rates and exchange rates (12.7 and 2.2 percent respectively) will be responsible for close to 15.0 percent of the variations. Innovations in human development will be important for service sector output variations. While innovations on literacy will account for 3.2 percent, those on changes in health and education expenditure combined will account for 11.9 percent of the variations in service sector output growth acceleration.

**Forecasts in Joint Multisector Behaviour**

It should be noted that the variables of economic transformation namely outputs of; agriculture sector (LNYA), industrial sector (LNYI) and services sector (ΔLNYS) entered the model in different forms, and their interpretation should differ likewise. Services sector output entered as difference unlike the other variables. The forecasts indicate that in ten years (by 2017), whereas of the 100% variation in agriculture output growth will be explained by innovations in agriculture sector itself to the tune of 83 percent, innovations in the industrial sector will on the other hand explain 9.2 percent, while 4.4 percent will be explained by innovations in services sector.

Looking at self-reliance of the sectors in terms of being able to support own variations using internal innovations, agriculture will be the first (83.5 percent), followed by
industry 51.7 percent and then services with 35.5 percent. This shows the level to which these sectors are integrated with each other. This seems to indicate that the lower the percentage of own variation determination, the higher the level of integration with the rest of the economy. This could be the reason why services sector has taken over from all the other sectors in terms of its contribution to gross domestic product. This situation is a precursor to the thinking that innovations in agriculture should be those that increase the linkage of the sector to the rest of the economic sectors (industry and services) through supporting downstream investments favouring industrial use of agriculture products on one hand; and on the other hand facilitate improved terms of trade for agriculture products and stimulate demand for processed agriculture products.

How human development will affect variations in output growth is illustrated in the following. It is noted that whereas human development outcomes, especially literacy and under five mortality ratio in this case, is important for economic development, forecasts show that innovations in human development will benefit more the services sector followed by the industrial sector. While literacy and under five mortality ratio innovations will explain 0.01 and 1.1 percent respectively of variations in agriculture output growth, the impact on industry output variations will be 0.05 and 8.9 percent determinant of the industrial output variations. In services, the two human development variables’ innovations will explain 1.0 and 21.0 of the variations in services sector output growth acceleration by the year 2017.

Innovations in agriculture and industry will explain 15.8 and 18.0 percent of variations in total adult literacy respectively by 2017. Services sector output growth
acceleration innovations will explain 14.6 percent of the adult literacy variations. At the same time, innovations in agriculture and industry will explain 3.4 and 7.2 percent of variations in total under five mortality ratio respectively, while the services sector output growth acceleration innovations will explain 0.4 percent of the under-five mortality ratio variations. It is important to note also that improvements in literacy will explain 10.5 percent of variations in under-five mortality ration variations.

The role of public expenditure is also seen to be important and different for each of the sectors. Of particular importance are the three expenditure differences included in the model, namely expenditure on education, expenditure on agriculture, and expenditure on transport and communication. Expenditures in education and transport/communications will explain to a greater magnitude the variations in agriculture output growth than expenditure on agriculture itself. Education expenditure will explain 1.6 percent while transport will explain 0.5 percent, compared to that of agriculture of 0.08 percent. With majority of the population employed being in agriculture sector, expenditure per capita in agriculture compared to education and roads is small. The effect of expenditures in education and roads on agriculture could be more pronounced because of the knowledge transfer from education as an externality, and the effect on agriculture product marketing of transport and communication expenditure. In the services sector, changes in education expenditure growth explain 2.7 percent, while agriculture expenditure, and transport and communication explain 6.5 percent and 3.3 percent respectively of the variation in service sector output growth acceleration. It can be seen here therefore that whereas agriculture expenditure benefits its own sector, it benefits industry and services even more. So this situation calls for investigation of what the expenditure in
agriculture purchases. How much of that expenditure in agriculture that directly benefits agriculture should be established with the view to investigating the efficiency of fiscal policy on agriculture in the next ten years.

What will explain expenditures by the year 2017? Considering the three variables of expenditure in the model, the following is the situation forecast. Variations in Education expenditure will be explained 36.1 and 34.0 percent by innovations in agriculture and industry sectors. 4.9 percent education expenditure variations will be explained by innovations in service sector output growth acceleration. Whereas only 7.2 percent of the variations in education expenditure will be explained by innovations in education spending itself, it will be 8.6 percent explained by agriculture expenditure growth changes. This indicates the importance of assessing importance of expenditure across expenditure sectors and votes, encouraging harmonization of expenditures and probably enhancing efficiency of spending through proper targeting. If there are common objectives in both education and agriculture sectors, why expenditure in the two sectors should be harmonized is supported by this finding.

Looking at agriculture expenditure, by 2017, forecasts indicate that 20.2 percent will be determined by innovations in agriculture spending itself, while innovations in agriculture output growth innovations will account for 29.3 percent. Innovations in industry sector should explain 8.3 percent while services sector output growth acceleration will be responsible for 5.7 percent. It is seen that literacy innovations should explain 28.9 percent of the variations in agriculture expenditure. This perhaps explains why there is emphasis on the fact that most of the people in agriculture are
illiterate, and therefore the reason why national agriculture advisory services programmes are part of the necessary functional literacy needed to be funded under literacy innovations, and not just reading and writing, which is the ordinary understanding of adult literacy.

Turning to expenditure on transport and communications, including roads infrastructure, we find only 12.3 percent of variations in expenditure determined by innovations is transport and communications itself. Actually 30.5, 17.8 and 17.5 percent of the innovations should be explained by innovations in agriculture, industry and services respectively. Only 9.1 percent of the variations in transport and communication expenditure are determined by innovations in under-five mortality ratio, for instance by supporting the roadmap for the reduction of maternal and neonatal mortality in Uganda through increasing perennial physical access by road to health centres.

From the above analysis evidence is found of existence of linkages between sector output growth, human development and public expenditure allocations in selected sectors. It has been possible to determine the magnitude of adjustment when there are changes away from the long run equilibrium levels of growth across sectors.
Chapter Seven

CONCLUSIONS AND RECOMMENDATIONS

This chapter winds up the study with conclusions and recommendations based on the findings.

7.1 Conclusions

The study has investigated the short run factor productivity changes in agriculture, industry and services sectors and there is significant correlation between the sizes of the sector output growth over the long run. Econometric links between the sector output growths of the three sectors over the long run exist. Enhancing sector productivity by increasing public expenditure on the key sectors and improving human development through human capital development influence sectoral transformation and increase economic growth. Therefore, the following conclusions are made in line with understanding and utilising the links that are found.

It is important to take into account the nature and magnitude of short and long-term relationships existing between sector output growth, human development, and public expenditure in the country’s policy frameworks to justify government strategic priorities over the medium and long-term term.

Public spending is positively related with output growth across sectors, and therefore any action that compromises the allocation of adequate resources and their effective use is detrimental to attaining fast economic growth and human development.
Uganda’s structural transformation can be influenced using fiscal measures to make rapid improvements in economic growth and human development. The coefficients of industry output and changes in services output as determinants of agriculture output were significant and positive. It was further found that industrial output growth and changes in service sector output growth lead to agriculture output growth, although industrial and services output growth are not a result of agriculture output growth.

This may further be qualified by the fact that industry and services are still dependent on imported raw materials and intermediate goods. The value of agriculture inputs locally supplied to industry as a proportion of industrial sector inputs, and the volume of agriculture commodity trade as proportion of the value of all services sector transactions in Uganda have been overtaken by imports and manufactured and non-agriculture commodities and services. Linkages originating from agriculture are not fully exploited and need strengthening, for instance the links between agriculture and industry through increased agriculture product processing. Investing in increasing agriculture productivity can increase the significance of the contribution of agriculture to industry and services as a back born sector of the economy. This is so if increased productivity is related to increasing reliability of the supply of agriculture output that is relevant to industry as inputs because industrial decisions are based on reliable input supply. Similarly, export markets for agriculture are larger where the supply is reliable, which is not the case with Uganda’s agriculture where there are immense seasonal affects of natural factors such as weather, thus not reliable to sustain a competitive export market.

Growth in services is important to agriculture, than agriculture is to services. This is in line with the fact that growth in service activities such as distribution and retailing benefit agriculture.
7.2 Recommendations

7.2.1 Invest in Strengthening the economic contribution of agriculture sector to Industry and services sectors

Innovations in agriculture should be those that increase the linkage of the sector to the rest of the economic sectors (industry and services) through supporting accelerated downstream investments favouring industrial use of agriculture products on one hand; and on the other hand facilitate improved terms of trade for agriculture products and stimulate demand for processed agriculture products. This arises from the finding that agriculture least contributes to other sectors’ output growth, yet innovations in the sector will remain heavily internal. The independent nature of agriculture needs to be scaled down so that what goes on in the agriculture sector contributes to driving the rest of the economic activities, and this has wider implications on economic growth.

7.2.2 Human Development Programmes Should Increase Focus On Links with Agriculture Sector to Increase Agriculture Output Growth

Having observed from the forecasts of the model that innovations in human development will benefit more the services sector followed by the industrial sector, there is need to increase the link between human development and agriculture development in the country so that developments in human development indicators benefit increase in agriculture output growth. This is based on the finding that literacy and under five mortality ratio innovations will explain far less variations in agriculture output growth, compared to the impact on industry and services where effects are greater.
This recommendation should further see a stronger link between human development and in the longterm to improve from the existing shortterm effects in agriculture sector, by creating resources that endure into the longrun. This is by ensuring that the labour involved in agriculture have enduring skills and health for them to shape agriculture sector, as opposed to leaving it to peasants.

7.2.3 Increase in public expenditure on agriculture itself and on transport and communication (Infrastructure) in order to increase long-term growth in agriculture sector output

The long run model shows that a positive change in public expenditure especially on agriculture itself and transport and communication lead to increase in agriculture sector output growth. Similarly there is a significant relationship between agriculture output growth and human development, particularly under-five mortality ratio. A reduction in mortality ratio should imply more time of agriculture labour.

In the long-run agriculture output changes will benefit from innovations or strategic ideas focused on agriculture itself, followed by infrastructure development, then productivity of direct factors of production, and then factors of human development. A one percentage change in the differenced expenditure (acceleration) on transport and communication expenditure variable contributes to 12% increase in agriculture output variable, while 16.9 percent will result from agriculture expenditure variable.

The ordering of priorities for agriculture development over the medium to long-term consideration should be given to innovations that directly impact on agriculture output first, followed by changes in public expenditure on infrastructure development.
7.2.4 Promote investment in both Physical and Human Capital Development to increase Sector Specific Growth

This recommendation is from the finding that education expenditure and electricity available on the local market cause industrial output growth significantly. This should be done with in the public expenditure framework. This is based on the finding that Therefore, the hypotheses that: expenditure on agriculture, expenditure on education and supply of electricity to Ugandans cause growth of industrial output over the long run are accepted.

In the services sector, accelerating both education expenditure growth and adult literacy leads to accelerated growth in service sector output. This shows that adult literacy and human development in that matter is important for growth of the services sector output.

7.2.5 Maintain Macroeconomic Stability to increase industrial output growth over the long run.

This recommendation is based on the finding that interest rate fluctuations, as well as current and lagged foreign exchange rate fluctuations were significant factors for industrial growth. Stability in foreign exchange and financial capital markets are important factors for industrial development. The lagged values of industrial and agriculture output were also important in sustaining industrial growth in the country in the long run.
7.2.6 **Government should deliberately Monitor Economic Transformation and analyse specific cross cutting factors related to inter-sectoral dynamics and adjustment to longterm economic growth targets.**

This is based on the finding that by 2017, self-reliance of the sectors in terms of being able to support own variations using internal innovations, agriculture will be the first (83.5 percent), followed by industry (51.7 percent) and then services (with 35.5 percent). A comprehensive framework to explain these innovations from time to time is needed to facilitate the capture and exploitation of opportunities related to economic growth.

7.2.7 **Focus public expenditure in agriculture sector to increase its contribution to the growth in other sectors.**

This is based on the finding that variations in the acceleration of service sector output growth is explained up to 2.7 percent by changes in education expenditure, while expenditure on agriculture and transport and communication explain 6.5 percent and 3.3 percent respectively. Whereas agriculture expenditure benefits its own sector, it benefits industry and services even more.

7.3 **Areas for further Research**

The study would have generated even better results if data on all human development and details of public expenditure within the sectors were available. Due to gaps in the data, the study selected representative indicators for purposes of generating insight into these inter-linkages. At the same time, data available in the national statistical abstracts is not exhaustive especially on the side of human development indicators, and noting that surveys are conducted once in two years; the available data in official
documents is not necessarily generated annually. At the same time, the data presented in the statistical abstracts do not apply a uniform price, as the base years are altered from time to time.

Whereas the methodology is good for the purpose to which it was applied, particularly vector error correction, the interpretation of parameter coefficients has to be cautiously undertaken given that the model consists of both differenced and level variables. The use of the Johansen procedure limited the results of the study because of the limited number of observations. The sample size of the study was small and therefore posed a limitation on the extent to which the number of lags was relaxed in the analysis.

This study has contributed to the identification of areas for further research, which could not be undertaken within its limits. The study helped to generate a system of equations relating to the variables used in the analysis. However, it should be important to see whether replacing some of these variables would generate similar results. Of particular importance is the analysis of human development and replacing the variables used in this study with other variables such as maternal mortality ratio and access to clean and safe drinking water, and the human development index. The other area that require further investigation is improving the quality of the data used, for instance by extending the time span from 33 to more years, and replacing the nominal with real values of sector output, and analyzing economies of scale. This will most likely yield better results.
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Appendices

Appendix 1: Parameters Estimated in the VECM Model

<table>
<thead>
<tr>
<th>Cointegrating Equations by sector</th>
<th>Endogenous Variable</th>
<th>Error Correction Parameter</th>
<th>Long-Term Parameters</th>
<th>Short-Term Parameters</th>
<th>Overall Constant</th>
</tr>
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<tbody>
<tr>
<td></td>
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<td>Regression Coefficients</td>
<td>Const</td>
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<tr>
<td>Agriculture Sector with Six endogenous Variables (Maximum 6 Cointegrating Equations)</td>
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<tr>
<td>Equation 1</td>
<td>Δ(LNYA,2)</td>
<td>Φ₁, Φ₉</td>
<td>Φ₂ to Φ₇, Φ₁₀ to Φ₁₅</td>
<td>Φ₈, Φ₁₆</td>
<td>Φ₁₇ to Φ₂₂</td>
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<td>θ₁₇ to θ₂₂</td>
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<tr>
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<td>Ω₂ to Ω₇, Ω₁₀ to Ω₁₅</td>
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<td>π₁₇ to π₂₂</td>
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<tr>
<td>5</td>
<td>Δ(LNIX,2)</td>
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<td>Γ₈, Γ₁₆</td>
<td>Γ₁₇ to Γ₂₂</td>
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<tr>
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<td>ω₁₇ to ω₂₂</td>
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<td>Industry Sector with Six endogenous Variables (Maximum 6 Cointegrating Equations)</td>
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<td>q₂ to q₇, q₁₀ to q₁₅</td>
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<td>Δ(LNEDX,2)</td>
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<td>ϕ₈, ϕ₁₆</td>
<td>ϕ₁₇ to ϕ₂₂</td>
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<td>Δ(LNIR,2)</td>
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<td>φ₂ to φ₇, φ₁₀ to φ₁₅</td>
<td>φ₈, φ₁₆</td>
<td>φ₁₇ to φ₂₂</td>
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<tr>
<td>5</td>
<td>Δ(LNEL)</td>
<td>Ψ₁, Ψ₉</td>
<td>Ψ₂ to Ψ₇, Ψ₁₀ to Ψ₁₅</td>
<td>Ψ₈, Ψ₁₆</td>
<td>Ψ₁₇ to Ψ₂₂</td>
</tr>
<tr>
<td>6</td>
<td>Δ(LNYA)</td>
<td>Y₁, Y₉</td>
<td>Y₂ to Y₇, Y₁₀ to Y₁₅</td>
<td>Y₈, Y₁₆</td>
<td>Y₁₇ to Y₂₂</td>
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</tbody>
</table>
### Appendix 1: Parameters Estimated in the VECM Model

<table>
<thead>
<tr>
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<th>Error Correction Parameter</th>
<th>Long-Term Parameters</th>
<th>Short-Term Parameters</th>
<th>Overall Constant</th>
</tr>
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<tbody>
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<td></td>
<td></td>
<td>Regression Coefficients</td>
<td>Const</td>
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#### Services Sector with Seven Endogenous Variables (Maximum Seven Cointegrating Equations)

<table>
<thead>
<tr>
<th>Equation</th>
<th>(\Delta(LNYS,2))</th>
<th>(\infty_1, \infty_{10}, \infty_{19})</th>
<th>(\infty_2 to \infty_9; \infty_{11} to \infty_{17}; \infty_{20} to \infty_{26})</th>
<th>(\infty_9, \infty_{18}, \infty_{27})</th>
<th>(\infty_{24} to \infty_{34})</th>
<th>(\infty_{35})</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>(\Delta(LNIR,2))</td>
<td>(\xi_1, \xi_{10}, \xi_{19})</td>
<td>(\xi_2 to \xi_9; \xi_{11} to \xi_{17}; \xi_{20} to \xi_{26})</td>
<td>(\xi_9, \xi_{18}, \xi_{27})</td>
<td>(\xi_{28} to \xi_{34})</td>
<td>(\xi_{35})</td>
</tr>
<tr>
<td>2</td>
<td>(\Delta(LNLI))</td>
<td>(\mu_1, \mu_{10}, \mu_{19})</td>
<td>(\mu_2 to \mu_6; \mu_{11} to \mu_{17}; \mu_{20} to \mu_{26})</td>
<td>(\mu_9, \mu_{18}, \mu_{27})</td>
<td>(\mu_{28} to \mu_{34})</td>
<td>(\mu_{35})</td>
</tr>
<tr>
<td>3</td>
<td>(\Delta(LNLI))</td>
<td>(\lambda_1, \lambda_{10}, \lambda_{19})</td>
<td>(\lambda_2 to \lambda_6; \lambda_{11} to \lambda_{17}; \lambda_{20} to \lambda_{26})</td>
<td>(\lambda_9, \lambda_{18}, \lambda_{27})</td>
<td>(\lambda_{28} to \lambda_{34})</td>
<td>(\lambda_{35})</td>
</tr>
<tr>
<td>4</td>
<td>(\Delta(LNER,2))</td>
<td>(\Sigma_1, \Sigma_{10}, \Sigma_{19})</td>
<td>(\Sigma_2 to \Sigma_9; \Sigma_{11} to \Sigma_{17}; \Sigma_{20} to \Sigma_{26})</td>
<td>(\Sigma_9, \Sigma_{18}, \Sigma_{27})</td>
<td>(\Sigma_{28} to \Sigma_{34})</td>
<td>(\Sigma_{35})</td>
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<tr>
<td>5</td>
<td>(\Delta(LNEX,2))</td>
<td>(f_1, f_{10}, f_{19})</td>
<td>(f_2 to f_8; f_{11} to f_{17}; f_{20} to f_{26})</td>
<td>(f_9, f_{18}, f_{27})</td>
<td>(f_{28} to f_{34})</td>
<td>(f_{35})</td>
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<tr>
<td>7</td>
<td>(\Delta(LNWX,2))</td>
<td>(\lambda_1, \lambda_{10}, \lambda_{19})</td>
<td>(\lambda_2 to \lambda_6; \lambda_{11} to \lambda_{17}; \lambda_{20} to \lambda_{26})</td>
<td>(\lambda_9, \lambda_{18}, \lambda_{27})</td>
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<td>(\lambda_{35})</td>
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#### Multisector Sector with Eight Endogenous Variables (Maximum Eight Cointegrating Equations)

<table>
<thead>
<tr>
<th>Equation</th>
<th>(\Delta(LNYA))</th>
<th>(\theta_1, \theta_{12}, \theta_{23}, \theta_{34})</th>
<th>(\theta_2 to \theta_{11}, \theta_{13} to \theta_{22}, \theta_{24} to \theta_{33}, \theta_{35} to \theta_{44})</th>
<th>(\theta_{11}, \theta_{22}, \theta_{33})</th>
<th>(\theta_{25} to \theta_{32})</th>
<th>(\theta_{33})</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(\Delta(LNYI))</td>
<td>(\rho_1, \rho_{12}, \rho_{23}, \rho_{34})</td>
<td>(\rho_2 to \rho_{11}, \rho_{13} to \rho_{22}, \rho_{24} to \rho_{33}, \rho_{35} to \rho_{44})</td>
<td>(\rho_{11}, \rho_{22}, \rho_{33})</td>
<td>(\rho_{25} to \rho_{32})</td>
<td>(\rho_{33})</td>
</tr>
<tr>
<td>2</td>
<td>(\Delta(LNIS,2))</td>
<td>(\eta_1, \eta_{12}, \eta_{23}, \eta_{34})</td>
<td>(\eta_2 to \eta_{11}, \eta_{13} to \eta_{22}, \eta_{24} to \eta_{33}, \eta_{35} to \eta_{44})</td>
<td>(\eta_{11}, \eta_{22}, \eta_{33})</td>
<td>(\eta_{25} to \eta_{32})</td>
<td>(\eta_{33})</td>
</tr>
<tr>
<td>3</td>
<td>(\Delta(LNLD,2))</td>
<td>(\nu_1, \nu_{12}, \nu_{23}, \nu_{34})</td>
<td>(\nu_2 to \nu_{11}, \nu_{13} to \nu_{22}, \nu_{24} to \nu_{33}, \nu_{35} to \nu_{44})</td>
<td>(\nu_{11}, \nu_{22}, \nu_{33})</td>
<td>(\nu_{25} to \nu_{32})</td>
<td>(\nu_{33})</td>
</tr>
<tr>
<td>4</td>
<td>(\Delta(LNAX,2))</td>
<td>(\eta_1, \eta_{12}, \eta_{23}, \eta_{34})</td>
<td>(\eta_2 to \eta_{11}, \eta_{13} to \eta_{22}, \eta_{24} to \eta_{33}, \eta_{35} to \eta_{44})</td>
<td>(\eta_{11}, \eta_{22}, \eta_{33})</td>
<td>(\eta_{25} to \eta_{32})</td>
<td>(\eta_{33})</td>
</tr>
<tr>
<td>5</td>
<td>(\Delta(LNWX,2))</td>
<td>(\lambda_1, \lambda_{12}, \lambda_{23}, \lambda_{34})</td>
<td>(\lambda_2 to \lambda_{11}, \lambda_{13} to \lambda_{22}, \lambda_{24} to \lambda_{33}, \lambda_{35} to \lambda_{44})</td>
<td>(\lambda_{11}, \lambda_{22}, \lambda_{33})</td>
<td>(\lambda_{25} to \lambda_{32})</td>
<td>(\lambda_{33})</td>
</tr>
<tr>
<td>8</td>
<td>(\Delta(LNWX,2))</td>
<td>(\theta_1, \theta_{12}, \theta_{23}, \theta_{34})</td>
<td>(\theta_2 to \theta_{11}, \theta_{13} to \theta_{22}, \theta_{24} to \theta_{33}, \theta_{35} to \theta_{44})</td>
<td>(\theta_{11}, \theta_{22}, \theta_{33})</td>
<td>(\theta_{25} to \theta_{32})</td>
<td>(\theta_{33})</td>
</tr>
</tbody>
</table>
Appendix 2: Characteristics of Residuals of Data Series (1975-2007)

Figure A1: Test on Stationarity of Residuals of Model Data Series

D(L NYAGRIC) Residuals

LNLABORAG Residuals

LNU5MR Residuals

LNLITE Residuals

D(LNROADEXP) Residuals

D(LNFERT) Residuals
### Appendix 3: Estimated Initial Cointegrating Relationship for Agriculture Sector

Dependent Variable: ΔLNYA;
Method: Least Squares; Sample (adjusted) to 1976-2007; Included 32 observations after adjusting endpoints; White Heteroskedasticity-Consistent Standard Errors & Covariance

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>LNLA</td>
<td>0.128396</td>
<td>1.484163</td>
<td>0.086510</td>
<td>0.9317</td>
</tr>
<tr>
<td>LNU5MR</td>
<td>1.123585</td>
<td>3.190604</td>
<td>0.352154</td>
<td>0.7276</td>
</tr>
<tr>
<td>LNL1</td>
<td>0.693962</td>
<td>2.002694</td>
<td>0.346515</td>
<td>0.7317</td>
</tr>
<tr>
<td>ΔLNRX</td>
<td>0.167340</td>
<td>0.057584</td>
<td>2.906013</td>
<td>0.0074</td>
</tr>
<tr>
<td>ΔLNF</td>
<td>-0.029687</td>
<td>0.054308</td>
<td>-0.546648</td>
<td>0.5893</td>
</tr>
<tr>
<td>C</td>
<td>-9.646417</td>
<td>27.21462</td>
<td>-0.354457</td>
<td>0.7259</td>
</tr>
</tbody>
</table>

R-squared: 0.267576
Mean dependent var: 0.015893
Adjusted R-squared: 0.126725
S.D. dependent var: 0.227298
S.E. of regression: 0.212408
Akaike info criterion: -0.093252
Sum squared resid: 1.173050
Schwarz criterion: 0.181574
Log likelihood: 7.492029
F-statistic: 1.899711
Durbin-Watson stat: 1.495970
Prob(F-statistic): 0.128816

Note: Please not that the most of the coefficients are not significant. Re-estimates are shown in Appendix 6

### Appendix 4: Estimated Cointegrating Relationship for Industry Sector

Dependent Variable: LNYI
Method: Least Squares
Sample (adjusted): 1976-2007
Included observations: 32 after adjusting endpoints

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
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<td>LNGSE</td>
<td>1.293382</td>
<td>0.228089</td>
<td>5.670515</td>
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<tr>
<td>ΔLNEDX</td>
<td>0.244068</td>
<td>0.115760</td>
<td>2.108401</td>
<td>0.0448</td>
</tr>
<tr>
<td>ΔLNIR</td>
<td>0.138380</td>
<td>0.220615</td>
<td>0.606623</td>
<td>0.5494</td>
</tr>
<tr>
<td>LNEL</td>
<td>0.318891</td>
<td>0.221829</td>
<td>1.437550</td>
<td>0.1625</td>
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<tr>
<td>LNYA</td>
<td>0.889417</td>
<td>0.147754</td>
<td>6.019562</td>
<td>0.0000</td>
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<tr>
<td>C</td>
<td>-3.853987</td>
<td>3.417563</td>
<td>-1.127700</td>
<td>0.2697</td>
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</tbody>
</table>

R-squared: 0.946486
Mean dependent var: 20.11369
Adjusted R-squared: 0.936195
S.D. dependent var: 1.042187
S.E. of regression: 0.263252
Akaike info criterion: 0.335951
Sum squared resid: 1.80184
Schwarz criterion: 0.610776
Log likelihood: 1.89711
F-statistic: 91.97164
Durbin-Watson stat: 0.766952
Prob(F-statistic): 0.000000

Note: Please not that the most of the coefficients are not significant. Re-estimates are shown in Appendix 7
Appendix 5: Estimated Cointegrating Relationship for Services Sector

Dependent Variable: ΔLNYS
Method used is least squares and the sample was adjusted to 1976-2007 with 32 observations included after adjusting endpoints.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ΔLNIR</td>
<td>0.193376</td>
<td>0.137461</td>
<td>1.406770</td>
<td>0.1718</td>
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<tr>
<td>LNL</td>
<td>-0.042531</td>
<td>0.222567</td>
<td>-0.191093</td>
<td>0.8500</td>
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<tr>
<td>ΔLNER</td>
<td>-0.132573</td>
<td>0.155207</td>
<td>-0.854167</td>
<td>0.4011</td>
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<tr>
<td>ΔLNHX</td>
<td>0.099935</td>
<td>0.103610</td>
<td>0.964535</td>
<td>0.3440</td>
</tr>
<tr>
<td>ΔLNEDX</td>
<td>0.220999</td>
<td>0.126536</td>
<td>1.746523</td>
<td>0.0930</td>
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<tr>
<td>ΔLNRX</td>
<td>0.145960</td>
<td>0.055469</td>
<td>2.631375</td>
<td>0.0144</td>
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<tr>
<td>C</td>
<td>0.202513</td>
<td>0.897698</td>
<td>0.225592</td>
<td>0.8234</td>
</tr>
</tbody>
</table>

R-squared | 0.670645 | Mean dependent var | 0.078859
Adjusted R-squared | 0.591600 | S.D. dependent var | 0.253581
S.E. of regression | 0.162054 | Akaike info criterion | -0.611137
Sum squared resid | 0.656536 | Schwarz criterion | -0.290507
Log likelihood | 16.77819 | F-statistic | 8.484330
Durbin-Watson stat | 2.887366 | Prob(F-statistic) | 0.000044

Note: Please note that the most of the coefficients are not significant. Re-estimates are shown in Appendix 8

Appendix 6: Parameter Estimates of the Cointegrating Relationship of Agriculture Model

Dependent Variable: LNYA; Method: ML – ARCH; Sample (adjusted): 1976 2007; Included 32 observations after adjusting endpoints; Convergence achieved after 45 iterations; and Bollerslev - Wooldrige robust standard errors & covariance.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>z-Statistic</th>
<th>Prob.</th>
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<tbody>
<tr>
<td>SQR(GARCH)</td>
<td>2.277654</td>
<td>0.338356</td>
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<tr>
<td>ΔLNRX</td>
<td>0.120831</td>
<td>0.014611</td>
<td>8.269879</td>
<td>0.0000</td>
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<tr>
<td>ΔLNAX</td>
<td>0.168910</td>
<td>0.023888</td>
<td>7.070835</td>
<td>0.0000</td>
</tr>
<tr>
<td>LNYA(-1)</td>
<td>0.944291</td>
<td>0.010847</td>
<td>87.05266</td>
<td>0.0000</td>
</tr>
<tr>
<td>LNU5MR</td>
<td>0.166038</td>
<td>0.041830</td>
<td>3.969370</td>
<td>0.0001</td>
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</tbody>
</table>

Variance Equation

| Perm: C | 0.023274 | 0.001554 | 14.97327 | 0.0000|
| Perm: [Q-C] | 0.523033 | 0.096389 | 5.426259 | 0.0000|
| Perm: [ARCH-GARCH] | -0.358068 | 0.097778 | -3.662067 | 0.0003|
| Tran: [ARCH-Q] | 0.090187 | 0.044364 | 2.032901 | 0.0421|
| Tran: [GARCH-Q] | -0.882618 | 0.032157 | -27.44758 | 0.0000|

R-squared | 0.822158 | Mean dependent var | 21.40182
Adjusted R-squared | 0.749404 | S.D. dependent var | 0.358946
S.E. of regression | 0.179687 | Akaike info criterion | -0.702565
Sum squared resid | 0.710320 | Schwarz criterion | -0.244523
Appendix 7: Parameter Estimates of the Cointegrating Relationship Regressors of Industry Model

The Dependent Variable is LNYI; Method: ML – ARCH; Sample (adjusted): 1977-2007; Included 31 observations after adjusting endpoints; Convergence achieved after 86 iterations; and Bollerslev - Wooldrige robust standard errors & covariance.

<table>
<thead>
<tr>
<th>Regressors</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>z-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ΔLNIR</td>
<td>0.197641</td>
<td>0.013978</td>
<td>14.13931</td>
<td>0.0000</td>
</tr>
<tr>
<td>ΔLNYA</td>
<td>1.258198</td>
<td>0.014857</td>
<td>84.68914</td>
<td>0.0000</td>
</tr>
<tr>
<td>LNYI(-1)</td>
<td>0.509332</td>
<td>0.023343</td>
<td>21.81969</td>
<td>0.0000</td>
</tr>
<tr>
<td>ΔLNLFIEEXP</td>
<td>1.971515</td>
<td>0.271439</td>
<td>7.263193</td>
<td>0.0000</td>
</tr>
<tr>
<td>LNEL</td>
<td>0.078715</td>
<td>0.035617</td>
<td>2.210027</td>
<td>0.0271</td>
</tr>
<tr>
<td>LNEDX(-1)</td>
<td>0.093645</td>
<td>0.020210</td>
<td>4.633668</td>
<td>0.0000</td>
</tr>
<tr>
<td>ΔLNER</td>
<td>0.070821</td>
<td>0.020620</td>
<td>3.434660</td>
<td>0.0006</td>
</tr>
<tr>
<td>LNYA(-1)</td>
<td>0.259692</td>
<td>0.028756</td>
<td>9.030878</td>
<td>0.0000</td>
</tr>
<tr>
<td>ΔLNER(-1)</td>
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<td>0.354271</td>
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<td>0.031041</td>
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Variance Equation

<table>
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<tr>
<th></th>
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<th>z-Statistic</th>
<th>Prob.</th>
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<tr>
<td>C</td>
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<td>1.817154</td>
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<tr>
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<td>SQR</td>
<td>GARCH</td>
<td>(1)</td>
</tr>
<tr>
<td>RES/SQR</td>
<td>GARCH</td>
<td>(1)</td>
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<td>0.291978</td>
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<tr>
<td>EGARCH(1)</td>
<td>-0.235024</td>
<td>0.295830</td>
<td>-0.794456</td>
<td>0.4269</td>
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R-squared                  | 0.974309    | Mean dependent var | 20.14663 |
| Adjusted R-squared        | 0.951829    | S.D. dependent var  | 1.042343 |
| S.E. of regression        | 0.228772    | Akaike info criterion | -0.703198 |
| Sum squared resid         | 0.837385    | Schwarz criterion   | -0.009333 |
| Log likelihood            | 25.89957    | F-statistic         | 43.34169 |
| Durbin-Watson stat        | 1.940880    | Prob(F-statistic)   | 0.000000 |
Appendix 8: Parameter Estimates of the Cointegrating Relationship
Regressors of Services Model

<table>
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<tr>
<th>Regressor</th>
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<th>Std. Error</th>
<th>z-Statistic</th>
<th>Prob.</th>
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<tbody>
<tr>
<td>GARCH</td>
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<td>2.662467</td>
<td>3.738831</td>
<td>0.0002</td>
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<tr>
<td>D(LNIR)</td>
<td>0.080323</td>
<td>0.025647</td>
<td>3.131909</td>
<td>0.0017</td>
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<tr>
<td>D(LNL)</td>
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<td>0.192004</td>
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<td>0.0000</td>
</tr>
<tr>
<td>D(LNER)</td>
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<td>0.056721</td>
<td>-6.640509</td>
<td>0.0000</td>
</tr>
<tr>
<td>D(LNEDX)</td>
<td>0.225403</td>
<td>0.025208</td>
<td>8.941626</td>
<td>0.0000</td>
</tr>
<tr>
<td>D(LNRX)</td>
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<td>-0.115187</td>
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Variance Equation

<table>
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<th>z-Statistic</th>
<th>Prob.</th>
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</thead>
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<tr>
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<td>0.288098</td>
<td>-13.79611</td>
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<tr>
<td>[RES/SQR[GARCH])(1)</td>
<td>-0.824059</td>
<td>0.135042</td>
<td>-6.102249</td>
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<tr>
<td>RES/SQR<a href="1">GARCH</a></td>
<td>-1.106500</td>
<td>0.109750</td>
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Appendix 9: Multisector Equation Coefficient Estimates

Independent Variable: LNYA

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<tr>
<th>Regressors</th>
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<td>LNYI</td>
<td>0.351062</td>
<td>0.053201</td>
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<tr>
<td>ΔLNEDX</td>
<td>0.304315</td>
<td>0.038501</td>
<td>7.903344</td>
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<tr>
<td>ΔLNHX(-2)</td>
<td>-0.114279</td>
<td>0.033709</td>
<td>-3.390145</td>
<td>0.0007</td>
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<tr>
<td>ΔLNRX(-3)</td>
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<td>0.011688</td>
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<tr>
<td>LNYA(-1)</td>
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<td>0.044282</td>
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<td>ΔLNYI(-1)</td>
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<td>ΔLNYS(-1)</td>
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Variance Equation

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<tr>
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Note: Bollerslev-Wooldrige robust standard errors & covariance
### Appendix 10: Vector Error Correction Estimates for Agriculture

D.F. =30; |t|-critical values: 0.683 =25%; 1.310 = 10%; 1.697 = 5%; 2.457=1%

<table>
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<td>t-stat</td>
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<td>Φ₁₁</td>
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</tr>
<tr>
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<td>-5.579462*</td>
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<td>D(LNRX(-1))</td>
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<tr>
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<td>Φ₅</td>
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<td>Φ₁₇</td>
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<table>
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<th></th>
<th>R-squared</th>
<th>Adj. R-squared</th>
<th>S.E. equation</th>
<th>F-statistic</th>
<th>Log likelihood</th>
<th>Akaike AIC</th>
<th>Schwarz SC</th>
<th>S.D. dependent</th>
<th>Determinant Residual Covariance</th>
<th>Log Likelihood</th>
<th>Akaike Information Criteria</th>
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Parameter coefficients are significant at: * at 25%; ** at 10%; *** at 5%; **** at 1%
Appendix 11: Vector Error Correction Estimates for Services

D.F. = 30; |t|-critical values: 0.683 = 25%; 1.310 = 10%; 1.697 = 5%; 2.457 = 1%

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<th>Cointegrating Equation 2</th>
<th>Cointegrating Equation 3</th>
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<tbody>
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<td>D(LNIR(-1))</td>
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<td>$\infty$</td>
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<td>$\infty$</td>
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Parameter coefficients are significant at: * at 25%; ** at 10%; *** at 5%; **** at 1%
## Appendix 12: Vector Error Correction Estimates for Industry Output

D.F. = 30; |t|-critical values: 0.683 = 25%; 1.310 = 10%; 1.697 = 5%; 2.457 = 1%

Parameter coefficients are significant at: * at 25%; ** at 10%; *** at 5%; **** at 1%

### Cointegrating Eq:

<table>
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<tr>
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<th>Cointegrating Equation 1</th>
<th>Cointegrating Equation 2</th>
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</thead>
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### Error Correction:

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R-squared 0.586043
Adj. R-squared 0.428345
Sum sq. resids 1.254205
S.E. equation 0.244385
F-statistic 3.716241
Log likelihood 5.052276
Akaike AIC 0.263182
Schwarz SC 0.683541
Mean dependent 0.090022
S.D. dependent 0.323227

Determinant Residual Covariance 7.32E-11
Log Likelihood 94.65029
Akaike Information Criteria -1.910020
Schwarz Criteria 1.172615
### Appendix 13: Vector Error Correction Estimates for Multi-sector Output
D.F. =30; [t]-critical values: 0.683 =25%; 1.310 = 10%; 1.697 = 5%; 2.457=1%

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### Error Correction: D(LNYA) D(LNYI)

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<tr>
<td>$\beta_2$</td>
<td>0.346743*</td>
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<tr>
<td>$\beta_3$</td>
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<td>0.65092</td>
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<tr>
<td>$\beta_4$</td>
<td>0.700307</td>
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<td>$\beta_5$</td>
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<td>0.54336</td>
</tr>
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<td>$\beta_6$</td>
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<td>0.33842</td>
</tr>
<tr>
<td>$\beta_7$</td>
<td>0.156100</td>
<td>0.37864</td>
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<tr>
<td>$\beta_8$</td>
<td>-0.213417</td>
<td>2.65639</td>
</tr>
<tr>
<td>$\beta_9$</td>
<td>-1.439754</td>
<td>4.06983</td>
</tr>
<tr>
<td>$\beta_{10}$</td>
<td>-0.153209*</td>
<td>0.22445</td>
</tr>
<tr>
<td>$\beta_{11}$</td>
<td>0.083052</td>
<td>0.14333</td>
</tr>
<tr>
<td>$\beta_{12}$</td>
<td>0.048611</td>
<td>0.11695</td>
</tr>
<tr>
<td>C</td>
<td>$\beta_{13}$</td>
<td>-0.006955</td>
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R-squared 0.289105 0.301981
Adj. R-squared -0.212704 -0.190739
S.E. equation 0.255944 0.352709
F-statistic 0.576125 0.612885
Log likelihood 6.835533 -2.785002
Akaire AIC 0.410964 1.052333
Schwarz SC 1.018150 1.659519
S.D. dependent 0.232417 0.323227

Parameter coefficients are significant at: * at 25%; ** at 10%; *** at 5%; **** at 1%
## Appendix 13 Cont’d:

**Vector Error Correction Estimates for Multi-sector Output**

D.F. = 30; [t]-critical values: 0.683 = 25%; 1.310 = 10%; 1.697 = 5%; 2.457 = 1%

### Cointegrating Eq:

<table>
<thead>
<tr>
<th>CointEq3</th>
<th>Parameter</th>
<th>St. err</th>
<th>t-stat</th>
<th>CointEq4</th>
<th>Parameter</th>
<th>St. err</th>
<th>t-stat</th>
</tr>
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<td>LNYA(-1)</td>
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<td></td>
<td>ε35</td>
<td>0.000000</td>
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<td></td>
</tr>
<tr>
<td>LNYI(-1)</td>
<td>ε25</td>
<td>0.000000</td>
<td></td>
<td>ε36</td>
<td>0.000000</td>
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<td></td>
</tr>
<tr>
<td>DL(LNYS(-1))</td>
<td>ε26</td>
<td>1.000000</td>
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<td>ε37</td>
<td>0.000000</td>
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<tr>
<td>LNLI(-1)</td>
<td>ε27</td>
<td>0.000000</td>
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<td>ε38</td>
<td>1.000000</td>
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<td></td>
</tr>
<tr>
<td>LN5MR(-1)</td>
<td>ε28</td>
<td>4.169503 ***</td>
<td>2.38243</td>
<td>1.75010</td>
<td>ε39</td>
<td>1.514727 *</td>
<td>1.66150</td>
</tr>
<tr>
<td>DLNLNX(-1)</td>
<td>ε29</td>
<td>-0.293130 ***</td>
<td>0.19635</td>
<td>-1.49283</td>
<td>ε40</td>
<td>-0.290318 ***</td>
<td>0.13694</td>
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<tr>
<td>DLNRX(-1)</td>
<td>ε30</td>
<td>-0.051630</td>
<td>0.13358</td>
<td>-0.38574</td>
<td>ε41</td>
<td>-0.165843 ***</td>
<td>0.09334</td>
</tr>
<tr>
<td>DTREND(75)</td>
<td>ε31</td>
<td>-0.143794 *</td>
<td>0.16692</td>
<td>-0.86144</td>
<td>ε42</td>
<td>0.230329 ***</td>
<td>0.11641</td>
</tr>
<tr>
<td>C</td>
<td>ε32</td>
<td>0.048225 ***</td>
<td>0.0281</td>
<td>1.71206</td>
<td>ε43</td>
<td>0.006562</td>
<td>0.01964</td>
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<td></td>
<td>ε33</td>
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<td>-11.83709</td>
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### Error Correction:

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<thead>
<tr>
<th>D(LNYS,2)</th>
<th>D(LNL1)</th>
<th>D(LNSR,1)</th>
<th>D(LN5MR(-1))</th>
<th>D(LNEDX(-1,2))</th>
<th>D(LNAX(-1,2))</th>
<th>D(LNRX(-1,2))</th>
<th>C</th>
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<tbody>
<tr>
<td>CointEq1</td>
<td>ε1</td>
<td>-0.661576 ***</td>
<td>0.30104</td>
<td>-2.19761</td>
<td>γ1</td>
<td>0.050087 ***</td>
<td>0.02709</td>
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<tr>
<td>CointEq2</td>
<td>ε12</td>
<td>0.277902 *</td>
<td>0.25539</td>
<td>1.08814</td>
<td>γ12</td>
<td>-0.047972 ***</td>
<td>0.02298</td>
</tr>
<tr>
<td>CointEq3</td>
<td>ε23</td>
<td>-1.407521 ***</td>
<td>0.58093</td>
<td>-2.42289</td>
<td>γ23</td>
<td>-0.051996 *</td>
<td>0.05228</td>
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<tr>
<td>CointEq4</td>
<td>ε34</td>
<td>5.969349 ****</td>
<td>2.16637</td>
<td>2.75546</td>
<td>γ34</td>
<td>-0.191821 *</td>
<td>0.19497</td>
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<tr>
<td>DLNLNY(-1)</td>
<td>ε45</td>
<td>0.899597 ***</td>
<td>0.48493</td>
<td>1.85510</td>
<td>γ45</td>
<td>-0.046311 *</td>
<td>0.04364</td>
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<tr>
<td>DLNLNY(-1)</td>
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<td>-0.115405</td>
<td>0.30203</td>
<td>-0.38210</td>
<td>γ46</td>
<td>0.059948 ***</td>
<td>0.02718</td>
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<tr>
<td>DLNLNY(-1,2)</td>
<td>ε47</td>
<td>0.058983</td>
<td>0.33792</td>
<td>0.17455</td>
<td>γ47</td>
<td>0.009147</td>
<td>0.03041</td>
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<tr>
<td>DLNLNI(-1,2)</td>
<td>ε48</td>
<td>-5.471558 ***</td>
<td>2.37074</td>
<td>-2.30795</td>
<td>γ48</td>
<td>-0.295926 ***</td>
<td>0.21336</td>
</tr>
<tr>
<td>DLNL5MR(-1)</td>
<td>ε49</td>
<td>4.878190 **</td>
<td>3.63219</td>
<td>1.34304</td>
<td>γ49</td>
<td>0.926973 ****</td>
<td>0.32689</td>
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<tr>
<td>DLNL5MR(-1,2)</td>
<td>ε50</td>
<td>-0.158736 *</td>
<td>0.20032</td>
<td>-0.79243</td>
<td>γ50</td>
<td>-0.008445</td>
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<tr>
<td>DLNLNX(-1,2)</td>
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<td>0.282251 ***</td>
<td>0.12792</td>
<td>2.20653</td>
<td>γ51</td>
<td>-0.029341 ****</td>
<td>0.01151</td>
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<tr>
<td>DLNLNX(-1,2)</td>
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<td>0.10438</td>
<td>0.44276</td>
<td>γ52</td>
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<td>0.00939</td>
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<tr>
<td>C</td>
<td>ε53</td>
<td>0.132602 ***</td>
<td>0.06327</td>
<td>2.09596</td>
<td>γ53</td>
<td>0.022288 ***</td>
<td>0.00569</td>
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- R-squared: 0.799794
- Adj. R-squared: 0.6658472
- S.E. equation: 0.228421
- F-statistic: 5.659385
- Log likelihood: 10.24850
- Schwarz SC: 0.790619
- S.D. dependent: 0.390862

Determinant Residual Covariance: 4.07E-19
Log Likelihood: 294.6366
Akaike Information Criteria: -10.30910
Schwarz Criteria: -3.770182

Parameter coefficients are significant at: * at 25%; ** at 10%; *** at 5%; **** at 1%
### Appendix 14: Pair-wise Granger Causality Tests for Agriculture (2 Lags)

<table>
<thead>
<tr>
<th>Null Hypothesis</th>
<th>Obs</th>
<th>F-Statistic</th>
<th>Probability</th>
<th>Decision</th>
</tr>
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<tbody>
<tr>
<td>LNLA does not Granger Cause D(LNYA)</td>
<td>30</td>
<td>0.20196</td>
<td>0.81845</td>
<td>Reject</td>
</tr>
<tr>
<td>D(LNYA) does not Granger Cause LNLA</td>
<td></td>
<td>0.79691</td>
<td>0.46184</td>
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</tr>
<tr>
<td>LNU5MR does not Granger Cause D(LNYA)</td>
<td>30</td>
<td>0.09499</td>
<td>0.90971</td>
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</tr>
<tr>
<td>D(LNYA) does not Granger Cause LNU5MR</td>
<td></td>
<td>0.07854</td>
<td>0.92469</td>
<td>Reject</td>
</tr>
<tr>
<td>LNLI does not Granger Cause D(LNYA)</td>
<td>30</td>
<td>0.13555</td>
<td>0.87388</td>
<td>Reject</td>
</tr>
<tr>
<td>D(LNYA) does not Granger Cause LNLI</td>
<td></td>
<td>0.00350</td>
<td>0.99651</td>
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</tr>
<tr>
<td>D(LNRX) does not Granger Cause D(LNYA)</td>
<td>30</td>
<td>0.00164</td>
<td>0.99836</td>
<td>Reject</td>
</tr>
<tr>
<td>D(LNYA) does not Granger Cause D(LNRX)</td>
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<td>1.08201</td>
<td>0.35426</td>
<td>Reject</td>
</tr>
<tr>
<td>D(LNF) does not Granger Cause D(LNYA)</td>
<td>30</td>
<td>0.01070</td>
<td>0.98936</td>
<td>Reject</td>
</tr>
<tr>
<td>D(LNYA) does not Granger Cause D(LNF)</td>
<td></td>
<td>3.84329</td>
<td>0.03505</td>
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### Appendix 15: Pair-wise Granger Causality Tests for Services (2 Lags)

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<tr>
<th>Null Hypothesis</th>
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<th>F-Statistic</th>
<th>Probability</th>
<th>Decision</th>
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<tr>
<td>D(LNIR) does not Granger Cause D(LNYS)</td>
<td>30</td>
<td>0.84491</td>
<td>0.44150</td>
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<tr>
<td>D(LNYS) does not Granger Cause D(LNIR)</td>
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<td>0.12473</td>
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<tr>
<td>LNLI does not Granger Cause D(LNYS)</td>
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<td>0.88179</td>
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<tr>
<td>D(LNYS) does not Granger Cause LNLI</td>
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<td>0.02220</td>
<td>0.97806</td>
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</tr>
<tr>
<td>D(LNER) does not Granger Cause D(LNYS)</td>
<td>30</td>
<td>0.73185</td>
<td>0.49104</td>
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<tr>
<td>D(LNYS) does not Granger Cause D(LNER)</td>
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<td>5.82198</td>
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<tr>
<td>D(LNHX) does not Granger Cause D(LNYS)</td>
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<td>3.75230</td>
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<tr>
<td>D(LNYS) does not Granger Cause D(LNHX)</td>
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<td>0.59482</td>
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<tr>
<td>D(LNEDX) does not Granger Cause D(LNYS)</td>
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<td>4.03139</td>
<td>0.03037</td>
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</tr>
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<td>D(LNYS) does not Granger Cause D(LNEDX)</td>
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<td>0.60091</td>
<td>0.55604</td>
<td>Reject</td>
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<tr>
<td>D(LNRX) does not Granger Cause D(LNYS)</td>
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<td>0.80214</td>
<td>0.45957</td>
<td>Reject</td>
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<tr>
<td>D(LNYS) does not Granger Cause D(LNRX)</td>
<td></td>
<td>2.11864</td>
<td>0.14127</td>
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</table>
### Appendix 16: Pair-wise Granger Causality Tests for Industry (2 Lags)

<table>
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<th>Null Hypothesis</th>
<th>Obs</th>
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<th>Probability</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>LNGSE does not Granger Cause LNYI</td>
<td>31</td>
<td>6.12587</td>
<td>0.00661</td>
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<tr>
<td>LNYI does not Granger Cause LNGSE</td>
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<td>0.24832</td>
<td>0.78194</td>
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</tr>
<tr>
<td>D(LNEDX) does not Granger Cause LNYI</td>
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<td>0.93360</td>
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<tr>
<td>LNYI does not Granger Cause D(LNEDX)</td>
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<td>0.39591</td>
<td>0.67721</td>
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</tr>
<tr>
<td>D(LNIR) does not Granger Cause LNYI</td>
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<td>1.39320</td>
<td>0.26690</td>
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<td>LNYI does not Granger Cause D(LNIR)</td>
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<td>0.86268</td>
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<td>0.74725</td>
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<td>1.23459</td>
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### Appendix 17: Pair-wise Granger Causality Tests across Sectors (2 Lags)

<table>
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<th>Null Hypothesis</th>
<th>Obs</th>
<th>F-Statistic</th>
<th>Probability</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>LNYI does not Granger Cause LNYA</td>
<td>31</td>
<td>1.23459</td>
<td>0.30745</td>
<td>Reject</td>
</tr>
<tr>
<td>LNYA does not Granger Cause LNYI</td>
<td></td>
<td>3.43382</td>
<td>0.04750</td>
<td>Accept</td>
</tr>
<tr>
<td>D(LNYS) does not Granger Cause LNYA</td>
<td>30</td>
<td>0.05588</td>
<td>0.94577</td>
<td>Reject</td>
</tr>
<tr>
<td>LNYA does not Granger Cause D(LNYS)</td>
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<td>6.32477</td>
<td>0.00599</td>
<td>Accept</td>
</tr>
<tr>
<td>D(LNYS) does not Granger Cause LNYI</td>
<td>30</td>
<td>2.42300</td>
<td>0.10919</td>
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<td>LNYI does not Granger Cause D(LNYS)</td>
<td></td>
<td>2.52523</td>
<td>0.10026</td>
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Figure A2: Standardized Residual Graphs of Fitted Models’ Residuals

Industry Model Residuals

Agriculture Model Residuals

Services Model Residuals

Multisector Model Residuals
Appendix 18: VAR Impulse Response Analysis

Figures A4: Variance Decomposition of the Services VAR
Figures A6: Variance Decomposition of the Industry VAR

- Variance Decomposition of LNIND
- Variance Decomposition of LNDE
- Variance Decomposition of DLNEDEXP
- Variance Decomposition of DLNINTRATE
- Variance Decomposition of LNUMEDOM
- Variance Decomposition of LNYAGRIC
Figures A8: Variance Decomposition of the Agriculture VAR

Variance Decomposition of D(LNYAGRIC)

Variance Decomposition of LNLABORAG

Variance Decomposition of LNU5MR

Variance Decomposition of LNLITE

Variance Decomposition of D(LNROADEXP)

Variance Decomposition of D(LNFERT)
Figures A9 Variance Decomposition of the Multisector VAR