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**Sources of Economic Growth in Zambia, 1970-2013: A Growth Accounting Approach**

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**Abstract**

Most empirical work on sources of economic growth for different countries lack country-specific empirical evidence to guide policy choices in individual developing countries and previous studies of factor productivity tend to focus on the entire economy or a single sector. In this study, we use the recently developed growth accounting tools to explicitly determine the sources of economic growth at both national and sectoral levels in Zambia between 1970 and 2013. We use data from World Development Indicators and Zambia's Central Statistical Office. On average, total factor productivity (TFP) contributes about 5.7% to economic growth. Sectoral analysis shows that agriculture contributes the least to GDP and that within each sector; factors that contribute to growth differ. Structural transformation has been slow and contributed to the observed inefficiency. We outline the implications of the observed growth and provide recommendations.

*Keywords*: Total factor productivity; growth accounting; economic growth; Zambia.

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## 1.0 Introduction

Economic growth, an important concept of development economics is a crucial step in the development ladder and the achievement of a high and sustainable rate of economic growth remains a central theme for many world economies. Recent years have witnessed a growing debate on determinants of economic growth and income distribution across countries. Empirical studies have shown that economic growth rates differ among countries due to technology adoption (Romer, 1986 [1]; Aghion and Howitt, 1989 [2]), varying determinants of efficiency of savings and investment (World Bank, 1990 [3]) and differing rates of accumulation of physical and human capital resources (Solow, 1956 [4]; Mankiw *et al.* 1992 [5]). For least developed countries (LDCs) in Sub-Saharan Africa (SSA), availability of natural resources, poor economic policies, access to the sea, tropical climate, volume of exports, a longer life expectancy and increased investment rates are some of the factors that drive economic growth (Sachs and Warner, 1997 [6]; Upreti, 2015 [7]).

Though the amount of empirical papers investigating the sources of economic growth for different countries has expanded significantly, country-specific empirical evidence to guide policy choices in individual developing countries remains arcane (Chirwa and Odhiambo, 2016 [8]). Policy makers and political economists in least developed countries strive to tackle the enigma of slow economic growth rates (or lack of it) recorded by their economies. For example, the empirical evidence of slow economic growth rate for African economies is generally sourced from cross-country regressions which fail to take care of individual country diversity of experiences (Altug et *al.,* 2007 [9]; Anyanwu, 2014 [10]; Chirwa and Odhiambo, 2016 [8]). Such studies could only be of vast importance at regional but not at individual country level. In addition, little empirical work has closely examined determinants of economic growth for most developing countries and Zambia is no exception. For example, we are aware only of Chirwa and Odhiambo (2016 [8]) that empirically determine Zambia's macroeconomic determinants of economic growth. Their study does not reveal factor productivity of the Zambian economy or any of the broad economic sectors *viz*; agriculture, industry and service.

Further, previous studies of factor productivity tend to focus on the entire economy or a single sector of the economy. As Herrendorf *et al.* (2013 [11])and Johnson (1970 [12]) have pointed out; a fundamental feature of growth is a decline in the agriculture's sectoral and labour share in total value-added, an increase in the service sector's share in value added and labour, while industry's shares may rise or fall depending on a number of factors. Thus this study takes a more comprehensive approach by estimating

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Zambia's sources of economic growth by sectors; agriculture, industry and service in a systematic manner that yields insights into the country's sources of structural transformation. Our integrated approach to measuring factor productivity provides insights into the sources of structural transformation not otherwise obtainable from just an economy-wide or a single sector approach. We do so by employing a sectoral analysis mainly separated into two time periods—before the structural adjustment programmes (1970-1991) and post-reforms (1992-2013). This distinction allows us to capture underlying differences in sectoral contribution to economic growth which is extremely important as pre and post reform periods have had important implications on Zambia's economic growth (Ndulo and Mudenda, 2010 [13]).

Zambia is a least developed country located in SSA and agriculture is the mainstay of about 70% of the population (Human Development Report (HDR), 2015 [14]). Approximately the same fraction of people whose primary economic activity is agriculture lives in the rural areas and about 77% of them are poor (Central Statistical Office (CSO), 2016 [15]). Agriculture, further, contributes, on average, about 18% to GDP. For the industry sector, it has varied in magnitude since Zambia's independence in 1964. Ndulo and Mudenda (2010 [13]) showed that industry sector contributed 6% to Gross Domestic Product (GDP) but its contribution rose significantly between 1964 and 1975. Its contribution to the share of exports is mainly concentrated in total non-traditional exports though it was quite volatile over the years (Ndulo and Mudenda, 2010 [13]). The service sector is Zambia's largest formal employment sector and its growth between 1965 and 2002 stood at 3% per annum and strong performance in the tourism, transport and telecommunications sectors have contributed to the continued rise in the services sector (CSO, 2016 [15]).

Taken together, these facts reflect the importance of the three sectors to Zambia's economy. The achievement of the Zambian government's goal of food security and efficiency in both industry and service sectors may have to rely on improved productivity in all three sectors. It follows that measurement and therefore a comparison of TFP in all the sectors is crucial for providing insightful answers to questions such as: where has resource efficiency been concentrated, as among agriculture, industry, and the service-producing sectors? To the best of our knowledge, no empirical studies exist that provide TFP estimates in both industry and services sectors for Zambia perhaps due in part to unavailability or considerable doubt of the how reliable existing data are. Some researchers have recently made considerable efforts to estimating productive efficiency in agriculture but none of them have explicitly incorporated estimates of agricultural TFP in Zambia. They have instead used partial measures such as technical efficiency in crop production in a selected region in Zambia (see Chiona, 2014 [16]; Musaba and Bwacha, 2014 [17]; Ng'ombe and Kalinda, 2015 [18]; Abdulai and Abdulai, 2016 [19]). Though these measures are useful to providing sub-sectoral

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perspectives, they do not provide a broad outlook of general productivity growth of the agricultural sector. Thus the second objective of this study is to determine the sources of growth within each sector. Unlike some studies that consider only capital and labour, we include land in our analysis, which is a key resource for agriculture's sectoral growth.

In the following sections, we first present a brief background of the three sectors, the methodology and the data sources. We proceed to the results and discussion section and then the last section highlights the conclusions and policy implications.

## 2.0 Background

### 2.1 Agricultural sector

Maize (*Zea mays* L.) dominates Zambia's agriculture and its production dates back to the 16$^{th}$ Century, the period when Zambia's main staple crops were sorghum *(Sorghum bicolar* L.) and millet *(Eleusine coracana* L.). Maize gradually replaced sorghum and millet as the country's staple crops and by 1964, maize had already accounted for more than 60% of Zambia's total planted area for major crops (Byerlee and Carl, 1997 [20]). Up to early 1990s, the sector was still dominated by maize and lacked private sector participation in the areas of agricultural marketing, input supply and processing. In 1992, the Zambian government embraced agricultural sector policy reforms, as part of the general economic reforms that fell under pursuit of the structural adjustment programmes. These were targeted at liberalizing the agricultural sector alongside promoting private sector participation in the agricultural supply chain (Ministry of Agriculture and Co-operatives (MACO), 2004 [21]).

Zambia's agriculture is dominated by smallholder farmers and is still underdeveloped (Chirwa and Odhiambo, 2016 [8]). However, Zambia still has the potential to expand its agricultural production, owing to its massive resource endowment in arable land, labour and water resources. Bordered by eight countries and being a member of the Common Market for Eastern and Southern Africa (COMESA) and the Southern African Development Community (SADC) bolsters its market for agricultural produce. The country has access to the European Union agricultural markets through the Everything but Arms (EBA) initiative in addition to access to the U.S. market through the African Growth Opportunities Act (AGOA). By 2009, exports of agricultural products from Zambia to COMESA had reached a total of 125 million US$ and to the European Union a total of 147 million US$ (Ndulo and Mudenda, 2010 [13]).

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### 2.2 Industry sector

After Zambia's independence from Britain in 1964, the industry sector contributed about 6% to GDP and copper accounted for over 90% of foreign exchange. Between 1964 and 1975, the country experienced rapid economic growth relative to earlier periods and other countries in SSA. This growth rate was attributed to increased investments in industry sector whose proportion of total investment rose from about 7% in 1964 to about 12% in 1980 (Ndulo and Mudenda, 2010 [13]). Between 1964 and 1991, the share of value added in the industry sector rose at 15% and manufactured goods also diversified.

**Table 1. Proportion of Manufactured Products Exported from Zambia by Year**

| Product | 1992 | 1995 | 2001 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|
| Building materials (%) | 6.2 | 4.9 | 5.6 | 3.2 | 2.9 | 1.7 | 5.5 |
| Chemical products (%) | 3.2 | 1.9 | 4.7 | 7.9 | 4.1 | 8.3 | 14.3 |
| Engineering products (%) | 40.2 | 32.8 | 16.7 | 36.9 | 58.7 | 45.5 | 46.3 |
| Textiles and garments (%) | 24.3 | 29.0 | 27.0 | 10.5 | 4.0 | 4.8 | 4.1 |
| Leather (%) | 0.6 | 1.0 | 3.1 | 1.5 | 1.0 | 1.3 | 1.6 |
| Petroleum oils (%) | 1.8 | 9.0 | 1.3 | 5.5 | 2.7 | 4.4 | 4.0 |
| Processed foods (%) | 23.0 | 21.3 | 33.8 | 25.6 | 21.1 | 24.8 | 18.8 |
| Other manufactures (%) | 0.6 | 0.0 | 7.2 | 8.5 | 5.0 | 8.4 | 4.4 |
| Non-metallic (%) | 0.1 | 0.1 | 0.7 | 0.4 | 0.5 | 0.7 | 1.1 |
| Total manufactures (%) | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

Source: Ndulo and Mudenda, 2010.

Commonly manufactured commodities such as food and beverages reduced from 52% in 1970 to about 22% in 1980 while chemical products increased in the same period. But manufactured commodities contributed about 0.7% to the total exports. These mainly comprised copper cable, menswear, sugar and molasses, cement, crushed stone and lime and explosives as of 1980 (Ndulo and Mudenda, 2010 [13]). A summary of contribution of output from the industry sector from 1992 to 2008 is presented in table 1.

Following the structural adjustment programmes in 1990s, industry value added to GDP dropped from 15 to about 9.5% (Ndulo and Mudenda, 2010 [13]). Inflation rose to 69% in the 1990s from about 11.6% in the 1980s. It averaged around 127% between 1990 and 1993. By 1995, inflation rate was about 25% and was maintained this way till 2000. The exchange rate rapidly depreciated and the real interest rates were negatively large (Dijohn, 2010 [22]).

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### 2.3 Services sector

The Services sector captures the monetary value of such service as finance, communications, transport, distribution, health, education, tourism and foreign direct investment. We also consider trade services to encompass cross-border trade by both road and air transport. Between 1960 and 2002, about 90% of Zambia's economic growth was attributed to service sector growth and since 2002, it has continued to contribute about 50% of GDP's growth rate (Matoo and Payton, 2007 [23]).

The services sector's growth rate was low before 2002 and Mattoo and Payton (2007 [23]) contend that government intervention and structural adjustment programs could be the causes. For example, government had continued to regulate the telecommunications industry. The telecommunications sector had not been fully liberalised as government continues to limit the number of players. In general, other changes in sub-sectors under the services sector have also contributed to changes in the services sector over the years. For example, the Consumer Unity and Trust Society (CUTS) (2008 [24]) estimates that Zambia's tourism sector's contribution to GDP was about 2.4% from 2001 to 2006. The transport and communication sectors grew by 6.5% in 2004. CUTS (2008 [24]) attribute this growth rate to increased economic output and activities in sectors such as agriculture and mining, with value added arising from a relatively active tourism sector. Being such a large sector, it follows that determining its productivity is necessary to understanding its efficiency and contribution to overall economic growth.

## 3.0 Methodology

Estimation of TFP dates back to studies by Solow (1957 [25]) and for more than a decade, a share of empirical studies on TFP has expanded significantly. These studies have estimated TFP using different methodologies. Available methods include indexing methods, non-parametric approaches such as the Malmquist-type index, data envelopment analysis (DEA) and the parametric stochastic frontier analysis (SFA). Many statistical agencies, such as the U.S. Bureau of Labour Statistics use the Growth Accounting Techniques based on Törnqvist indices to determine market sector multifactor productivity. Despite a variety of estimation methods, estimation of TFP has a common feature: it is founded on the theory of a production function which is commonly specified as a real valued function of capital (K), labour (L) and technology. Technology is typically assumed to be Hicks neutral, exogenous and homogenous across countries.

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Studies by Hayami and Ruttan (1985 [26]) and Wen (1993 [27]) used index methods, while Coelli and Rao (2005 [28]) use a DEA framework — an approach that uses mathematical programming techniques to evaluate the relative performance of a set of peer entities called decision making units (DMU) that convert (one or more) inputs into (one or more) outputs. While indexing methods might be simple to apply, Wang *et al.* (2009 [29]) note that their main difficulty is in determining the kind of index to use. The DEA framework is a powerful tool but has its shortcomings. For example, it is not based explicitly on an assumed statistical model and thus the properties of the efficiency estimates are ambiguous (Greene, 2008 [30]). Greene (2008 [30]) noted that the estimators from DEA framework do not naturally produce standard errors for the coefficients which SFA is able to. SFA pioneered by Aigner *et al.* (1977 [31]) and Meeusen and van den Broeck (1977 [32]), has also extensively been used to determine productive efficiency.

Greene (2008 [30]) shows that SFA possesses an advantage over DEA framework in production efficiency studies because it possesses the 'stochastic' aspect that enables it to handle more appropriately measurement problems and other stochastic influences that would elsewhere show up as sources of inefficiency. Despite that strength, Wang *et al.* (2009 [29]), notes that SFA is not free from endogeneity of independent variables and there exists some difficulty of estimation by maximum likelihood estimation. Our study does not delve into constant quality price indices and dual approaches to growth accounting as used by many. Our major contribution is the use of economic theory to guide estimation of sectoral resource stocks using secondary data sources which in turn allows estimation of TFP. Unlike previous studies, this study mainly uses the recently developed growth accounting methods by Roe *et al.* (2014 [33]) to estimate total factor productivity underpinned by neoclassical growth theory. We use Roe *et al.* (2014 [33])'s methodology because it facilitates the use of more easily available time series data than reliance of micro level data that is seldom available across sectors of the economy.

Following Roe *et al.* (2014 [33]), the approach permits establishing whether a sector contributes its "fair share" to economic growth and also provides insights into the effects of intermediate factors of production on economic growth thereby identification of TFP from Solow residual. Let nominal economy GDP at equilibrium be defined as

$$Y_n = p_1 Y_1 + p_2 Y_2 = r^k K + wH \quad (1)$$

where the nominal values added in this two sector-two final good economy are the price terms $p_j$, $j$=1,2; $Y_n$ is value added, $Y_1$, $Y_2$ are output values, $K$ is physical capital, $H$ is human capital, $r^k$ for $K$ and $w$ for $H$ are factor rental prices equal to their marginal value products at equilibrium. A GDP function can therefore

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be defined for an economy producing any number of final goods and that the GDP function could help to distinguish the importance of imported intermediate factors of production, such as energy, chemicals and transportation services among others. Assuming an economy with both nominal and real GDP values and a two sector economy employing neoclassical technologies to produce two final goods, $Y_1$ and $Y_2$, using the services of capital $K$ and labour $H$

$$Y(t) = F^j\left(K(t)_j, A(t)H(t)_j\right), \qquad A(t) = e^{xt}, j = 1,2 \text{ (Roe } et\ al. \text{ 2014 [33])}$$

Economic theory postulates that holding $p_1$ and $p_2$ constant, say their values in period $t^*$, real GDP can be interpreted, denominated in period $t^*$ constant prices as

$$Y^{\text{real}}(t) = p_1(t^*)Y_1(t) + p_2(t^*)Y_2(t)$$

Letting $Y_j(t)$ be the equilibrium value of good $j$ in a small and open Hecksher-Ohlin (H-O) economy, the GDP value obtained equals the value obtained upon solving the following problem for each period $t$. For simplicity, dropping the ($t$) notation, we obtain the following

$$Y = G(p_1, p_{2,} K, AH) \equiv \underset{\{K_1, K_2, L_1, L_2\}}{Max} \left\{ \sum_j p_j Y^j(K_j, AH_j) \mid \sum_j K_j \leq K, \sum_j H_j \leq H \right\} \quad (2)$$

$A$ is constant and the function $G(.)$ is homogenous of degree one in prices and $AH$ and $K$. By envelope properties of $G(.)$ (see Woodland, 1982 [34]), and considering equation (2) in real terms, the left hand side of equation (2) is an appropriate aggregator of individual sector technologies $Y^j(K_{j,} AH_j)$. In short, an aggregator of the sector production function $Y^j(K_{j,} AH_j)$ with their production "competitive" market determined levels of inputs $K, AH$ yielding $K, AH$ is equation (2) which is the GDP function. equivalent to an aggregate production function regardless of its functional form. Following Roe *et al.* (2014 [33]), allowing prices to vary, the nominal price effect on changes on $Y_n$ would be as follows

$$\frac{\dot{Y}_n}{Y_n} = \frac{1}{G(.)} = \overbrace{G_{p1}(.)}^{=y1} p_1 \frac{\dot{p}_1}{p_1} + \overbrace{G_{p2}(.)}^{=y2} p_2 + \overbrace{G_K(.)}^{=r^k} K \frac{\dot{K}}{K} + \overbrace{G_{AH}(.)}^{=\hat{w}} \left( A \frac{\dot{A}}{A} H + A \frac{\dot{L}}{L} H \right)$$

where $\dot{A}/A = x$. The value of $\hat{w}$ is determined from the firm's optimization problem

$$\max_{L,K} pf(AL, K) - wL - r^k K$$

where

$$pf_{AL}A = w \qquad pf_K = r^k \Rightarrow pf_{AL} = \frac{w}{A} = \frac{w}{e^{xt}} \equiv \hat{w}$$

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Therefore with $\hat{w} = wA^{-1}$, we have; $\frac{\dot{Y}_n}{Y_n} = \frac{Y_1 p_1}{G(.)p_1}\dot{p}_1 + \frac{Y_2 p_2}{G(.)p_2}\dot{p}_2 + \frac{r^k K}{G(.)K}\dot{K} + \frac{wH}{G(.)}\left(x + \frac{\dot{H}}{H}\right)$

By additional simplification, we obtain equation (3).

$$\frac{\dot{Y}_n}{Y_n} = s_1\frac{\dot{p}_1}{p_1} + s_2\frac{\dot{p}_2}{p_2} + S_K\frac{\dot{K}}{K} + (1 - S_K)\left(x + \frac{\dot{H}}{H}\right) \tag{3}$$

where $s_j$ is the sector shares in GDP. The last term in equation (3) is the Solow residual. In order to deal with the price terms, equation (3) is expressed as follows

$$\overbrace{\frac{Y_n}{Y_n} - \left(s_1\frac{\dot{p}_1}{p_1} + s_2\frac{\dot{p}_2}{p_2}\right)}^{\text{real GDP growth}} = \frac{\overbrace{\dot{Y}}^{\text{real GDP}}}{Y} = (1 - S_K)\left(x + \frac{\dot{H}}{H}\right) + S_K\frac{\dot{K}}{K} \tag{12}$$

With these results, Roe *et al.* (2014 [33]) establish the proposition that growth accounting with a multi-sector GDP function as the underlying construct gives identical results as an aggregate production function albeit without an aggregation problem. Further analytical illustrations to derive sectoral TFPs are presented in the appendix.

## 4.0 Data

Data used in this study come from the World Bank's World Development Indicators (WDI) and Central Statistical Office (CSO)[1]—the national statistics bureau in Zambia. WDI did not have all data for all the variables of interest and CSO data were instead used if available in such cases. For example, the WDI data did not have estimates of labour force shares by sector while CSO had for about four years. In total, our data have 29 variables observed over a period of 44 years (from 1970 to 2013). Two series, gross Fixed Capital formation (investment) and employment shares by sector had to be reconstructed as indicated below. The rest of the series were complete. Finally, for economy-wide and sectoral level factor shares, we use the Global Trade Analysis Project (GTAP) values for 2007. There were no other credible estimates we could find for Zambia except these provided by GTAP as shown in table 2.

[1] We are aware of the challenges arising from differences in national and WDI data. But Zambia, as shown by Jerven (2011 [35]) has more credible and highly correlated national and WDI data than most countries in SSA. This means we can combine CSO and WDI data without losing much accuracy.

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**Table 2. Economy-wide and Factor Shares (%) in Value Added**

| 2007 Factor Share (from GTAP) | Economy | Agriculture | Industry[2] | Services |
|---|---|---|---|---|
| Labour share | 0.590 | 0.577 | 0.425 | 0.672 |
| Capital share | 0.381 | 0.245 | 0.575 | 0.328 |
| Land share | 0.030 | 0.177 | | |

### 4.1 Data Issues

*Gross Fixed Capital Formation (or investment)*: Gross Fixed Capital Formation data were available in constant and current local currency units (LCU) as well as in percentage of GDP. However, the LCU data were missing for the period 1994-2009 and 2011-2013, whereas the percentage data are available for the entire period. Besides, for the years when both LCU and percentage data are available, these two categories of data do not add up. For instance, the percentage data suggest 21.1% of GDP is used for investment in 2010, while the LCU data suggest the investment amounts to 25.9% of GDP (174 million LCU out of 97,216 million LCU). For consistency, the percentage data were chosen instead of the LCU data, since the former are available for the entire period. That is, the investment data were re-constructed using the data on GDP and the percentage of investment in GDP.

*Employment Share by Sector*: The data on sectoral employment share is available only for the four years of 1990, 1998, 2000, and 2005 from the central statistical office. However, the data for the year of 1990 does not sum up to unit. Hence, the agricultural labour share in 1990 is reconstructed as a residual of other sectors' labour share. Labour employment share in agriculture is regressed on the rural population ratio for the available four years, with R-squared value being 0.542. And the industrial labour share is regressed on the urban population ratio, with R-squared value being 0.968. The missing labour share data for agriculture and industrial sectors are then estimated using the regression equations for, respectively, the rural and urban population ratios, which are available for the entire period. Finally, the labour share of the service sector is estimated as the residual of other sectors' labour shares.

[2] The industry sector as considered in WDI data comprises manufacturing, mining, construction and utilities. Where necessary however, we use the terms industry and manufacturing interchangeably.

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## 5.0 Results and Discussion

### 5.1 Economy-wide Analysis

Table 3 shows economy-wide growth accounting results for different periods between 1971 and 2013. We separate the analysis into 5 time periods to capture the trend at shorter intervals as a way of describing the economy. Growth accounting analysis at the economy-wide level was implemented in a theoretical framework with exogenous rate of capital depreciation ($\delta = 0.035$) for the period 1971-2013. Over the period, the economy grew, on average, by 3.2% annually, of which productivity increase (TFP) accounted for only 5.7% (0.0018/0.0319). This implies that most of GDP growth for the same period is attributed to the increases in input use.

**Table 3. Economy-wide Growth Accounting Results**

| | 1971-1980 | 1981-1990 | 1991-2000 | 2001-2013 | 1971-2013 |
|---|---|---|---|---|---|
| | Mean | Mean | Mean | Mean | Mean |
| GDP growth rate (%) | 1.45 | 1.08 | 1.75 | 7.26 | 3.19 |
| L force growth rate (%) | 2.96 | 2.54 | 2.64 | 2.63 | 2.69 |
| L contribution to growth (%) | 120.69 | 138.89 | 89.14 | 21.35 | 49.84 |
| K stock growth rate (%) | 2.66 | 1.27 | 2.93 | 7.09 | 3.74 |
| K contribution to growth (%) | 69.66 | 44.44 | 62.00 | 37.19 | 44.51 |
| Z growth (%) | -0.01 | 0.48 | 0.78 | 0.42 | 0.42 |
| Z contribution to growth (%) | 0.00 | 0.93 | 1.14 | 0.14 | 0.31 |
| Solow Residual (TFP) (%) | -90.34 | -83.33 | -53.14 | 41.46 | 5.64 |

Notes: L=Labour, K=Capital and Z= Agricultural land. Share contribution to growth is calculated as pp contribution to growth divided by growth in GDP, expressed as a percent. For example; K share contribution= K growth contribution/GDP growth= (1.42/3.19)*100= 44.5%.

Increase in labour force accounts for nearly half (49.8%) of the growth of GDP. Capital accumulation also plays an important role as its contribution (44.5%) to growth is closely behind that of labour. The growth of labour in turn can come from such factors as increase in population and more people joining the labour force. Agricultural land growth contributed the least to GDP growth in this period (1970-2013) at around 0.3%. This is probably because new marginal lands that are less fertile are being brought into production as opposed to changes in land quality.

As indicated in table 3, breaking the period into four intervals (1971-1980, 1981-1990, 1991-2000, and 2001-2013) shows the rising trend of productivity growth, captured by TFP. The mean TFP before 2000 is 0.001, implying that most of growth is attributed to the increase in input use (mostly labour). However,

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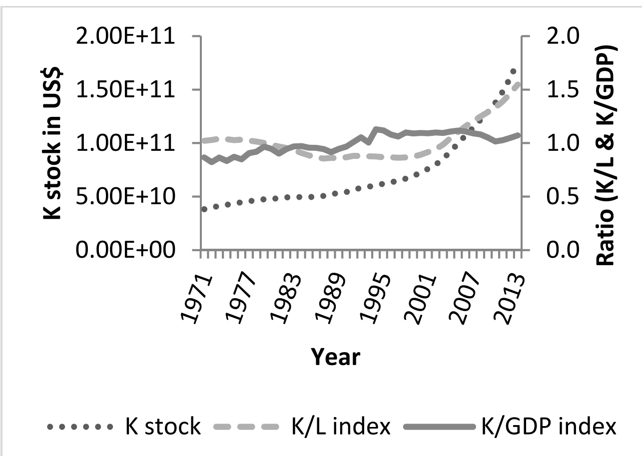
productivity growth begins to accelerate from the year 2000. TFP growth amounts to 0.03 for the period 2001-2013. That is, 41% (GDP growth divided by Solow residual) of total GDP growth during the period is attributed to the improvement in resource productivity (TFP). This is also confirmed in Figure 2, which shows the trend of Solow residual and TFP over time. One reason for the low TFP before 2000 and high TFP after that could be increased education levels raising the workers' skills (our labour variable does not have skills dimension, this is captured in through TFP). This could the case for Zambia as the education sector was the focus of the first regime and the number of locally trained graduates increased sharply from independence in 1964 (Carmody, 2004 [36]). During the same period (2001-2013), we see for the first-time capital stock growing tremendously and its contribution to growth surpassing that of labour. Some industries, perhaps, benefited from foreign direct investment and plausibly some of this capital that started flowing in came with state of the art technology to allow the country become more efficient—allowing for an increase in resource productivity.



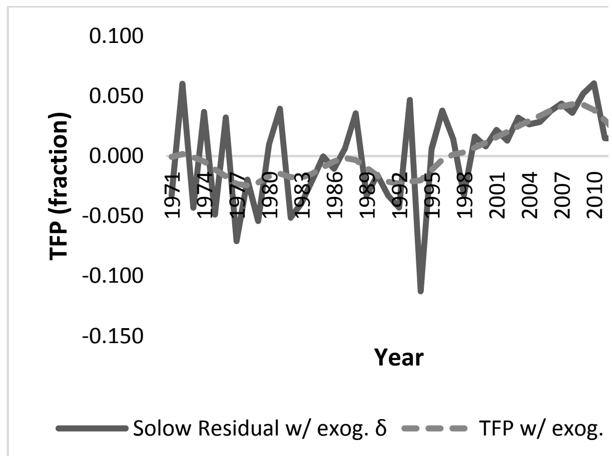




**Figure 1: Evolution of capital stock, K/L and K/GDP**

**Figure 2: Solow Residual and TFP**

Figure 1 illustrates the evolution of the economy in terms of capital deepening, defined as the capital to labour ratio with exogenous depreciation rate (δ). Before 2000, its trend was rather decreasing; implying economic growth (or lack thereof) during the same period was due to the growth of labour force and insufficient capital investment.

Capital deepening begins to accelerate, albeit slowly in the late 1990s and at a faster rate in the 2000s, increasing labour productivity and significantly improving growth performance during the period, as seen also in Table 3. During this same period (2000-2013), the economy in terms of GDP grew at 7.3% per annum, capital stock grew by 7.1% per annum and the labour force grew by 2.6% per annum. The capital

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contribution to GDP was highest in this same period at 2.7%, while labour growth rate and contribution to GDP declined slightly during the same period. Figure 2 shows the TFP over the years and a trend line is plotted alongside. From the figure, TFP was on average negative for most part before around 1998. Starting from 1999, TFP rose steadily to contribute significantly to the growth of the economy.

### 5.2 Sectoral Analysis

Next, we address whether the features of growth of the aggregate economy emanated from all sectors of the economy or they are specific to a particular sector. We disaggregate the data and analyse each sector's contribution to GDP as well as the contribution to employment. Figure 3 shows the trend of GDP share by each sector for the period 1970-2013. Note that the typical structural transformation experienced by developing countries is observed only after 1995. Since 1995, agriculture's share to GDP shrunk, while the shares of other sectors are on the rise. Before 1995, however, little trend is observed in sector GDP shares.

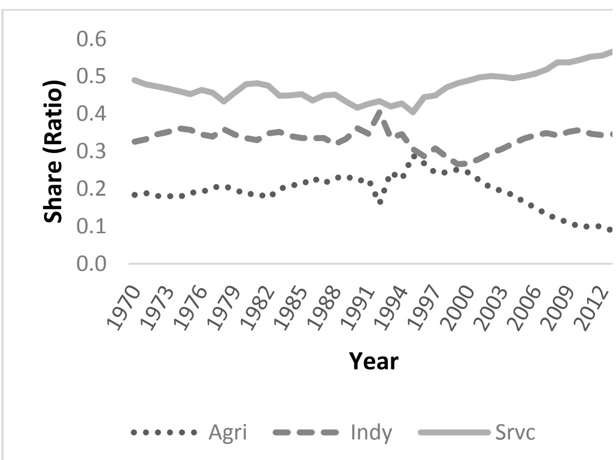


**Figure 3: GDP share by sector**

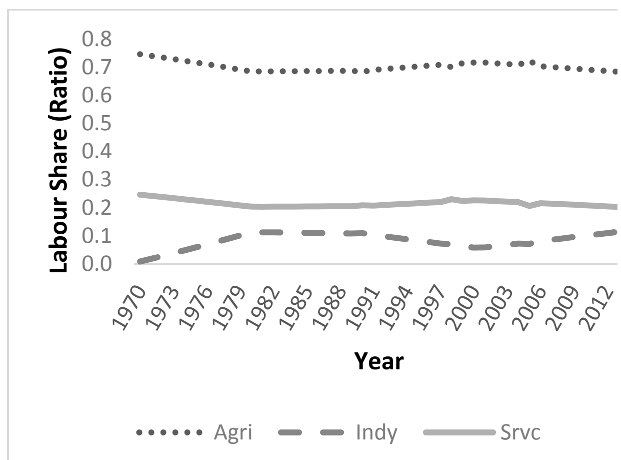


**Figure 4: Labour share by sector**

Agriculture's share to GDP also shrunk immediately after the 1990 attempted structural adjustment reforms, while industry's share to GDP rose. However, this trend is reversed when government changed most of its liberalisation policies before starting them again in 1994. Most economies take a development path where industry and services sectors are expected to contribute more while agriculture declines as the country moves to a more technologically advanced level (Byerlee *et al.,* 2009 [37]; Cervantes and Brooks, 2009 [38], Herrendorf *et al.,* 2014 [11]). Zambia seems to be on course in this line with both services and industry sectoral share contribution rising since 1999 while that of agriculture is falling. However, other authors

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argue that even industry begins to decline as the economy moves "traditional industry-intensive 'Machine Age' economy to a more services-intensive 'Information Age'" (Rodrik, 2015 [39]).

**Table 4. Sectoral Growth Contribution to Growth and "Fair Share" Contribution Analysis of the Three Sectors (1971-2013)**

| Sector | Arithmetic Mean |
|---|---|
| Sector Growth (%) | |
| GDP | 0.0323 |
| Agriculture | 0.0214 |
| Industry | 0.0344 |
| Services | 0.0367 |
| Sector Shares (%) | |
| Agriculture | 19.25 |
| Industry | 33.35 |
| Services | 47.40 |
| Sector % Point Contribution to GDP growth* | |
| Agriculture | 0.0060 (16.44) |
| Industry | 0.0116(31.77) |
| Services | 0.0189(51.78) |
| Sector Growth Contribution to GDP Growth in % | |
| Agriculture | 37.57 |
| Industry | 10.40 |
| Services | 0.86 |
| SUM | 48.84 |
| Contribution departure from share in % | |
| Agriculture | 75.2243 |
| Industry | -85.2911 |
| Services | -103.0619 |

*Numbers in parentheses are sectoral % contribution to growth

Figure 4 illustrates the trends of employment shares by each sector, which we find to be quite stable over time. It is noted, however, that the labour shares in agriculture and services have been gradually declining, while the labour share of the industrial sector has been increasing—these trends are non-monotonic. Particularly noteworthy is the extremely low productivity of agricultural labour. The agriculture sector accounts nearly 70% of the labour force, but only produces 10% to 30% of value added. This is probably because more than 46% of the people engaged in agriculture have other sources of income or jobs that mainly include owning a business, non-agricultural wage and supplying labour to other farms (Bigsten and Tengstam, 2008 [40]). This suggests that agriculture is a repository to which labour goes when it cannot find income elsewhere. In table 4, we use the knowledge that a sector's contribution, in percentage to growth

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in GDP should equal its share in GDP— "fair" share— if the economy is in long run equilibrium. The "fair share" contribution is calculated as that sector's mean contribution to GDP expressed as a proportion of the sum of the sectors' contribution from 1971 to 2013.

Over the same period (1971-2013), GDP grew by 3.2 % while agriculture, industry and services grew by 2.1%, 3.4% and 3.7% respectively. The service sector grew the most, followed by industry and lastly agriculture with a difference of almost 10 percentage points between each of the two sectors (services and industry) and agriculture. Annual sector shares are 19.3% for agriculture, 33.3% for industry and 47.4% for services. Industry's slow growth in the 1970s and 1980s was as result of the underdeveloped industrial base (Ndulo and Mudenda, 2010 [13]). Mean contribution to GDP growth is 1.89% for services, 1.16% for industry and 0.6% for agriculture in declining order. The figures in parentheses are 'fair share' contribution. In theory, we expect that if the economy is in long run equilibrium (steady state), labour and capital should grow at the same rate as the capital per worker is constant (Abel *et al.,* 2008 [41]).

Agriculture is contributing less than its fair share as its contribution of 16.4% is less than its share of 19.3% in economy GDP. The same applies for industry, while service is doing more than its fair share with a contribution of 51.8% compared to its share of 47.4%. Agriculture lags by about 3% (19.3 - 16.4 = 2.9) while industry lags by 1.5% (33.3 - 31.8=1.5) in terms of contributing its fair share. So, fair share is what we would expect in long-run equilibrium. We might call a sector contributing less than its share as a laggard sector. From this, we clearly see that agriculture is a laggard sector

### 5.3 Sectoral TFP Analysis

In figure 5, sectoral capital stocks are plotted against time. The y-axis is capital stocks in natural logarithm and the slopes of the fit lines represent annual compound rate of growth in the capital stock. As indicated by the slopes, all three sectors have different capital growth rates. From about 1998 the growth rates in service and industry sectors have almost been similar but agriculture capital stock has declined. Compound rate of growth (average slope) in service sector has its average about 3.5% while for the industry sector, its average is about 3%. Compound rate of growth in agriculture has been the slowest at about 2.1%. This fall coincided with government's involvement in the output market through the Food Reserve Agency (FRA) which started buying maize in 1997 and the input subsidy program (Farmer Input Support Program) which started in 2002.

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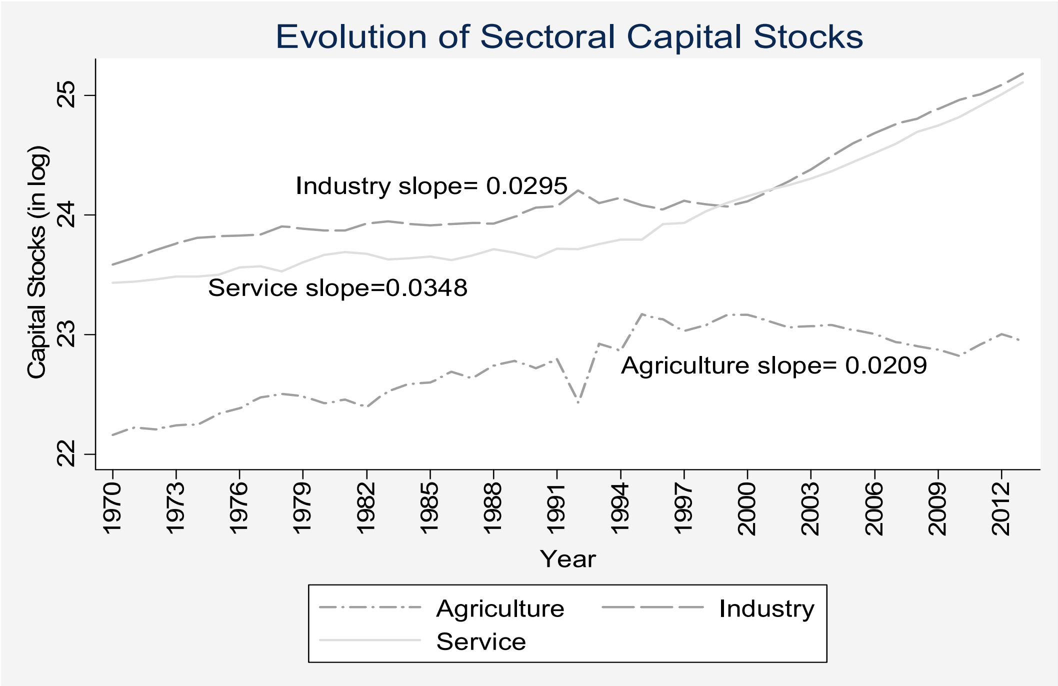


**Figure 5: Sectoral capital stocks**

Studies by Mason and Myers (2013 [42]), and Mulungu and Chilundika (2015 [43]) have shown that this kind of government involvement crowded out the private sector and reduced investments in both the input and output markets. Sometimes economic growth may not be observed directly from labour and capital changes and two measures; capital deepening (capital stock per worker) and TFP capture such growth. In table 5, we present capital deepening results for each sector. Capital deepening for agriculture is positive during from 1971 to 1991, the period when Zambia had its first Republican President. From 1992 to 2013, capital deepening was declining. This could, among other factors, be due to an increase in the number of people employed in agriculture as confirmed by figure 4 while the capital stock per agricultural worker have been decreasing from 1995 (Figure 5).

Capital deepening in industry decreased at 16% in during the period 1971 to 1991 and increased at about 2% per annum during the period 1992 to 2013. The low capital deepening in the first period could be a result of an economy that depended heavily on labour with outdated capital stock. Low savings and poor mechanisms of transferring the savings to investors is another plausible explanation. In that period, skilled labour which is more efficient was scarce as higher education was still limited to only a few citizens. For example, at independence, Zambia only had 100 African educated graduates. Zambia therefore faced a critical shortage of skilled manpower in the years following independence.

**Table 5. Sectoral Capital Deepening for Different Periods**

| | Annual Mean 1971-1991 | Annual Mean 1992-2013 | Annual Mean 1971-2013 |
|---|---|---|---|
| Agriculture | | | |
| K stock growth | 0.032 | 0.020 | 0.026 |
| L growth | 0.024 | 0.026 | 0.025 |
| Capital Deepening | 0.008 | -0.006 | 0.001 |
| Industry | | | |
| K stock growth | 0.024 | 0.053 | 0.039 |
| L growth | 0.184 | 0.033 | 0.107 |
| Capital Deepening | -0.160 | 0.020 | -0.068 |
| Service | | | |
| K stock growth | 0.015 | 0.066 | 0.041 |
| L growth | 0.019 | 0.026 | 0.022 |
| Capital Deepening | -0.005 | 0.040 | 0.018 |

This shortage was noticed by the first Republican president who we quote; *"Expanding our Secondary School Education and paying greater attention to the requirements of university education, in order to produce qualified personnel… and help establish sound administrative cadres for upper and middle grades in government, commerce and industry, agriculture extension schemes and public works, for which good education is a must – has no substitute."*[3]

A close inspection of the data shows that this happened in the year 1972 when labour force grew by about 124% from the year 1970[4]. Overall, we find capital deepening in industry during the period 1971- 2013 to be declining at 6.8%. Service sector overall witnessed a rise in capital deepening of approximately 2% per annum over the same period (1971-2013). However, when separated into two time periods, capital deepening before 1991 is declining and increasing from 1992 to 2013. The number of people employed by the service sector rose steadily while capital stocks rose faster, at a rate almost equal to the rate in the industry sector.

[3] Former Zambia Republican President: Foreword to Mwanakatwe, J. M. (1971 [44]), The Growth of Education in Zambia since Independence.

[4] This could be as a result of the method we have used to estimate the labour shares in each sector, i.e. regressing the available years on urban population for industry and rural population for agriculture with the residual being service.

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Overall, growth rates in the labour force have not been so different between agriculture and service sectors (2.5% compared to 2.2%) while labour growth rate in the industry sector has been high at around 11% per annum. This increase in labour observed in the industry sector could possibly be arising from the increased production in the mining industry and the opening of new industries processing food items. Industry and service sectoral capital stocks have been growing almost at the same rate of about 4%.

Table 6 shows results from the sectoral growth accounting. For each sector, we show the contribution of capital, labour and TFP to the growth of the sector. For agriculture, we include the contribution of land. We divide time into three periods; the pre-reform period of 1971-1991, the post reform period from 1992 to 2013 and the overall (1970-2013). We do this so as to observe differences in the sectoral TFPs between the two periods. The first column in each period reports the point contribution to a sector's growth and the second column reports the share of the factor's contribution to the sector growth.

**Table 6. Factor Contribution to Sector Growth**

| **Period** | **1971-1991** | | **1992-2013** | | **1971-2013** | |
|---|---|---|---|---|---|---|
| Sector | Annual Mean Growth Rate (%) | Factor Contribution to Sector Growth (%) | Annual Mean Growth Rate | Factor Contribution to Sector Growth (%) | Annual Mean Growth Rate | Factor Contributio to Sector Growth (%) |
| **Agriculture** | | | | | | |
| Output growth | 0.0236 | | 0.0192 | | 0.0214 | |
| L's share | 0.0137 | 57.87 | 0.0150% | 77.85 | 0.0143 | 67.07 |
| K's share | 0.0079 | 33.36 | 0.0049% | 25.42 | 0.064 | 29.71 |
| Z's share | 0.0004 | 1.69 | 0.0011% | 5.52 | 0.007 | 3.46 |
| Solow residual | 0.0017 | 7.07 | -0.0017 | -8.79 | 0.00 | -0.23 |
| **Industry** | | | | | | |
| Output growth | 0.0157 | | 0.0522 | | 0.0344 | |
| L's share | 0.0781 | 498.75 | 0.0142 | 27.15 | 0.0454 | 132.13 |
| K's share | 0.0138 | 88.37 | 0.0307 | 58.76 | 0.0224 | 65.35 |
| Solow residual | -0.0763 | -487.12 | 0.0074 | 14.09 | -0.0335 | -97.47 |
| **Service** | | | | | | |
| Output growth | 0.0073 | | 0.0648 | | 0.0367 | |
| L's share | 0.0129 | 176.39 | 0.0172 | 26.48 | 0.0151 | 41.06 |
| K's share | 0.0048 | 65.41 | 0.0216 | 33.34 | 0.0134 | 36.46 |
| Solow residual | -0.0104 | -141.80 | 0.0260 | 40.18 | 0.0083 | 22.48 |

Notes: L's, K's and Z's shares are labour, capital and agricultural land contributions to sectoral growth respectively.

From the GTAP factor shares in table 2, industry is the most capital intensive sector followed by service sector while service is the most labour intensive sector followed by agriculture. If a sector uses more capital, then capital should contribute more than labour combined with labour augmenting technological change in long-run equilibrium. In transition, however, this simply means capital should grow faster than Harrod plus labour force.

For instance, labour should account for the highest share of the growth in the services sector as should capital in the industry sector, assuming a long-run equilibrium. A close look at each sector's growth rate in the first period shows that agriculture had the highest growth rate at approximately 2.4% per annum compared to about 1.6% for the industry sector. Services sector has had the slowest growth in terms of value added at about 0.7% per annum. In the post reform era, following market liberalization, the private sector was allowed to stimulate economic gains and agriculture value added slowed down (to about 2% per annum) while service sector made the highest gains (at 6.5% growth per annum). The industry sector was then growing at about 5.2% per annum.

Overall, we find that the service sector had grown more from 1971-2013 at about 3.7% per annum than the industry sector at 3.4% per annum while agriculture has lagged behind on an average of 2.1% per annum. For agriculture, instead of only the two traditional inputs of labour and capital, there was growth in agricultural land contribution which is minimal at 3.5%. Capital did not follow the pattern. Its contribution to sectoral growth matches the order of intensity of use across the sectors. Capital accounted for 65% of the growth in industry overall followed by service where it accounted for about 37% while accounting for only a paltry (paltry because the cost of capital goods in this sector was still high) 30% in the agriculture sector.

When disaggregated into two time periods, we see that in the first period industry's growth is still mainly accounted for by capital but followed by service and not agriculture. In the second period, the pattern is the same. As for the overall period, capital contributes about 59% of the growth witnessed in the industry sector and about 44% and 33% of the growth in agriculture and service sectors, respectively.

Labour does not follow the theorised long run pattern of intensity of use and contribution to growth equally. While the service sector is most labour intensive, followed by agriculture, the contribution of labour to service sector growth is only 41 % compared to about 132% contribution to the industry sector and lastly about 67% to agriculture. In the first period, labour contributes more to services but still less than the

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contribution to industry which is at a staggering close to 500%[5]. This pattern changes from 1992 to 2013 as labour contributes more to agriculture followed by industry and then the service sector.

A closer look at the respective sectoral TFPs shows that only service sector has had a positive TFP with industry and agriculture having below zero TFPs. Industry has the lowest TFP at -0.033, followed by agriculture at -0.004 while service sector has the highest at 0.008. These TFPs account for -97%, 18% and 22.5% for the industry, agriculture, and service sectors growth, respectively. Low TFPs for agriculture in developing countries are common in the literature. As can be seen from figure 4 above, industry's labour share in total employment has increased while those of agriculture and services have marginally declined during the period under review. Focussing on industry, we see that labour contributes more to industry growth than capital.

One plausible explanation for this low TFP in industry has to do with inefficiency in the sector. As shown from literature (for example El-Hadji, 2013 [45]), openness in the economy leads to efficiency in the industry sector as non-efficient firms are pushed out of the production and the remaining ones are more efficient. However, with the protectionist policies of 1970s-1990s, most firms that were government owned were inefficient and it is only after the liberalisation and privatisation of state run parastatal institutions that the efficiency in the sector began to improve. This is matched by a positive TFP for industry in the second period (post-reform), in which it accounted for about 14% of the growth in the sector.

The second period (1992-2014) is also the time when the world experienced a commodity boom and rise in exports of minerals, which could explain the increase in productivity. Lack of openness also meant that the level of competition the firms were exposed to was low. The McKinsey Global Institute through its study of different countries find a link between the level of competition that firms are exposed to and the productivity of the sector as measured by TFP (Manyika *et al.,* 2010 [46]). Technology use in the sector could also be another reason for this low productivity.

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[5] Again, we suspect this conspicuous contribution of labour could be rooted in the data problems.

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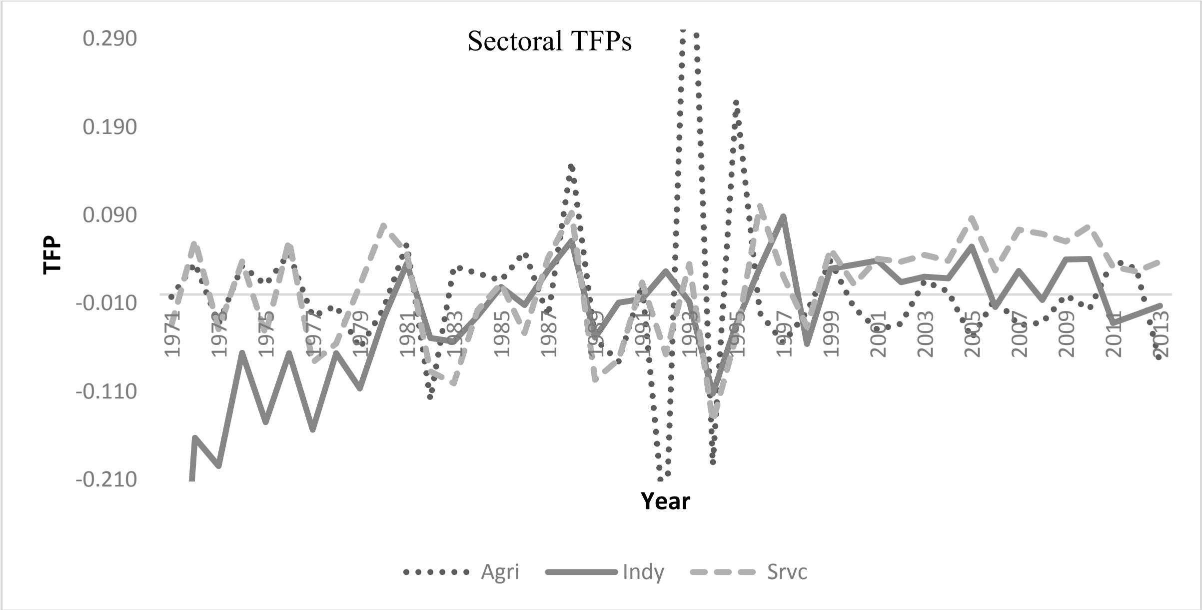


**Figure 6: Sectoral TFPs, 1971-2013.**

Service outperforming other sectors in the economy is not equally new. For example, Mukherjee (2013 [47]) find that the service sector has had the highest TFP in India. The service sector ––especially the telecommunications and transport sub-sectors have continued to perform well, benefiting heavily from foreign direct investment.

From figure 6, we see that agricultural TFP has been the most volatile, especially around the early 1990s, at the inception of the structural adjustment programmes and other reforms. Service TFP has been the most stable overtime while industry TFP is extremely low in the 1970s and only improving around 1996 and stabilizing in the positive region from then on. According to Roe *et al.* (2014 [33]), it is expected of agriculture to have quite a volatile TFP given that it is dependent on weather. A case in point for Zambia is 1992 when it is lowest in the whole series. This is the year in which Zambia experienced the worst drought ever recorded to date.

Agriculture is generally considered a low labour productivity sector in developing countries and is used to measure the pace of development by focusing on share of labour employed by the sector. In developed countries, the share of labour in agriculture is small while in developing countries almost everyone is employed in agriculture. Multiple reasons, which are also plausible in the case of Zambia, have been advanced for this low TFP (see for example, Isaksson, 2007 [48]; Aguiar *et al.,* 2016 [49]). These include; investment-dependent growth, differences in productivity arising from differences in economy-wide productivity, barriers to the use of modern intermediate inputs in agriculture, and policies that impact

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negatively on agriculture. These barriers reduce the incentives for farmers in poor countries to use modern inputs that are crucial for improving agricultural productivity. There is need for a more nuanced analysis to understand why TFP in agriculture has remained this low by probably understanding the underlying factors in the years it was high. The agricultural TFP has virtually remained stable around zero for much of the time except when it was very volatile. This low TFP includes recent years when Zambia has experienced increased agricultural production because of good weather.

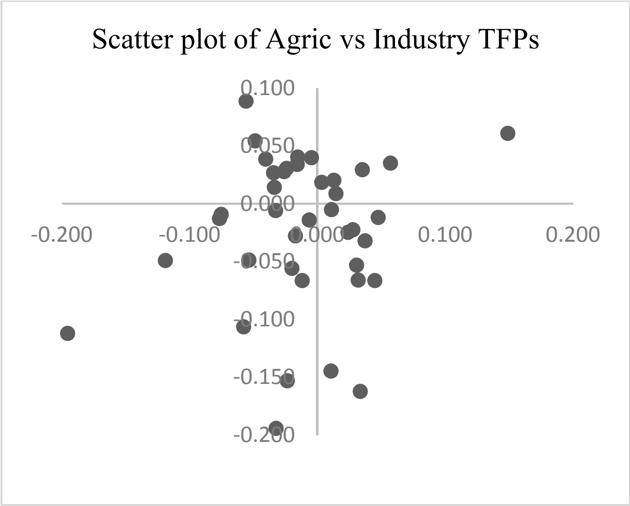


**Figure 7: Agriculture vs Industry TFP**

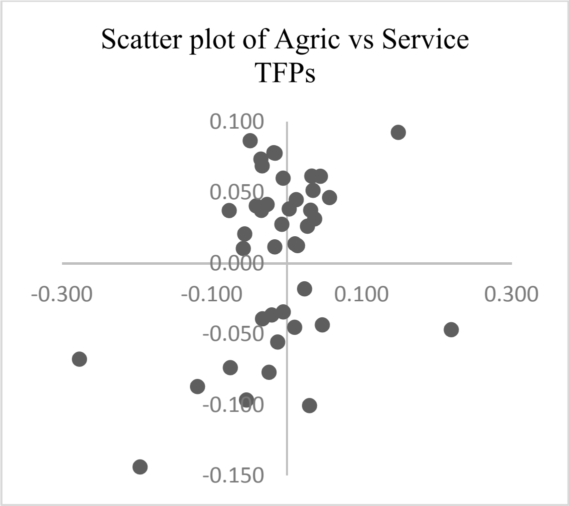


**Figure 8: Agriculture vs Service TFP**

Figure 7 shows the scatter plots for agriculture TFP against industry while Figure 8 shows scatter plots for agriculture and service TFPs. From the graphs, observations appearing in the first and third quadrant suggest that TFP in one sector may spillover to TFP in the other sector. This means that there could be positive spill over effects from service to agriculture— for example technological change in services spills over to TFP in agriculture, through, for example, lower cost transport services, more efficient marketing facilities and so on that have improved under services. The positive relationship between agriculture could come from the fact as the industrial sector develops, it demands from the agriculture sector inputs and raw materials that go into manufacturing. Koo and Lou (1997 [50]) find that industry growth contributes to growth in the agriculture sector even though they model a two-sector economy. Even though this analysis on spillover is not conclusive, we feel it is a logical question to pose. As structural transformation continues and more labour is moved from agriculture to industry and services, there will be positive benefits for agriculture through the spill over effects.

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## 6.0 Conclusion

This study uses the recently developed growth accounting tools by Roe *et al.* (2014 [33]) to determine the sources of growth in Zambia's agricultural, industry and service sectors between the period 1970 and 2013. We use data from World Development Indicators and Zambia's Central Statistical Office. Our results suggest that overall, capital and labour growth have been the main drivers of growth. TFP over the period 1970-2013 accounts for only 5.7% of the growth compared to labour growth which accounts for around 50% of the growth. Agriculture employs more people than the two sectors with about 70% of the labour force employed in agriculture. This huge number also means that with low capital investments in the sector, capital deepening has been the lowest among the three sectors. Even though capital stocks have been rising, the rise cannot be compared to that observed in industry and services sectors.

Our results from sectoral analysis covering the pre-reform and the post-reform time periods tell two different stories. First, the pre-reform era was characterised by below zero TFP. Service TFP was below zero. Industry TFP was below zero as well. Second, post-reform era saw services TFP increase significantly contributing about 22.5% to the growth of the sector probably because labour productivity increased in this sector. Industry TFP changed from negative to being positive. Though industry was immediately hit hard after the reforms in the 1990s, there was considerable gain in the 2000s that offsets this negative effect (Risnick and Thurlow, 2014 [51]). Agriculture TFP stayed almost the same in both time-periods at around zero in the pre-reform years and just above zero after the reforms. Capital deepening in the sectors also differed across the two periods. Agriculture capital deepening was very low in both periods. Industry and services had negative capital deepening in pre-reform but had positive capital deepening in post-reform era.

Overall, we find agriculture TFP as the most volatile especially around the early 1990s when there was change of government and the new government began the structural adjustment programmes. The volatility is also attributed to weather as more than 90% of the agricultural production in Zambia is rain-fed (MACO/FAO, 2004). In terms of analysis of contribution to growth and share of GDP, we find that agriculture contributes less than its fair-share to growth while service contributes more than its fair share despite the positive correlation with services and industry sectors. This low contribution to GDP combined with a low capital deepening (lower than services but higher than industry) suggest that there are factors that could be slowing down structural transformation. One factor that could be slowing down structural transformation is the land rights and tenure system in rural Zambia where 93% of the land is under customary land without title for the smallholder farmers who use it (Adam, 2003 [52]). This tends to affect

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the reallocation of labour from agriculture to other sectors (de Janvry *et al.,* 2015 [53]). Service seems to be the only sector performing well on contribution and productivity measures.

From our results, we suggest the following. Growth in agricultural sector could be attributed to mainly labour growth. There is need to attract capital in agriculture. Deliberate efforts must be made to allow farmers adopt new technologies and encourage use of machinery. Even though there is zero tax on agricultural equipment, credit constraints have left most farmers unable to take advantage of this measure. Despite employing about 70% of the labour, agriculture contributes less to the economy and does not meet its fair share contribution. Labour productivity in a sector filled mainly with smallholder farmers is low. Policies to educate the population and reduce illiteracy levels, and encourage labour reallocation to more efficient sectors like services would help improve resource use in the economy overall. Resnick and Thurlow (2014 [51]) show that the period after the reforms, labour moved into agriculture which has low value-added per worker and this reduced the value added in the whole economy. Further, we suggest institutional and economic reforms as potential sources of sectoral productivity growth and that more research and development should be encouraged for perhaps a more detailed understanding of the factors affecting growth of these sectors and determining the factors influencing the productivity at sector and national levels.

For efficient structural transformation, reforming land rights for farmers to allow them title deeds for security of ownership even without their presence is important. de Janvry *et al.* (2015 [53]) show that the key constraint imposed by insecure property rights is the requirement of continued presence and cultivation even when one is not productive. These secure lands would increase the efficiency of labour allocation by allowing and inducing less productive farmers to migrate into other sectors of the economy leaving more productive farmers to cultivate more land. The smallholder farmers who migrate would also get benefits in the sectors that they migrate to (Adamopoulos and Restuccia, 2014 [54]; de Janvry *et al.,* 2015 [53]). When less productive smallholder farmers leave for other sectors, this would allow agricultural TFP to rise faster than in non-agriculture, so productivity will tend to rise and converge (Ranis and Fei, 1961 [55]).

As in every empirical study, our study has the following shortcoming. Our data on labour were estimated because their unavailability for most periods. While this could be a shortcoming, we used the best available approach as earlier suggested to estimate the labour input values which we believe underprops our study's novelty.

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**Appendix: Sectoral Output Contributions to GDP and TFPs adapted from Roe *et al.* (2014 [33])**

**1.0 Sectoral Output Shares and Contributions to Growth in GDP**

To measure Zambia's sector output shares and contributions to economic growth, we employ the previous methodology by first focusing on sector growth and determine if each sector makes its fair contribution to growth in economy GDP. We then lay out the theory for estimating sectoral capital shocks $K_t(t)$ for $j = (a$ =agriculture, $i$=industry, $s$=service) and using this computation, we determine sectoral factor contributions and their TFP's to economic growth. Following Roe et al. (2014 [33]), we measure whether a sector contribution is greater than its share in GDP or whether it is a laggard thus suggesting a possible impediment to growth. This analysis then provides a setting for and analysis of each sector's capital, labour, land and TFP contribution to Zambia's sectoral growth.

Let growth in real economy GDP be denoted as

$$y = \frac{\dot{Y}}{Y} \cong \frac{GDP(t) - GDP(t-1)}{GDP(t-1)}$$

Following Roe et al. (2014), we then calculate the sectoral source of growth in real economy as follows:

$$y = s_a(t)y_a + s_i(t)y_i + s_s(t)y_s \qquad (1)$$

where the sector share in GDP is $s_j = {Y_j}/{Y},$ $j$=($a$=agriculture, i=industry, s=service). Therefore, sector percentage point contribution to growth is given by:

$$\left[ y = \overbrace{s_a(t)y_a}^{\text{agriculture}} + \overbrace{s_i(t)y_i}^{\text{industry}} + \overbrace{s_s(t)y_s}^{\text{service}} \right] \times 100$$

where $s_a$, $s_i$ and $s_s$ represent agricultural, industry and service sectors, respectively. To determine if sector $j$ contributes its fair share to growth in economy, neoclassical growth theory predicts that long run equilibrium is one where the rate of growth in real GDP approximates

$$y \cong x + n$$

where $x$ is the rate of Harrod growth and $n = \frac{\dot{L}}{L}$. Then each sector should growth at rate $x + n$ so that,

$$y_j = y = x + n, j = a, m, s\,.$$

Then $$\frac{\dot{Y}_j}{Y_j} = \alpha_j \frac{\dot{K}_j}{K_j} + (1-\alpha_j)\frac{\dot{L}_j}{L_j} + \overbrace{(1-\alpha_j)x}^{TFP, Harrod = x}$$

In long run equilibrium, a growth model exhibiting balanced growth predicts

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$$\frac{\dot{Y}_j}{Y_j} = \alpha_j (x+n) + (1-\alpha_j)n + (1-\alpha_j)x = x+n$$

In terms of contribution terms

$$100 \times 1 = 100 \times \alpha_j + (1-\alpha_j) \times 100 \,,$$

So if $\alpha_j > (1-\alpha)$, K should contribute more than labour combined with labour augmenting technological change. In transition growth (i.e., before long run equilibrium), capital should grow faster than Harrod plus labour force, i.e.

$$\frac{\dot{K}_j}{K_j} > x+n,$$

That is, it is possible for $\alpha_j < (1-\alpha)$ and for *K's* contribution to exceed that of labour plus Harrod.

## 2.0 Estimation of Sectoral TFP

Following Roe et al. (2014), we first focus on theory used to guide our estimation of sectoral capital stocks. We then draw upon similar economic conditions underlying our growth accounting assumptions utilizing sectoral version of the GDP function. To determine each sector's TFP in a three-sector economy, we add to the H-O model another final good sector that employs labour capital and for a general case where a given factor, land denoted Z is fixed. The capital market clearing equation is

$$C^1_{r^k} y_m + C^2_{r^k} y_s - \pi_{r^k} Z = k \qquad (2)$$

As observed in equation (2), the term $\pi_{r^k}$ is the derivative of the indirect sector level profit function $\pi(p,w,r^k)H$ with respect to $r^k$ where:

$$\pi(p,w,r^k)Z \equiv \underset{L_a K_a}{Max}\left\{F^3(K_a A(t) L_a : Z) - r^r K_a - wL_a\right\}$$

where $p_a$ is agriculture's output price and is assumed exogenous and like other prices, normalized to unity, while $\hat{w} = w / A(t)$. Following Roe *et al*. (2014 [33]) and assuming neoclassical Cobb-Douglas production technologies, the capital market clearing equation becomes

$$\alpha_{km}\frac{C^m Y_m}{r^k} + \alpha_{ks}\frac{C^s Y_s}{r^k} + \frac{\alpha_{ka}\pi Z(t)}{\alpha z r^k} = K$$

$$= \alpha_{km}\frac{Y_m}{r^k} + \alpha_{ks}\frac{Y_s}{r^k} + \frac{1}{r^k}\frac{\alpha_{ka}}{\alpha z}\pi Z = K$$

The rental share of land in total sector revenue is $\alpha Z \equiv \pi Z / Y_a$ while agricultural sector's supply function is $\frac{1}{\alpha H}\pi Z = Y_a$. By substituting into the capital market clearing equation, we obtain the following

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$$\alpha_{km}\frac{Y_m}{r^k}+\alpha_{ks}\frac{Y_s}{r^k}+\frac{\alpha_{ka}Y_a}{r^k}=K \tag{3}$$

Whose equivalence is

$$\overbrace{\alpha_{km}\frac{Y_m}{r^k}\left(\frac{\dot{Y}_m}{Y_m}-\frac{\dot{r}^k}{r^k}\right)}^{I_m}+\overbrace{\alpha_{ks}\frac{Y_s}{r^k}\left(\frac{\dot{Y}_s}{Y_s}-\frac{\dot{r}^k}{r^k}\right)}^{I_s}+\overbrace{\alpha_{ka}\frac{Y_a}{r^k}\left(\frac{\dot{Y}_a}{Y_a}-\frac{\dot{r}^k}{r^k}\right)}^{I_a}=\dot{K}\cong I=I_m+I_s+I_a \tag{4}$$

for the case where land, $Z$ is constant. For our case where Z is variable, we the agricultural sector's cost function

$$C^a(r^k,w,\pi)Y_a$$

which results in the capital market clearing equation shown below[6]

$$\alpha_{k1}\frac{Y_1}{r^k}+\alpha_{k2}\frac{Y_2}{r^k}+\frac{\alpha_{k3}Y_3}{r^k}=K \tag{5}$$

Equation (5) is identical to equations (3) and (4). The equivalence is shown in equation (6)

$$\alpha_{km}\frac{Y_m}{r^k}+\alpha_{ks}\frac{Y_s}{r^k}+\frac{\alpha_{ka}Y_a}{r^k}=r^k \tag{6}$$

where sectoral $K_j$ is calculated as follows

$$K_j(t)=\alpha_{kj}\frac{Y_j(t)}{r^k(t)},\ j=i,s,a \tag{7}$$

Consequently

$$K(t)=\sum_j K_j(t)\,.$$

Once the LHS terms of equation (5) are known, implicit rate of return on capital $r^k(t)$ can be computed. Roe *et al*. (2014 [33]) observe that we require no knowledge of the fixed factor other than its shadow or rental value used in the calculation of $\alpha_{ka}$ or utilize the value reported in the Global Trade Analysis Project (GTAP) data set. Therefore, the Solow's residual for the sector employing the fixed factor $H$ with technology $F^a(K_a,A(t)L_a;Z)$ is

$$TFP_a=\frac{\dot{Y}_a}{Y_a}-\alpha k_a\frac{\dot{K}_a}{K_a}-\alpha L_a\frac{\dot{L}_a}{L_a}-(1-\alpha k_a-\alpha L_a)\frac{\dot{Z}}{Z} \tag{8}$$

If data on land, *Z(t)* are unavailable, the effects of $(1-\alpha k_a-\alpha L_a)\frac{\dot{Z}}{Z}$ would be embodied in our estimate of Solow's residual.

[6] See Roe *et al.* (2014 [33]) for cases where firms face different $r^k$.

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