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HUMAN CAPITAL AND ECONOMIC GROWTH:
A CROSS-MUNICIPALITY PANEL-DATA ANALYSIS IN SOUTH AFRICA

By

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at the
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2018
Supervisor: Professor Nicholas Ngapha
DECLARATION

I Ntombomzi Gloria Mabindisa hereby declare that this minor dissertation is wholly my own work and that all sources have been accurately reported and acknowledged. This minor dissertation has not been submitted to any other university or institution of higher education for the purpose of gaining a degree.
ACKNOWLEDGEMENTS

1Chron 28:19, “All this, I have in writing as a result of the LORD’s hand on me, and He enabled me to understand all the details of the plan.” All Glory be to God!

I wish to extend appreciation to my supervisor Prof Nicholas Ngepah for giving me a chance. Your guidance, insight and critical comments resulted into the completion of this research. I’d like to thank Mr Charles Saba for support, encouragement and proofreading my work.

To my husband Linda Mabindisa, ndiyabulela Ndlela for your love, support, patience and prayers. To our children - Emihle, Okuhle and Asemahle; thank you for being there for me. Saturdays will remain library days for us. Please take the baton further.

To my parents and parents in-love, thank you for your sacrifices, endless support and encouragement.

To family and friends, thank you for your love and understanding. To my manager, Mr Bangane, thank you for allowing me to attend to my research work.
ABSTRACT

The South African economy is characterised by high levels of low-skilled labour and low levels of skilled labour. There is a consistent discussion on skills development among the different spheres of government and other key economic stakeholders. The inadequacy of the education and skills of the South African workforce is presented annually by the Global Competitiveness report as one of the most problematic factors for doing business in the country. The skills development programmes seek to add to the skill pool and up-skill the previously disadvantaged population to the skilled cohort. It is, therefore, necessary to ask what extra growth benefits would the up-skilling of the workforce bring to the economy.

This study investigates the effect of human capital of employed labour on economic output and growth in South Africa. The proxy used for human capital is the three different skill levels of the employed labour - skilled, semi-skilled and low-skilled. This research illustrates the influence of human capital through an endogenous growth model, with a panel data technique, using cross municipality data for the period between 1993 and 2016. A Granger causality test confirms bi-directional causality between human capital and total output as well as between total employment and total output. Upon detecting potential endogenous effects between key variables (human capital and total output), a system generalised method of moments is used for estimation as it controls for endogeneity.

The resultant aggregate findings suggest that human capital has a positive and a significant impact both on total output and economic growth. The disaggregated proxy of human capital shows that higher levels of skilled employment associate with higher total output and economic growth. However, against theoretical expectations, the share of low-skilled employment is associated with higher contribution to total output and output growth compared to the share of semi-skilled employment. The data reveals that according to the structure of the economy, the Agriculture and Mining sectors have attracted the highest share of low-skilled employment. While the contribution of the low-skilled employment share in these sectors is positive, the overall growth of the same sectors (Agriculture and Mining) has a muted contribution to total economic growth. This suggests that the capacity of these sectors is underutilised and therefore their potential for growth has not been fully realised.

The findings on the effect of skilled employment on economic growth are in line with theoretical literature and therefore the study concludes that human capital in the form of skilled labour has a positive effect on both economic output and growth in South Africa. This informs policy
to prioritise the up-skilling of the labour force in order to contribute positively towards value
generating economic activities in South Africa.
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<td>S</td>
<td>Employed people with skills</td>
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<td>SS</td>
<td>Employed people with semi-skills</td>
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<tr>
<td>LS</td>
<td>Employed people with low skills</td>
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<td>FEM</td>
<td>Fixed Effects Model</td>
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<td>FDI</td>
<td>Foreign Direct Investment</td>
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<td>GDP</td>
<td>Gross Domestic Product</td>
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<td>GMM</td>
<td>Generalised Method of Moments</td>
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<td>LDC</td>
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<td>MDG</td>
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<td>NDP</td>
<td>National Development Plan</td>
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<tr>
<td>OECD</td>
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<tr>
<td>REM</td>
<td>Random Effect Model</td>
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<tr>
<td>RGVA</td>
<td>Real Gross Value Added</td>
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<td>SARB</td>
<td>South African Reserve Bank</td>
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<tr>
<td>SYS GMM</td>
<td>System Generalised Method of Moments</td>
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<tr>
<td>TFP</td>
<td>Total Factor Productivity</td>
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<td>OLS</td>
<td>Ordinary Least Squares</td>
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CHAPTER 1

1 INTRODUCTION

1.1 BACKGROUND

Economic growth literature highlights three mechanisms that show a causal relationship between the education component of human capital and economic growth. Firstly, education is a key instrument that shapes the human capital fibre equipping the labour force for higher productivity levels (Mankiw, Romer and Weil, 1992). Secondly, education increases the innovative capacity of the economy and brings knowledge of new technologies, products and processes which then promote efficient production activities that boost economic growth. This view is supported by theories of endogenous growth developed by Lucas (1988), Howitt and Aghion (1998) and Romer (1990). Lastly, education facilitates the diffusion and transmission of knowledge needed to understand and process new information as well as successfully implement new technologies to promote economic growth (Benhabib and Spiegel, 1994; Nelson and Phelps, 1966). Acemoglu (2009) notes that in the case of farming, educated farmers accept and adapt easily to the utilisation of new technology or seeds in order to increase productivity and income levels.

The South African economic landscape has been characterised by different levels of economic growth from the democratic transition period which saw a lifting of sanctions, the ushering in of open trade and increased levels of foreign direct investments (FDI). The political shift accelerated the country’s position as a gateway to the African continent by diversifying the economy beyond the mining and agricultural sectors to expand the financial services, retail and manufacturing sectors. A commodity boom period between 2004 and 2007 also affirmed the country’s global standing in trade (Frankel et al., 2008:04). However, the global financial crisis of 2008 – 2009 resulted in a significant decline in South Africa’s exports and jobs (South African Reserve Bank, 2009:56).

As a country that grapples with poverty, inequality and unemployment, the government developed a national document - National Development Plan (NDP). The NDP regards investment in human capital as a critical instrument that will reduce inequality levels and prepare people to participate in income generating economic activities (National Development Plan, 2011:119). An educated, skilled and healthy workforce is an important factor in realising higher levels of total output.
1.2 PROBLEM STATEMENT

According to the World Bank (The World Bank, 2015:12), developing economies have been reported as having steady economic growth post the 2008-09 economic crises. The performance of the South African economy was reported as lagging behind other middle-income countries like Brazil, India and China. The post-apartheid South African economy has been characterised by high levels of unemployment, inequality and poverty. This is despite impressive economic growth rates recorded between 2005 and 2008. Data from Statistics South Africa (Stats SA) shows that employment growth has not reflected similar improvements (Mahadea and Simson, 2010:391). Contrary to the Gross Domestic Product (GDP) growth trend of developing countries where labour-intensive industries in the primary and secondary sectors are the main contributors, the South African GDP growth is led by the tertiary sector (Stats SA, 2016: Q42016). Imbs, (2013:529) considers this structural shift as “premature de-industrialisation”. South Africa’s large pool of low and semi-skilled labour is likely to be rendered redundant in some of the employment opportunities offered by the tertiary sector. This is similar to Witherick's (1999:25) view of the negative impact of rising service sector jobs on low and semi-skilled people of the United Kingdom in the 1980’s.

An inadequately educated workforce has been highlighted as one of the problematic factors for doing business in South Africa (Schwab, 2017:324). This deficiency has the potential of containing FDI and capital inflows. In this regard, Gross Domestic Investment as a percentage of GDP also decreased from 28 per cent to 19 per cent between 1980 and 2016 (South African Reserve Bank, 2018). Borensztein et al., (1998:126) inform that the effect of the flow of advanced technology through FDI is determined by the absorptive capability of the hosting economy or country.

Denison (1985) confirmed that an extended number of years in school between the years 1929 – 1982 explained about 25 per cent of income per capita growth in the United States. However, the quality of tertiary education in South Africa has been reported as less capable of adequately preparing people for effective participation in the labour sector (Fedderke et al., 2003:1). The alignment of the basic education policy with industry requirements would give basic skills to secondary school learners to meet entrance requirements of the labour sector. Secondly, the increasing growth momentum of the tertiary sector (services) requires matching skills from the labour force. Lastly, increasing mechanisation and technological advancement of production processes require specialised skills. It is therefore important that the set of skills
provided by South African education institutions is in line with the demand for labour required by key economic sectors.

Therefore, a study to determine the effect of human capital on South Africa’s economic growth is important to inform policy. Some empirical studies (Barro et al., 1993 and Bassanini and Scarpetta, 2002) use education levels, school enrolment, education attainment, number of years in school as proxies for human capital. This study will use the skill levels (skilled, semi-skilled and low-skilled) in order to capture the real effect of the employed labour on economic output across the municipalities of South Africa. The skills proxy is also used by Hanushek et al., (2015) in investigating the returns associated with different measures of cognitive skills (human capital). Measuring human capital by different skill levels includes those with school attainment, individual ability and labour market experience (Hanushek et al., (2015)). This is in line with the assumption that education boosts labour productivity and equips people for ease of technological adaptation (Verspoor, 1990:21).

1.3 RESEARCH OBJECTIVES OF THE STUDY

To achieve the aim of the study, the following objectives will be examined;

1. To investigate whether human capital in the form of skills has an impact on economic output and economic growth.

2. To establish if there is a causal effect between skilled employment and total output as well as between skilled employment and total employment.

3. To recommend policies that will align the labour force to skill levels that have a high contribution to total output.

The research question of the study is;

What is the impact of human capital (skilled employment) on economic output and growth in South Africa?
The hypotheses that this study seeks to answer is:

- Null : \( H: \beta = 0 \)  Skilled employment does not have a significant effect on economic output in South Africa

- Alt :\( H: \beta \neq 0 \)  Skilled employment has a significant effect on economic output in South Africa

- Null : \( H: \beta = 0 \)  Semi-skilled employment does not have a significant effect on economic output in South Africa

- Alt :\( H: \beta \neq 0 \)  Semi-skilled employment has a significant effect on economic output in South Africa

- Null : \( H: \beta = 0 \)  Low-skilled employment does not have a significant effect on economic output in South Africa

- Alt :\( H: \beta \neq 0 \)  Low-skilled employment has a significant effect on economic output in South Africa

1.4 PURPOSE STATEMENT

Ghalandarzehi and Safdarie (2012:165) report that growth in 192 countries is anchored by labour force (64%), natural resources (20%) and physical capital (16%). Therefore an investment in scarce and critical skills will prompt the benefits of human capital which include ease of technological transfer and productivity (Michaud and Vencatachellum, 2003:604). Using the combination of time series data on skills level and economic growth from 1993 – 2016 and cross-section data of municipalities in South Africa, the study aims to analyse the impact of human capital on the economic output and growth in South Africa.

1.5 SIGNIFICANCE OF THE STUDY

It is expected that the empirical findings of the study will inform policy makers on whether human capital has a significant impact on economic output and growth in South Africa. Previous studies on human capital like that of Borojo and Jiang (2015) have emphasised quantitative measures of human capital like enrolment rates at primary, secondary and tertiary levels. However, Hanushek and Kimko (2000) focused on the qualitative measure of human capital by capturing the internationally comparable mathematics and science scores of the labour force. One of the most problematic factors for doing business in South Africa is the inadequately educated labour force (Schwab, 2017:324). This may be partially caused by a misallocation of labour resources resulting in low levels of productivity (Beukes et al., 2017:5).
It is welcome that the National Treasury’s 2018 Budget Review mentioned the improvement of the quality of education and skills development as one of the three structural reforms of the National Development Plan. This study assesses the effect of different skill levels of employed labour on economic output. The outcome of the study informs of an appropriate skill level that has the highest positive contribution to the economy. As a result, the outcome will assist in identifying strategic interventions (improving skills and human capital formation) to develop a more competitive and diversified economy (National Development Plan, 2011).

1.6 STRUCTURE OF THE STUDY

This study is outlined in five chapters. An introduction of the study is presented in chapter One. A review of the theoretical background and literature on empirical findings on economic growth and human capital studies is presented in Chapter Two. Chapter Three discusses the methodology, presenting the functional form and the estimation technique used. Chapter Four presents estimation results which include preliminary data, model specification tests, Granger causality test results and the outcomes of three estimators. The output of system Generalised Method of Moments (GMM) is discussed. Lastly, Chapter Five concludes the study and presents policy recommendations as guided by the results of the study.
CHAPTER 2

2 LITERATURE REVIEW

2.1 INTRODUCTION

This chapter discusses the literature on economic growth and human capital. This is done by defining the construct of economic growth and identifying its determinants. Further analyses of literature on human capital as a determinant of economic growth are discussed. The study will use skill levels (skilled, semi-skilled and low-skilled) of the employed labour as a proxy for human capital.

2.2 DEFINING ECONOMIC GROWTH

Ayal and Karras (1998:337) define economic growth as the increase in real GDP per capita. The GDP is a widely used measure of economic growth which represents the total production or the value of goods and services recorded within the borders of a country for a specified time period. Economic growth is an output generated from varying economic inputs and resources including capital, skilled labour and technology (Hall and Sobel, 2008:73).

Throughout the development of economic growth theory, classical economists have been concerned with the sustainability of economic growth levels. Sustained economic growth depends on a number of factors that include innovation, professionalised education and the training of a highly qualified labour force (Popa, 2016:232). The study also discusses the endogenous and exogenous determinants of economic growth.

2.3 DETERMINANTS OF ECONOMIC GROWTH

The discussion of the determinants of economic growth is to show that the total output of an economy is a function of different variables with varying magnitudes that either advance or contain growth. These variables are divided into two categories, the proximate determinants and deep determinants as illustrated in FIGURE 1 and discussed below. Proximate determinants include the country’s endowments (labour, physical and human capital) and the productivity levels at which these endowments produce goods and services for the economy.
2.3.1 Proximate determinants

Proximate determinants - capital goods, natural resources, labour and entrepreneurship - are key elements that shape a country’s economic output (Landau, 1995:776). These would then inform policy in countries experiencing low economic growth rates. According to Smith (1776:82), increased labour productivity and higher levels of savings bode well for total output. As a result, he advocated for controlled population growth and untamed capital accumulation to boost output per capita. A positive contribution of labour, however, depends on its size and
quality. Having lived during the industrial period, when the output of machines surpassed that of labour, Ricardo (1821:472) gave more credit for economic growth to the owners of capital. However, Marx (1872:538) regarded physical capital as key to economic growth with labour productivity only accelerated by technological advancement.

Mulligan and Sala-i-Martin (1993:770) discuss the imbalances between human and physical capital. These authors conclude that a country with higher levels of human capital tends to have a higher investment in physical capital. This is similar to Lucas’ (1990:93) observation that the reason physical capital does not flow to poor countries is that their marginal products of capital are less than those of developed countries due to low levels of human capital. De Freitas (2014:16) also notes that “higher levels of human capital per worker have a potential to mitigate the diminishing returns of physical capital”. This suggests that high levels of human capital tend to prolong asset life through maintenance and appropriate use.

While holding different views on capital accumulation and labour productivity, classical economists such as Smith (1776), Ricardo (1821) and Schumpeter (1942) concur on the positive effect of technological progress on economic growth. Marx (1872:538) further highlights the disadvantage of technological growth as dampening labour demand and therefore resulting in unemployment in the long run. Growth theories predict that physical capital accumulation and technology improvement lead to higher economic growth performance (Wang and Wong, 2009:701) However, high returns from the two factors (physical capital and technology), depend on the availability of skilled labour.

Bayraktar-Sağlam (2016:275) and Romer (1990:98) report that the invention of higher quality products and technological progress contribute to sustainable economic growth. Young, (1995:650) illustrates how accelerated growth in most of East Asian Tiger economies: Hong Kong, Singapore, South Korea and Taiwan, can be attributed to their growth in technology. However, empirical evidence identifies growth in total factor productivity (TFP) as being the main catalyst of economic growth. TFP “is the portion of output not explained by the amount of inputs used in production” (Comin, 2010:01) South Africa’s growth performance is increasingly reliant on efficiency gains associated with growth in TFP (Du Plessis and Smit, 2007:668 and Fedderke, 2005:07).
As depicted in Figure 1, in a fast paced and technologically evolving environment, industries are constantly searching for innovative ways to improve competitiveness against global peers. This has presented other dynamics, called deep determinants, which enhance economic growth and include aspects such as: trade openness (imports and exports), technology, geographical location (participation in the global value chain) and the changing quality of the labour force (human capital).

2.3.2 Deep determinants

Deep determinants of economic growth are variables that enhance the country’s ability to exploit high value from the factors of production. These fundamental determinants include institutions, geography, openness to trade, technological innovation and human capital (Seleteng and Motelle, 2016:230). For the purpose of this study, the other determinants will be discussed briefly in order to focus on human capital.

The presence of regulators brings stability and predictability of processes. Among others, institutions help manage property rights and thereby mitigate risks on investment (North and Thomas, 1973:08). The presence of effective institutions is critical when transacting costs are high, as they ensure efficiency in the markets. Institutions are regarded as enabling agents under organised authoritative frameworks, attracting risky businesses while deterring extractive business activities. The existence of institutions like the judicial system gives the assurance of fairness and confidence to capital holders when dealing with uncertain and risky transactions (Rodrik, 2002).

Another element is the geographic layout of the country that may accelerate or inhibit the factors of production. Coastal locations tend to offer ease of access to global markets giving local businesses exposure and preference to global value chains. Sokoloff (1988:813) confirms the positive relation between patenting rates and proximity to navigable waterways. Geographic location also informs weather patterns that may favour economic sectors like agriculture and mining. Gallup et al., (1998:179) argue that coastal areas tend to host growing cities that boast manufacturing and trade activities that inform urbanisation trends. Rodrik et al., (2002:151) confirm the direct and indirect impact of geography on incomes through agricultural productivity and accessibility to markets, respectively.
Dritsakis et al., (2006:48) describe the level of openness to trade, the ratio of exports to GDP, as an important element of economic growth. Openness to trade, therefore, requires harmonious relations with the rest of the world as it is an enabling component that facilitates technology transfer and improved economies of scale. Politically stable governance would also bode well for trade relations, signed agreements and relevant trading blocks. FDI inflows are a good mechanism to boost capital formation ranging from public infrastructure to business services. However, Dritsakis et al., (2006:49) argue that the country receiving FDI has to possess matching skills and technological know-how in order to realise significant and lasting economic results from FDIs.

According to Solow (1965: 85) technological progress is a critical input in the production function as it ensures positive production levels even when the diminishing returns to all types of capital prevail. This suggests that technological innovation has been the main catalyst and a major component of sustained economic growth in highly industrialised economies. Similarly, Romer (1990:98) notes that the invention of new ideas has kept developed countries at the forefront due to technology transfer attained through international trade. Romer (1990:98) further reports that the combination of new ideas and large amounts of human capital advances economic growth. Gregorio and Lee (1999:01) also highlight that some level of preparedness by the main production inputs, which include human capital, enabled the East Asian Tiger economies to exploit opportunities that resulted in their rapid growth.

This is in-line with the main focus of the study which seeks to explore the contribution of the employed South African labour force to economic output and growth. The state of human capital informs on whether the human effect is capable of utilising the factors of production efficiently to attain higher production output from the limited resources. Theoretical and empirical studies on human capital are discussed below.

2.4 DEFINING HUMAN CAPITAL

Appleton and Teal (1998:09) define human capital as human characteristics that include knowledge, skills, strength and vitality, obtained through education and nutrition (health), which enhance an individual’s chances to participate in an economic activity that would most likely improve income levels. Romer (1996:126) considers human capital as the second type of capital that embodies specific kind of abilities, skills and knowledge of workers. Mankiw and Taylor (2006:508) define human capital as “knowledge and skills that workers acquire through
education, training and experience”. Similarly, Kleynhans (2006:55) explains human capital as elements embodied in human beings that boost the quality of labour through skills and knowledge, allowing for lower production costs. This enables firms to reduce the prices of their goods and services while production output is on the rise for the same or reduced production time. Todaro and Smith (2004:130) note that improved labour productivity without firms incurring extra cost of training is likely to shift the total production function to a higher level. This process of improved competitiveness lowers the rate of diminishing marginal returns assumed by the endogenous growth theory (Cypher and Dietz, 1997:115). Kleynhans’ definition of human capital is applied as it is in line with the intention of the study to present human capital as a labour edifying element.

2.5 THEORETICAL LITERATURE - ECONOMIC GROWTH MODELS

Solow’s (1957:312) aggregate production function defines output of a macro economy as a product of capital and labour as well as unobserved technological change over time. However, the main source of the thriving impact of technological change on economic growth was not explored extensively until the 1990’s, with Mankiw et al., (1992:415) adding human capital as a factor of production.

Nelson and Phelps’ (1966:75) framework gives emphasis on human capital - educated employees - as an enabling agent to higher levels of economic growth, especially in technologically advanced countries. In this framework, it is explained that human capital is a catalyst that accelerates productivity levels through innovation and ease of adaptation to new technological ways of manufacturing. They conclude that higher endowment of human capital results in increased levels of innovation. Solow (1956), Nelson and Phelps (1966) and Lucas (1988) concur that human capital is important for economic growth. The study adopts the augmented Solow growth model as it includes human capital as an independent factor. The Solow growth model and its augmented form are discussed below.

2.5.1 Solow Growth Model

Solow’s (1956:66) neoclassical growth model gives a framework that decomposes output into different factors in the aggregate production function of a closed economy. The framework highlights some dimensions caused by savings, population growth and technological progress on economic growth. The Solow model is based on the assumptions that:
1) the economy has one sector producing one commodity that can either be saved (S) or used for investment (I),
2) the economy is closed to international trade and has no government intervention,
3) varying composition of factors of production - labour and capital; and
4) exogeneity of technical progress, population growth and the depreciation rate of capital stock.

A number of theories agree to include labour (L), and capital (K) as the main factors of production. However, Solow seeks to establish the impact of each worker using available technology to improve output as well as a worker who uses capital stock to increase productivity levels. Solow’s neoclassical aggregate production function introduces total output (Y) as a function of capital (K) and labour (L) inputs using a Cobb-Douglas production function shown as

\[ Y = F(K, L) \] (2.1)

Solow adds that technology \((A_t)\) is a critical component of the production function.

\[ Y = A_tF(K, L) \] (2.2)

Solow gives an assumption that technology is exogenous, thereby suggesting that all countries have technology as a public good. This view is disputed by Romer (1990: S71). The production function presents an average worker’s output \(\frac{Y}{L}\) with the resources at his/her disposal \(\frac{K}{L}\) and the efficiency of labour (E) shown below as

\[ \frac{Y}{L} = F\left(\frac{K}{L}, E\right) \] (2.3)

The basic production function fulfils the three conditions stating that:

i) all values of \(K\) and \(L\) are greater than zero, therefore implying that output will be a product of any amount of capital with a certain amount of labour – positive but diminishing marginal returns to both capital and labour;
production function shows that the factors of production grow at constant rates, meaning that an increased level of input (either labour or capital) will be evident on the total output $F(\lambda K, \lambda L) = \lambda Y$. This condition suggests that the economy is saturated and therefore any extra effort or specialisation will have no effect on output per worker; and,

that as the capital-labour ratio $\left( \frac{K}{L} \right)$ approaches infinity, the marginal product of capital approaches zero.

FIGURE 2 shows that the benefit of increasing the capital-labour ratio is mainly realised through a higher output level per worker. However, this benefit erodes over time due to diminishing returns. In FIGURE 3, Solow’s model illustrates that in the presence of technology, additional capital per unit of labour will result in an upward shift of output per worker, moving from a steady state, from $y_a$ to $y_b$. This shows that technological progress equips labour with an efficient and value generating ability that has a positive effect on the labour’s output even as capital (k) remains unchanged.

*FIGURE 2: Production function per capita*

![Production function per capita](source: Snowdon & Vane (2005:605))
2.5.2 Augmented Solow Model

Lucas (1988:17) and the neoclassical economists (Mankiw et al., 1992:416) are of the view that human capital is in its own right an ordinary input like capital and labour to the aggregate production function as follows:

\[ Y_t = A_t K_t^\alpha L_t^\beta H_t^\mu \]  

(2.4)

Where \( Y_t \) is total output, \( A_t \) is technology growing at an exogenous rate, \( K_t \) is physical capital, \( L_t \) is labour force and \( H_t \) is human capital.

The dispute of whether human capital should be treated as an ordinary input to the aggregate production function has been caused by the different types of proxies used for human capital such as school enrolment rates, educational attainment, the completion of primary, secondary and / or tertiary education. A common factor in developed countries is the combination of physical and human capital factors as key determinants of economic output (Bayraktar-Sağlam, 2016:271). This suggests that the existence of physical capital gives a platform for skills and abilities embodied in the labour force to explore value generating economic activities.
Mankiw et al. (1992:408) augmented the Solow’s neoclassical model to include human capital as an additional factor of production. However, similar to the subjection of physical capital to diminishing returns, human capital has limitations. This leaves technological innovation as the main driver of economic growth. With such shortcomings, Romer (1986:1005) posited in the endogenous growth model that economic growth is an endogenous outcome of an economic system. In this model, technological progress is not regarded as a residual but as a result of growth factors included in the model. Human capital is treated as a function of ideas and innovations that can generate continuous growth rather than just shifting the economy’s steady state.

An endogenous model, therefore, allows education to influence growth through its effect on technological change and diffusion in the economy. As such, Nelson and Phelps (1966:70) argue that “educated people make good innovators so that education speeds the process of technological diffusion”. The extension of the Solow model by Mankiw et al., (1992:408) includes the human capital component as an independent input to the Cobb-Douglas production function with labour augmenting technological progress presented as follows:

$$Y_t = K_t^\alpha H_t^\beta (A_t L_t)^{1-\alpha-\beta}$$

(2.5)

The exponents ($\alpha$, $\beta$, $1-\alpha-\beta$) measure the elasticity of output to respective inputs. The extended Solow model has three assumptions:

1) people forego consumption so as to invest in human capital as if for investing in physical capital;
2) human capital depreciates at the same constant rate as physical capital; and,
3) output can either be used for consumption or investment purposes.

Engelbrecht (2003:43) highlights the dynamic role played by human capital both as an input in the aggregate production function and as a catalyst for innovation and technological progress. Becker et al., (1990:S37) state that there is a negative correlation between human capital and population growth. This is further reiterated by Rosenzweig’s (1990:S39) view that developed countries are characterised by low population growth and high levels of human capital in terms of education, education attainment, on the job training and vocational skills. The drawbacks of the augmented Solow model represented by Mankiw et al., (1992:409) include the assumption of perfect competition and the absence of market failures.
2.6 EMPIRICAL LITERATURE – RELATIONSHIP BETWEEN HUMAN CAPITAL AND ECONOMIC GROWTH

A number of studies that have investigated the impact of human capital on economic growth have used different proxies, with a majority opting for education as a proxy for human capital (Awad et al., 2013 and Barro et al., 1993). The endogenous growth model argues that a certain level of education advances technological innovation which then contributes favourably towards economic growth. However, a better education resulting in higher innovation is on its own, a function of high economic growth, thereby suggesting reverse causality (Blundell and Bond, 1998:18 and Bayraktar-Sağlam, 2016:275). Considering that skilled employees have an educational element, it is expected that the “skilled” cohort in this study will have a positive contribution to economic output.

2.6.1 Human capital and Economic growth

Pouris and Inglesi-Lotz (2014:01) agree on the importance of education to economic growth as well as a certain level of causality between the two variables. However, there is no unison with regards to the direction of causality as well as the magnitude of the influence. Lee et al., (2011:469) argue that the direction of causality depends on the developmental phase of a resident country, with a stronger causality relationship recorded for developing countries, as they observe and learn from early developers. Nelson and Phelps (1966:70) concur that a country with a highly educated labour-force would easily imitate economies that are technologically advanced. This suggests that if least developed countries (LDCs) are investing significantly in higher education, they are more likely to innovate at a faster pace, creating a possibility to catch up with leading innovators (Benhabib and Spiegel, 1994:145).

There appears to be a strong correlation between school enrolment and long-run economic growth (Barro, 2001:212 and Mankiw et al., 1992:421)). One additional year in schooling years translates into a rise in GDP per capita of 6 per cent (Bassanini and Scarpetta, 2002:403)). Blundell et al., (1999:18) also report on the positive contribution of manpower qualifications and skills to productivity and competitiveness. However, Murphy et al., (1991:529) report that in a number of studies, the impact of human capital may be enhanced or limited by a selected proxy. The authors argue that engineers are usually cited as having a higher impact on economic growth compared to legal professionals. Furthermore, Easterly (2001:69) argues that the combination of quality education, economic institutions and capital has a muted effect.
on growth in countries where facilitating factors like functioning markets and legal systems are not established. This shows that the value generating effect of human capital may be limited by other factors. The mismatch of allocating cognitive skills to socially unproductive activities may render human capital unfruitful to economic growth (Pritchett, 2001:387).

Bils and Klenow (2000:1170) argue that there is a high correlation between education investments and economic growth owing to a reverse causality, where higher economic growth levels result in increased investment in education. Further, the relationship between the two variables, human capital - proxied by education - and economic growth, is compromised by the use of proxies such as the “the number of years in school attendance” where each extra year in education, whether in primary or tertiary level, is considered to yield an equal additional benefit to total output. Also, the absence of a unanimous benchmark for a human capital proxy as well as a lack of accurate data and different methodological preferences cast doubt on the assessment of the impact of human capital on economic growth.

Empirical studies (Abbas, 2001 and Borojo and Jiang, 2016 and Petrakis and Stamatakis, 2002)) disaggregate the education proxy into different levels: primary, secondary and tertiary, in order to detect the impact of each level on economic growth. Results from these studies suggest that education in primary level has a positive contribution to economic growth of LDCs, while tertiary education has a significant contribution to developed countries where innovation and adoption of technology is critical. A similar outcome was reported by Gyimah-Brempong et al., (2006:525). This study follows a similar approach where a proxy for human capital (skills) will be divided into three categories of skilled, semi-skilled and low-skilled employees. According to Wage Indicator Paycheck.in (2018), skilled employees have specialised training and are able to rate their performance, and accumulate specific expertise in line with their tertiary education. Semi-skilled employees have basic skills that enable them to perform repetitive tasks while low-skilled employees have no particular skills and no formal education with jobs that mostly require physical strength.

The proxy for human capital is disaggregated in order to capture the effect of each of the three skill levels of the employed labour force on the domestic economy. TABLE 1 below shows different types of jobs associated with each skill level.
TABLE 1: Jobs Assigned to Different Skill Levels

<table>
<thead>
<tr>
<th>Skilled</th>
<th>Semi-skilled</th>
<th>Low-skilled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professional, semi-professional and technical occupations</td>
<td>Clerical and Sales occupations</td>
<td>All occupations</td>
</tr>
<tr>
<td></td>
<td>Transport, delivery and communications occupations</td>
<td>not elsewhere classified</td>
</tr>
<tr>
<td>Managerial, executive and administrative occupations</td>
<td>Services occupations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Farmer and Farm manager</td>
<td></td>
</tr>
<tr>
<td>Certain transport occupations, e.g. pilot navigator</td>
<td>Artisan, apprentice relate occupations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Production foreman and production supervisor</td>
<td></td>
</tr>
</tbody>
</table>

Source: Quantec

2.7 THE STATE OF HUMAN CAPITAL IN THE SOUTH AFRICAN LABOUR SECTOR

Growth theory has reported a positive impact of human capital on economic growth as either an independent factor or an accelerating agent to growth. With regards to South Africa, the human capital component, comprising of an educated, skilled and experienced labour force, stems from a historical divide that administered a racially classified education system. The democratic state inherited a skewed human capital where universities designated for Blacks, Coloureds and Indians were associated with the low quality output. Students from these universities were considered to have limited research capacity compared to their white counterparts (Fedderke et al., 2003:14).

Pritchett (2001:369) notes that the low developmental impact of education is partly a result of a low quality of education offered at schools. Low levels of human capital prolonged over an extended period of time may have a negative impact on the country’s efforts of attracting investments. According to the Quantec’s online data, the current structure of SA’s total employed labour is characterised by a high number of semi-skilled employees, followed by low-skilled and a muted number of skilled workers. This is in line with a persistent “inadequately educated workforce” reason reported as one of key problematic factors for doing business in South Africa – annual Global Competitiveness Report (Schwab, 2017:324).

While democracy ushered in increased access to education at all levels, Pauw et al., (2006:24) argue that enrolment at tertiary institutions was highly biased towards academic streams compared to technical streams. This resulted in a muted employment pool of skilled labour in different sectors including manufacturing. In line with this, Kleynhans (2006:58) found that the education level of labour in general needs to be improved through vocational and industry related courses.
Van Zyl and Bonga-Bonga (2009:05) assessed the relationship between fiscal expenditure on human capital and the efficiency of the human resource in stimulating economic growth. The authors concluded that the expenditure by the South African government on education and training does not result into an adequate preparation of the labour-force to embark on technologically advanced tasks. The less adequate capacity of the South African labour to adapt to the requirements of future jobs is also portrayed by Samans and Zahidi (2017:02) in FIGURE 4 (South Africa at the bottom right—Low capacity, High exposure). The figure shows that the capability of the South African labour (measured by the quality of education and the extensiveness of skills) scored below average. This is despite the country’s high exposure to innovative trends of latest technology and diversified economic activities. The authors call for an urgent need for efforts to close the skill gap in the continent as a significant number of African countries fall below average capacity.

FIGURE 4: Africa’s capacity to adapt and exposure to the future of jobs

Source: Samans and Zahidi (2017:2) World Economic Forum Analysis

2.8 CONCLUSION

In discussing the long-standing quest of what constitutes economic growth, a number of determinants of economic growth are explored as either proximate or deep determinants. Also, a combination of variables like technology and human capital (Gregorio and Lee, 1999:01) are deemed necessary for economic growth. While theoretical models have a unanimous positive view on the impact of human capital on economic growth, empirical studies give conflicting
views on the significance of human capital on economic growth. Other studies are questioning whether it is the quality or quantity of human capital that has a significant impact on economic growth while others argue the direction of causality as well as the magnitude of the impact.

In the South African context, the country still grapples with the adequacy of an educated workforce despite the notable rise in access to educational institutions (Schwab, 2017:324). This necessitates the consideration of the quality of education and skills offered in the country. Local studies emphasise the importance of an adequately capable labour force in advancing the economy of South Africa. The study seeks to investigate the impact of human capital of the employed labour force on economic output and growth.
CHAPTER 3

3 RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter outlines the methodology used to investigate the impact of human capital on the economic output and growth in South Africa. Theoretical research on the determinants of economic growth has highlighted the importance of human capital (Solow (1956), Nelson and Phelps (1966) and Lucas (1988)). Endogenous growth models such as the augmented Solow growth model presented human capital as a critical factor of economic growth. The empirical approach for this study is applied using a static (Pooled Ordinary Least Squares, fixed effects model - FEM) and a dynamic system (Generalised Method of Moments - SYS GMM). The chapter presents the functional form, description and sources of variables, Granger causality test as well as an estimation technique.

3.2 FUNCTIONAL FORM

In order to estimate the impact of human capital on economic output and growth, the study will use a theoretical framework of the Cobb-Douglas production function. According to Solow’s neoclassical aggregate production function, total output (Y) is a function of capital (K) and labour (L) inputs shown as:

\[ Y = F(K, L) \tag{3.1} \]

Neoclassical economists like Mankiw et al., (1992:416) have shown the flexibility of this framework to allow the inclusion of different economic variables like technology and human capital as shown below.

\[ Y_t = A_t K_t^\alpha L_t^\beta H_t^\mu \tag{3.2} \]

Where \( A \) is technology growing at an exogenous rate and \( H \) is human capital. For the purpose of this study, the Cobb-Douglas production function will be adjusted to include three different skill levels (skilled, semi-skilled and low-skilled) as proxies for human capital. Three methods
of analysis will be utilised. The first method is a widely utilised ordinary least squares (OLS), with equations for total output at level and log transformed presented as;

$$\text{Output}_{i,t} = \beta_0 + \beta_1 S_{i,t} + \beta_2 SS_{i,t} + \beta_3 LS_{i,t} + \beta_4 Capital_{i,t} + \epsilon_{i,t} \quad (3.3)$$

$$L.\text{Output}_{i,t} = \beta_0 + \beta_1 L.S_{i,t} + \beta_2 L.SS_{i,t} + \beta_3 L. LS_{i,t} + \beta_4 L. Capital_{i,t} + \epsilon_{i,t} \quad (3.3.1)$$

The equation above shows logarithm of all variables, with $L.\text{Output}$ showing a logarithm of total output. $\beta_0$ is a constant term while $\beta_1 L.S_{i,t}$ shows a logarithm of skilled employment, $\beta_2 L.SS_{i,t}$ represents a logarithm of semi-skilled employment and $\beta_3 L. LS_{i,t}$ depicting a logarithm of low-skilled employment - all these variables are proxies for human capital at different skill levels. The variable $\beta_4 L. Capital_{i,t}$ is a logarithm of gross fixed capital formation and $\epsilon$ is a random error term.

The weakness of a pooled OLS estimator (3.3.1) is that it does not consider time and individual effects. As a result, the study will explore other estimators. The second method is static panel data models where FEM and Random effects (REM) models are expected to deal with possible heterogeneous issues. The two equations below (3.4 - level and 3.4.1 - log transformed) can be estimated using either fixed or random effects models;

$$\text{Output}_{i,t} = \alpha_i + \beta_1 S_{i,t} + \beta_2 SS_{i,t} + \beta_3 LS_{i,t} + \beta_4 Capital_{i,t} + \epsilon_{i,t} \quad (3.4)$$

$$L.\text{Output}_{i,t} = \alpha_i + \beta_1 L.S_{i,t} + \beta_2 L.SS_{i,t} + \beta_3 L. LS_{i,t} + \beta_4 L. Capital_{i,t} + \epsilon_{i,t} \quad (3.4.1)$$

The $\alpha_i$ term shows municipal specific fixed effects that indicate unobserved heterogeneous or individual effects. A hausman test will be used to decide whether a fixed or random effects model is appropriate.

Borojo and Jiang (2016:414) argue that there is a possibility of endogeneity when dealing with economic growth due to its dynamic phenomenon. The existence of endogeneity will be evaluated by a Granger causality test. For the purpose of this study, the Dumitrescu-Hurlin test for Granger Non-causality will be done between economic output and human capital (skilled employment). An equation depicting causality from economic output to human capital is presented as;
\[ s_{i,t} = \alpha_{i,t} + \sum_{k=1}^{K} \gamma^{(k)} s_{i,t-k} + \sum_{k=1}^{K} \beta^{(k)}_{i} \text{output}_{t-k} + \epsilon_{1i,t} \quad (3.5) \]

\[ i = 1,2, ... N; \ t = 1,2, ..., T \]

Where, output is a proxy for economic growth; S is skilled employment (a proxy for human capital); \( \gamma \) and \( \beta \) are the slope coefficients; \( i \) representing each municipality in a panel; \( t \) is the year in the panel; \( K \) is the number of lag length; \( \alpha \) is the intercept of the equation and \( \epsilon \) is an error term.

Similarly, equation showing causality from human capital to economic output is presented as

\[ \text{output}_{i,t} = \alpha_{i,t} + \sum_{k=1}^{K} \gamma^{(k)} \text{output}_{i,t-k} + \sum_{k=1}^{K} \beta^{(k)}_{i} s_{i,t-k} + \epsilon_{2i,t} \quad (3.6) \]

These equations will test the direction of causality between the two variables (human capital and total output). Another causality test is between total output and total employment and between total employment and total output. Equations are shown below. Also, an assumption is that lag orders of \( K \) are identical for all cross-section units of the panel. \( K \) represents the number of lags

\[ \text{empl}_t_{i,t} = \alpha_{i,t} + \sum_{k=1}^{K} \gamma^{(k)} \text{empl}_t_{i,t-k} + \sum_{k=1}^{K} \beta^{(k)}_{i} \text{output}_t_{i,t-k} + \epsilon_{2i,t} \quad (3.7) \]

\[ \text{output}_t_{i,t} = \alpha_{i} + \sum_{k=1}^{K} \gamma^{(k)} \text{output}_t_{i,t-k} + \sum_{k=1}^{K} \beta^{(k)}_{i} \text{empl}_t_{i,t-k} + \epsilon_{2i,t} \quad (3.8) \]

\[ i = 1,2, ..., N; \ t = 1,2, ..., T \]

Where, \( \text{empl}_t \) representing total employment. It is expected that the Granger causality test will suggest whether there is endogeneity between total output and human capital as well as between the total output and total employment. As discussed above, in the likely presence of endogeneity, a dynamic system GMM model is a preferred estimator as it is able to correct endogeneity.

The system GMM model is characterised by the presence of a lagged dependent variable (\( \Delta L. \text{Output}_{i,t-1} \)) on the right hand side of the equation. ... Therefore, equation 3.9 shows the ability of the system GMM model to remove unobserved individual specific effects by first – differencing (\( \Delta \)) the growth equation. presented as;
\[ \Delta L. Output_{i,t} = a \Delta L. Output_{i,t-1} + \beta_1 \Delta L. S_{i,t} + \beta_2 \Delta L. SS_{i,t} + \beta_3 \Delta L. LS_{i,t} + \beta_4 \Delta L. Capital_{i,t} + \Delta \epsilon_{i,t} \]

with \( i = 1, \ldots, N; \ t = 1, \ldots, T \) (time) \hfill (3.9)

Furthermore, functional forms for estimating the impact of the different shares of skill levels (of total employment) on total economic output are presented below as;

\[ \text{Output}_{i,t} = \beta_0 + \beta_1 S_{i,t} + \beta_2 SS_{i,t} + \beta_3 LS_{i,t} + \beta_4 \text{Capital}_{i,t} + \epsilon_{i,t} \] \hfill (3.10)

\[ L. Output_{i,t} = \alpha_i + \beta_1 L. S_{i,t} + \beta_2 L. SS_{i,t} + \beta_3 L. LS_{i,t} + \beta_4 L. \text{Capital}_{i,t} + \epsilon_{i,t} \] \hfill (3.10.1)

\[ L. Output_{i,t} = \alpha_i + \beta_1 L. S_{i,t} + \beta_2 L. SS_{i,t} + \beta_3 L. LS_{i,t} + \beta_4 L. \text{Capital}_{i,t} + \epsilon_{i,t} \] \hfill (3.11)

\[ \Delta L. Output_{i,t} = a \Delta L. Output_{i,t-1} + \beta_1 \Delta L. S_{i,t} + \beta_2 \Delta L. SS_{i,t} + \beta_3 \Delta L. LS_{i,t} + \beta_4 \Delta L. \text{Capital}_{i,t} + \Delta \epsilon_{i,t} \] \hfill (3.12)

Where \( S_{i,t}, \ SS_{i,t} \) and \( LS_{i,t} \) are shares of skilled, semi-skilled and low-skilled employment, respectively.

As with models estimated for the impact of human capital on economic output, the estimation of the impact of human capital on economic growth will follow the same method. The estimation equations presented below are for pooled OLS, Fixed effects and system GMM, respectively.

\[ g_{i,t} = \beta_0 + \beta_1 L. S_{i,t} + \beta_2 L. SS_{i,t} + \beta_3 L. LS_{i,t} + \beta_4 L. \text{Capital}_{i,t} + \epsilon_{i,t} \] \hfill (3.13)

\[ g_{i,t} = \alpha_i + \beta_1 L. S_{i,t} + \beta_2 L. SS_{i,t} + \beta_3 L. LS_{i,t} + \beta_4 L. \text{Capital}_{i,t} + \epsilon_{i,t} \] \hfill (3.14)

\[ \Delta g_{i,t} = a \Delta g_{i,t-1} + \beta_1 \Delta L. S_{i,t} + \beta_2 \Delta L. SS_{i,t} + \beta_3 \Delta L. LS_{i,t} + \beta_4 \Delta L. \text{Capital}_{i,t} + \Delta \epsilon_{i,t} \] \hfill (3.15)
Where the variable $g$ represents economic growth and $g_{i,t-1}$ depicts a lagged dependent variable of economic growth. The equations below will estimate the impact of the three different shares of skill levels (of total employment) on economic growth;

$$g_{i,t} = \beta_0 + \beta_1 L. Sh_S i_t + \beta_2 L. Sh_SS i_t + \beta_3 L. Sh_LS i_t + \beta_4 L. Capital_{i,t} + \epsilon_{i,t}$$ (3.16)

$$g_{i,t} = \alpha_i + \beta_1 L. Sh_S i_t + \beta_2 L. Sh_SS i_t + \beta_3 L. Sh_LS i_t + \beta_4 L. Capital_{i,t} + \epsilon_{i,t}$$ (3.17)

$$g_{i,t} = a\Delta g_{i,t-1} + \beta_1 \Delta L. Sh_S i_t + \beta_2 \Delta L. Sh_SS i_t + \beta_3 \Delta L. Sh_LS i_t + \beta_4 \Delta L. Capital_{i,t} + \Delta \epsilon_{i,t}$$ (3.18)

The sources of the data used in this study are discussed in the next section.

### 3.3 DESCRIPTION AND SOURCES OF DATA

The study will use municipal data across six key economic sectors – Agriculture, forestry and fishing; Mining and quarrying; Manufacturing; Wholesale and retail trade; Catering and accommodation; Transport, storage and communication and Finance, insurance, real estate and business services for 24 years of observations. All data is extracted from Quantec – a South African based consultancy providing an online database for macro and regional economic, industry and international trade data. Variable names and descriptions and sources are depicted in TABLE 2 below.
TABLE 2: Variables, description and data sources

<table>
<thead>
<tr>
<th>Variables</th>
<th>Meaning</th>
<th>Data source</th>
<th>Theoretical expectation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output (dependent variable)</td>
<td>Real Gross Value Added - Real Output at basic prices,</td>
<td>Quantec</td>
<td></td>
</tr>
<tr>
<td></td>
<td>R millions constant 2010 prices (1993 – 2016)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capital (K)</td>
<td>Gross Fixed Capital Formation, percentage change (1993 – 2016)</td>
<td>Quantec</td>
<td>positive</td>
</tr>
<tr>
<td>Labour (Empl_t)</td>
<td>Total employment (Number) (1993 – 2016)</td>
<td>Quantec</td>
<td>positive</td>
</tr>
<tr>
<td>Skilled (s)</td>
<td>Employed labour in a Formal Sector- Skilled (Number) (1993 – 2016)</td>
<td>Quantec</td>
<td>positive</td>
</tr>
<tr>
<td>Semi-skilled (ss)</td>
<td>Employed labour in a Formal Sector- Semi-Skilled (Number) (1993 – 2016)</td>
<td>Quantec</td>
<td>positive</td>
</tr>
<tr>
<td>Low-skilled (ls)</td>
<td>Employed labour in a Formal Sector- Low-Skilled (Number) (1993 – 2016)</td>
<td>Quantec</td>
<td>positive</td>
</tr>
<tr>
<td>g</td>
<td>Economic growth</td>
<td>Quantec</td>
<td>positive</td>
</tr>
<tr>
<td>Sh_s</td>
<td>Share of skilled employees</td>
<td>Quantec</td>
<td>positive</td>
</tr>
<tr>
<td>Sh_ss</td>
<td>Share of semi-skilled employees</td>
<td>Quantec</td>
<td>positive</td>
</tr>
<tr>
<td>Sh_ls</td>
<td>Share of low-skilled employees</td>
<td>Quantec</td>
<td>negative</td>
</tr>
</tbody>
</table>

Author’s computation

3.4 EXPECTED SIGNS OF VARIABLES

According to Mankiw et al., (1992:408), the relationship between human capital and economic growth is positive, with human capital regarded as enhancing the quality of labour. However, the relationship has been questioned, disputing the magnitude of the relationship, the sign of correlation and even the existence of the association (Fedderke and Luiz, 2005:20; Pritchett, 2001:387 and Benhabib and Spiegel, 1994:149). The study expects a positive sign between total output and human capital proxies - skilled, semi-skilled and to a lesser magnitude for low-skilled of the employed labour. This concurs with a study by Bayraktar-Sağlam (2016:271) reporting on the growth-inducing effect of tertiary education for high-income countries through innovation, diffusion and adoption of new technologies.

The role of labour on economic growth is highlighted by the quantity and quality of labour as one of the key inputs to total growth (Jajri and Ismail, 2010:488). It is expected that the quantity of labour will have a positive impact on economic growth. However, an increase in the supply of labour while other factors of production remain constant may lead to a reduced output over time. Total employment will be disaggregated into shares of skilled, semi-skilled and low-skilled groups. In line with the human capital proxies, a positive sign is expected between total output and the shares, albeit at a declining magnitude from skilled, semi-skilled and low-skilled
shares. A positive relationship between total output and capital is expected. Similar expectations are held for the total output growth model (economic growth). A Granger causality test will be conducted to confirm if endogeneity exists.

3.5 GRANGER CAUSALITY TEST

In order to determine the presence of causality between the variables of interest (total output, skilled employees and total employment) in this study, a Granger causality test will be done. Granger (1969:428) gives different definitions of causality, highlighting instantaneous causality (where a current value of X is better predicted if the current value of Y is included in the prediction) as well as causality lag (where the past value of X better predicts the forecasted value of Y). As discussed earlier, the direction of causality between human capital and total output differs, either bidirectional, unidirectional or a weak correlation between the two variables (Lee et al., 2011:05). A Granger causality test is used to determine whether there is causal relationship between human capital and total output in the different municipalities. Lopez and Weber (2017:05) caution that Granger causality in panel data assumes that the variables are stationary. However, Balan (2015:10) informs that the stationarity of the variables is not necessary if bootstrap Wald critical values are utilised. This study follows the panel causality test presented by Dumitrescu and Hurlin (2012) where a simple version of the Granger non-causality for heterogeneous panel data models is tested. The stationarity of the variables will however be tested by a Levin-Lin Chu unit root test which is appropriate for strongly balanced panels. The linear model presented below is followed:

\[ y_{i,t} = \alpha_i + \sum_{k=1}^{K} \gamma^{(k)} y_{t-k} + \sum_{k=1}^{K} \beta^{(k)}_i x_{t-k} + \epsilon_t \quad (i = 1,2, ..., N; t = 1,2, ..., T) \]  

(3.19)

Where \( x \) and \( y \) are two stationary variables observed for \( N \) individuals in \( T \) periods. The individual effects \( \alpha_i \) are assumed to be fixed in the time dimension. Another assumption is that the lag orders of \( K \) are identical for all cross-section units (municipalities) of the panel. The autoregressive parameters \( \gamma^{(k)} \) and the regression coefficients \( \beta^{(k)}_i \) are allowed to vary across groups. The causality is tested with the use of a Wald bar, Z-bar statistics and p-values with a null hypothesis suggesting no causality for all the units of the panel (Homogeneous Non-Causality). If the null hypothesis is rejected (where the p-value is less than 0.05) an alternative hypothesis (Heterogeneous Non-Causality) will be used, then the conclusion will be that there is causality between human capital and economic output in a specific municipality.
\[ H_0: \beta_i = 0 \forall i = 1, \ldots, N \]
\[ H_1: \beta_i = 0 \forall i = 1, \ldots, N_1 \]
\[ \beta_i \neq 0 \forall i = N_1 + 1, \ldots, N \]

The average statistic which is related with the null Homogeneous Non-Causality (HNC) hypothesis is suggested and presented below;

\[ W_{N,T}^{HNC} = \frac{1}{N} \sum_{i=1}^{N} W_{i,T} \] (3.20)

Where \( W_{i,T} \) shows the individual Wald statistics for the \( i \)th cross-section unit corresponding to the individual test \( H_0: \beta_i = 0 \). Under the null hypothesis of non-causality, each individual Wald statistic converges to a chi-squared distribution with \( K \) degrees of freedom for \( T \to \infty \).

\[ W_{i,T} \to \chi^2(K) \quad \forall i = 1, \ldots, N \]

The standardised test statistic \( Z_{N,T}^{HNC} \) for \( T, N \to \infty \) is presented as follows:

\[ Z_{N,T}^{HNC} = \sqrt{\frac{N}{2K}} (W_{N,T}^{HNC} - K) \to N(0,1) \]

### 3.6 ESTIMATION TECHNIQUE

The use of panel data is expected to yield reliable results of regression due to an increased number of observations that are likely to deter collinearity among independent variables and improve the degree of freedom. Furthermore, the use of panel data model will assist in controlling for municipal specific effects caused by factors that cannot be accurately measured. The extended Solow model highlights the effect of labour as embodied in human capital where a skilled labourer is assumed to contribute more to the total output compared to unskilled labour. Bond et al., (2010:1075) note that economic models suggest that growth in output is largely informed by levels of investment in capital and human capital. This study uses both static (pooled Ordinary Least Squares - OLS and fixed effects) and dynamic panel
(system GMM) models for robustness. However, the pooled OLS estimator does not consider
time and individual effects. Also, the dynamic element of economic growth would compromise
the OLS assumption of no correlation between a regressor and an error term.

On heterogeneity, it may be assumed that municipalities have similar experiences (as they
are subject to the same government, policies and laws) and therefore expected to react in a
similar fashion to different shocks. Municipalities are characterised by different aspects.
Among others, the location of municipalities – proximity to sea – offers an advantage of
exploring trade and tourism. Also, the dynamics of the population, infrastructure, mineral
endowment and the viability of certain industries have a significant impact on attracting skilled
resources to certain municipalities. This then suggests the presence of heterogeneity and
therefore prompts a need to control for such. Panel data modelling allows the use of either
Fixed or Random Effects to treat heterogeneity.

3.6.1 Fixed Effects Model

Fixed effects assume that there is constant heterogeneity over time between the individual
specific effect and the independent variable. The FEM is estimated with the equation below;

\[ Y_{it} = \alpha + \beta X'_{it} + \mu_i + \epsilon_{it} \]  

(3.21)

The use of FEM estimation involves two methods, a within-groups transformation and a
derifferencing method. According to Wooldridge (2002:267) a within-groups method is done
through an averaging equation. The within-groups uses the variation of the means of
explanatory variables in order to determine the change in the variation of the dependent
variable. However, the intercept and independent variables that remain unchanged for each
municipality over time are likely to drop out of the model, thereby reducing the degrees of
freedom. Also, dependent variables are likely to be inaccurate (compared to the original
specification) as they are calculated as deviations from the means of municipalities. The
difference approach of the fixed effects controls heterogeneity through the use of lags. This
method differences out individual variability across municipalities by subtracting the
observation of the preceding time period from the present time period.

3.6.2 Random Effects Model
Wooldridge (2009:489) argues that the FEM regards unobserved municipal specific differences ($\alpha_i$) as a nuisance parameter due to its correlation with one or more independent variables. However, the Random effects method allows $\alpha_i$ to be randomly distributed and therefore not correlated with independent variables as well as independently distributed from dependant variables. Hsiao (2007:11) presented the advantages of Random effects (REM) to include the estimation of the impact of time-invariant variables like gender dummy. Another advantage is that the number of parameters remain unchanged even when the sample size increases. These advantages are recorded as weaknesses or limitations of the FEM. Dynamic time series panels are often reported as affected by endogeneity, as independent variables are correlated to the lagged dependent variable. In order to select a suitable model between the FEM and REM, a Hausman test is an appropriate measure.

Least squares based inference methods (FEM and REM) are considered biased and inconsistent in controlling endogeneity (Bun and Sarafidis, 2013:02). However, GMM has been reported to give consistent results in dealing with endogeneity (Yakovlev, 2007:329). In order to test for endogeneity, a Dumitrescu-Hurlin test for Granger Non-causality between the variables of interest will be conducted.

### 3.6.3 GMM estimator

Certain estimation techniques of Generalised Method of Moments (GMM) are reported as adequate to control for endogeneity (Cingano, 2014:15 and Wintoki et al., 2012:558). The main sources of endogeneity are simultaneity, omitted variables and measurement error. In order to capture the correlation between independent variables and the error term, this study discusses the first difference GMM and the system GMM estimators. These estimators are developed for dynamic models of panel data introduced by Arellano and Bond (1991) and Blundell and Bond (1998). A stable dynamic model is shown below as:

$$\ln Y_{it} = a_0 + \theta \ln Y_{i,t-1} + \beta x_{it} + \gamma_t + \eta_i + \varepsilon_{it}$$

(3.22)

Where $Y_{it}$ and $Y_{i,t-1}$ represent output per worker and a lagged term of the same, respectively. Then $x_{it}$ denotes a set of control variables that determine economic growth in natural
logarithm, $\eta_i$ depicts unobserved municipal specific-effects such as geographic location or any factor that is an important determinant of growth. The term $\gamma_t$ shows unobserved time specific effects and $\epsilon_{it}$ is the time varying regression residual. The subscripts $i$ and $t$ show municipality and time period, respectively while $\ln$ symbolises logarithm. $\alpha, \beta$ and $\gamma$ are parameters and vectors to be estimated.

The combination of a lagged dependent variable ($Y_{i,t-1}$) and fixed effects term ($\eta_i$) renders the OLS estimator ineffective as the latter is correlated with the error term ($\epsilon_{it}$). Also, other explanatory variables are likely to be correlated with fixed effects. The study needs to estimate a consistent and unbiased dynamic growth model. The fixed effects therefore need to be eliminated. Also, the OLS estimator would not be suitable as the new error term ($\epsilon_{it} - \epsilon_{it-1}$) would be correlated with the lagged dependent variable ($Y_{i,t-1} - Y_{i,t-2}$). Another limitation would be omitted variables (variant or time-invariant), but the fixed effects term ($\eta_i$) will control for time-invariant omitted variables. The possibility of endogeneity of some explanatory variables will qualify the use of Generalised Method of Moments (GMM) proposed by Arellano and Bond (1991). This estimation technique controls for omitted time-invariant variables and corrects for endogeneity through the use of internal instruments. Also, the GMM removes unobserved individual specific effects ($\eta_i$) by first differencing the growth equation. The first difference equation is presented as:

$$
\ln y_{i,t} - \ln y_{i,t-1} = a_0 + \alpha (\ln y_{i,t-1} - \ln y_{i,t-2}) + \beta (x_{it} - x_{i,t-1}) + (\gamma_t - \gamma_t) + (\eta_i - \eta_i) + (\epsilon_{it} - \epsilon_{it-1})
$$

(3.23)

The first difference of equation 3.22 and an additional lagged level of the independent variable as an additional variable yields,

$$
\ln \Delta y_{it} = a_0 + \partial \ln \Delta y_{i,t-1} + \beta \ln \Delta x_{it} + \theta \ln x_{i,t-1} + \gamma + \Delta \epsilon_{it}
$$

(3.24)

In this equation, the explanatory variables that are endogenous are instrumented by lags from at least two periods and deeper while pre-determined variables are instrumented by lags from one period or deeper.
Roodman (2009:86) discusses the first difference GMM estimator as capable of eliminating country-specific effects by taking the first difference of all variables in the model and utilising the lag values \((y_{i,t-1}, x_{i,t-1})\) of the right hand side of the equation to control for endogeneity. The main weakness of the first difference GMM estimator is that it eliminates most of the variation in the data and that missing current data (from which to subtract previous variables) would result in the loss of data. Furthermore, first differencing suggests that lagged levels of the independent variables are weak instruments that may cause large biases and imprecision. The first difference estimator is however able to correct for omitted variables and endogeneity biases.

Another GMM estimator called the system GMM (Arellano and Bover, 1995 and Blundell and Bond, 1998) offers a combination of first difference GMM with an additional set of level equations to restore cross-sectional information lost in first difference GMM. Also, lagged first differences (on the right hand side) are used as instruments. However, this estimator holds an assumption that first differences (deviation of initial observation from their steady state) are not correlated with municipal specific effects. Ullah et al., (2018:11) conclude that the system GMM provides efficient and consistent estimates if the panel dataset is balanced. In the event of confirmed causality or reverse causality (as indicated by Bils and Klenow, (2000:1170)) this study will control endogeneity by using system GMM. A Sargan test will be used to test the validity of the instruments used.

### 3.7 CONCLUSION

This chapter presented a methodology used in the study in order to establish the impact of human capital on economic growth in South Africa. The use of a panel data method is expected to capture the time and individual effects of the variables of interest. A Granger causality test is done to confirm the presence of causality between variables of interest. The empirical approach for this study uses both static and dynamic estimators with the system GMM considered robust and superior as it controls endogeneity on independent variables.
CHAPTER 4

4 DATA ANALYSIS

4.1 INTRODUCTION

This chapter presents the results of the study. Firstly, preliminary data consisting of summary statistics and a correlation matrix is presented. Model specification tests are presented in order to determine the robustness of the estimates. A Granger causality test is applied to establish if there is endogeneity between the key variables. The system GMM estimator is expected to be robust in detecting violations of heteroscedasticity, normality and autocorrelation in errors, thereby ensuring additional efficiency and dealing with endogeneity. Results of different estimators like pooled OLS, fixed effects and system GMM are presented and discussed.

4.2 DESCRIPTIVE STATISTICS

This study mainly uses secondary data sourced from the Quantec database. Our main variables are total output (real gross value added) a proxy for economic output. Human capital is proxied by employed labour as skilled (s), semi-skilled (ss) and low-skilled (ls). Also, other variables like capital, total employment (empl_t) and formal employment (empl_f) were sourced from the Quantec database. Another estimation with output growth (g) as a dependent variable is presented. The sample comprises 269 municipalities, 6 economic sectors (Agriculture; Mining; Manufacturing; Wholesale and retail trade; Catering and accommodation; Transport, storage and communication; and Finance, insurance, real estate and business services) with annual data covering the period of 24 years (1993 – 2016).

4.2.1 Summary Statistics

The summary statistics presented in TABLE 3 show the data for the dependent variable at level (output) with an average of R941 million (m) and varies between 0 and R42 073m. The output growth (g) averages 0.028 per cent and varies between -0.6 per cent and 1 per cent. The minimum of growth rates indicates that some of the values are negative suggesting that if a need to take the logarithm of the variables arises, the logarithm of the growth rate will result in missing values for the negative values. The human capital proxies show that semi-skilled (ss) employment has the highest mean of 2 445 employees, followed by low-skilled (ls) at 1 061 employees and lastly the skilled (s) employees averaging 902 employees. A similar trend is reported for the standard deviation, suggesting high volatility within the semi-skilled
employed labour. Physical capital has an average of R187 million and varies between 0 and R9.8 billion for the determined period.

**TABLE 3: Summary statistics**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
<th>Variance</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>output</td>
<td>941.881</td>
<td>2451.804</td>
<td>0.000</td>
<td>42073.87</td>
<td>6011345</td>
<td>6.303</td>
<td>59.819</td>
</tr>
<tr>
<td>g</td>
<td>0.028</td>
<td>0.082</td>
<td>-0.609</td>
<td>1.019</td>
<td>0.00655</td>
<td>0.944</td>
<td>26.488</td>
</tr>
<tr>
<td>s</td>
<td>902.197</td>
<td>2922.796</td>
<td>0.000</td>
<td>57146</td>
<td>8542735</td>
<td>7.954</td>
<td>96.361</td>
</tr>
<tr>
<td>ss</td>
<td>2445.326</td>
<td>5987.084</td>
<td>0.000</td>
<td>110634</td>
<td>3.58e+07</td>
<td>6.375</td>
<td>62.230</td>
</tr>
<tr>
<td>ls</td>
<td>1061.220</td>
<td>2184.490</td>
<td>0.000</td>
<td>45346</td>
<td>4771994</td>
<td>5.009</td>
<td>41.570</td>
</tr>
<tr>
<td>capital</td>
<td>187.778</td>
<td>523.608</td>
<td>0.000</td>
<td>9816.485</td>
<td>274165.3</td>
<td>6.918</td>
<td>73.243</td>
</tr>
<tr>
<td>empl_t</td>
<td>5381.419</td>
<td>11906.570</td>
<td>0.000</td>
<td>185844</td>
<td>1.42e+08</td>
<td>5.342</td>
<td>43.653</td>
</tr>
<tr>
<td>empl_f</td>
<td>4408.742</td>
<td>10121.030</td>
<td>0.000</td>
<td>139729</td>
<td>1.02e+08</td>
<td>5.506</td>
<td>44.790</td>
</tr>
<tr>
<td>empl_inf</td>
<td>972.627</td>
<td>2735.989</td>
<td>0.000</td>
<td>67045</td>
<td>7485635</td>
<td>8.622</td>
<td>117.9033</td>
</tr>
</tbody>
</table>

Source: Author's computations

**4.2.2 Pairwise Correlation Matrix**

TABLE 4 presents the correlation matrix of the variables used. Statistically significant association is reported amongst a majority of the variables with a positive correlation between total output and capital recording a notable 90.4 per cent. The total output is positively related with all skill levels of the employed (human capital proxies), recording correlation coefficients of 78 per cent with skilled labour, 85 per cent with semi-skilled labour and 59.2 per cent with low-skilled labour. This suggests that the semi-skilled labour cohort has a significantly high correlation with total output in South Africa followed by the skilled and to a lesser extent the low-skilled of the employed labour.
Similarly, a correlation matrix with output growth (g) as a dependent variable shows a positive correlation between skilled employment and economic growth while reporting a negative correlation between low-skilled employment and economic growth. The weak correlation between physical capital and growth was unexpected and is not in line with Borojo and Jiang's (2015:116) emphasis on physical capital as a critical input for economic growth. The results of the pairwise correlation with the growth rate of output as the dependent variable are shown in TABLE 5 below.

**TABLE 5: Correlation Matrix for Output Growth**

<table>
<thead>
<tr>
<th>Variables</th>
<th>g</th>
<th>empl_t</th>
<th>s</th>
<th>ss</th>
<th>ls</th>
<th>sh_s</th>
<th>s_ss</th>
<th>sh_ls</th>
<th>capital</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>g</strong></td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>empl_t</td>
<td>0.005</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>s</td>
<td>0.032***</td>
<td>0.821***</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ss</td>
<td>0.003</td>
<td>0.963***</td>
<td>0.756***</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ls</td>
<td>-0.021</td>
<td>0.814***</td>
<td>0.521***</td>
<td>0.772***</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>sh_s</td>
<td>0.070***</td>
<td>0.235***</td>
<td>0.447***</td>
<td>0.220***</td>
<td>0.027***</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>sh_ss</td>
<td>0.034***</td>
<td>-0.075***</td>
<td>-0.041***</td>
<td>0.032***</td>
<td>-0.18***</td>
<td>0.048***</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>sh_ls</td>
<td>-0.078***</td>
<td>-0.088***</td>
<td>-0.179***</td>
<td>-0.116***</td>
<td>0.248***</td>
<td>-0.375***</td>
<td>-0.31***</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>capital</td>
<td>0.001</td>
<td>0.693***</td>
<td>0.696***</td>
<td>0.724***</td>
<td>0.499***</td>
<td>0.312***</td>
<td>0.048***</td>
<td>-0.016***</td>
<td>1.000</td>
</tr>
</tbody>
</table>

Source: Author's computations. Note: Significance levels***p<0.01, **p<0.05, * p<0.1
The structure of the labour force is presented by the different skill shares of the employed people in the formal sector – as defined in TABLE 2. The correlation between output and shares is in-line with theoretical expectation as a share of skilled employment (sh_s) is strongly positive at 31 per cent, followed by a share of semi-skilled (sh_ss) at 5 per cent while a share of low-skilled (sh_ls) is negatively correlated with output (Table 4). Similar results were reported in the correlation between output growth (g) and the shares in Table 5.

These results are in line with arguments made by Diebolt and Hippe (2016:25) that educated labour is an enabling agent to economic growth. The positive sign between total output and total employment as well as capital is in line with Mnif's (2016:111) argument that capital accumulation and labour productivity bode well for total output. These economic agents (capital and labour) are also recognised by Eicher (2000:24) as crucial for economic output. This study focuses on the quality embedded in labour, and the contribution of skilled, semi-skilled and low-skilled employees to economic output. The variation of the coefficients (in the different models) will inform the contribution of each of the proxies of human capital to total economic output.

4.3 MODEL SPECIFICATION TESTS

For the purpose of ensuring that the model yields robust results, different tests are carried out. Standard empirical analysis may be rendered invalid if variables are non-stationary. A Levin-Lin Chu unit root test will be done to avoid spurious regression results. Other tests discussed below include heterogeneity test, heteroscedasticity, Hausman test, a Sargan test and a Granger causality test.

4.3.1 Levin-Lin Chu unit root test

In order to ensure that key variables are stationary – not easily affected by short-term shocks in the long run – a Levin-Lin Chu unit root test was done and is presented in TABLE 6.
### TABLE 6: Levin-Lin Chu unit root test output

<table>
<thead>
<tr>
<th>Variables</th>
<th>Output</th>
<th>g</th>
<th>empl_t</th>
<th>s</th>
<th>ss</th>
<th>ls</th>
<th>capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-value</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Source: Author's computations. Note: All variables are significant at 1% level

This particular test is appropriate for the study considering that the Levin-Lin Chu test is mainly for strongly balanced panels. The hypothesis of the Levin-Lin Chu unit root test is as follows: $H_0$: Panels contain unit roots $H_1$: Panels are stationary. With all p-values less than 0.05, the null hypothesis is rejected and therefore all panels are stationary.

#### 4.3.2 Heterogeneity test

An F-test is done in order to confirm the existence of individual-specific heterogeneity in the panel data. The output for both the OLS and Random effects models (REM) suggest that there is a variance across municipalities as a null hypothesis $\text{Var}(\mu) = 0$ is rejected (Prob $> F = 0.0000$). See results in TABLE 10(a) and 10(b) in the appendix. This suggests that OLS and REM are not valid estimators for the study.

#### 4.3.3 Heteroscedasticity test

This test is conducted to determine whether the variance of the error term is constant across all observations. Heteroscedasticity is suspected in this study owing to different resource levels for each municipality. The Breusch-Pagan test results show that the estimated parameters have heteroscedasticity and as a result, the coefficients will not be efficient. The output of the tests is presented in TABLE 11. Given the detection of heteroscedasticity in the data of this study, the system GMM will be the best model to control for varying variable means.

#### 4.3.4 Hausman test

In order to decide on a preferred model between the FEM and REM, a Hausman test is conducted to determine if the fixed effects are correlated with independent variables. As this study is across municipalities, if municipality specific fixed effects are correlated with
independent variables then the fixed effect model is appropriate. The Hausman test hypothesis is presented as follows:

\[ H_0: \alpha_i \text{ (specific fixed effects) is independently distributed from } \chi_i \text{ (independent variables) } \]

\[ H_1: \alpha_i \text{ is correlated with } \chi_i \]

If the p-value is less than 0.05, then the null hypothesis will be rejected. The p-value in this case is = 0.000, the null hypothesis is rejected, and FEM is therefore regarded as appropriate for this study. The results of the Hausman test are in favour of the fixed effect model (FEM) as shown in the appendix as TABLE 13(a) and TABLE 13(b).

4.3.5 Significant specification test (Sargan test)

The significant specification test, also known as the Sargan Test, is a statistical test used for testing the validity of over-identifying restrictions. This test determines the validity of instrument variables utilised for the system GMM. Where the null hypothesis is:

\[ H_0: \text{Over-identifying restrictions are valid} \]

\[ H_1: \text{Over-identifying restrictions are not valid} \]

In this study, the p-values are greater than 0.05 for both total output and output growth (see Sargan’s p-values). This means that the null hypothesis is not rejected and therefore model over-identifying instruments are valid. The results of the Sargan test are presented in TABLE 9 and TABLE 14 of the appendix.

4.4 GRANGER CAUSALITY TEST

Romer (1994:3) argues that economic growth is an endogenous outcome of an economic system. This study assumes that there is endogeneity between the total output and the skilled component of the human capital proxies. This suggests that increased levels of economic growth prompt a need for skilled employees in order to perform value generating tasks that in return increase total output. Causality is also assumed between total output and total employment. A Granger causality test is used to indicate possibility of causality between human capital (skilled employment) and economic growth. the presence of endogeneity.
TABLE 7 presents overall results of the panel causality test between total output and human capital (s) from lag 1 to 4 across 269 municipalities of South Africa. The proxy of skilled labour (s) is considered to be highly embedded with an educational element (compared to semi-skilled and low-skilled labour). With the stationarity of variables confirmed through a unit root test, the panel results show that the p-values of the Z-bar and Z-bar tild statistics are significant at 1%. The study applies the hypothesis of Dumitrescu and Hurlin (2012:06) as follows;

\[ H_0: \beta_i = 0 \forall i = 1, ... N \text{ (Homogenous non-causality)} \]
\[ H_1: \beta_i \neq 0 \forall i = 1, ..., N \text{ (Heterogeneous causality), } \beta_i \neq 0 \forall i = N_1 + 1, ..., N \]

<table>
<thead>
<tr>
<th>TABLE 7: Causality between Economic output and Human capital</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Panel Test Statistics</strong></td>
</tr>
<tr>
<td>Lag length</td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>4</td>
</tr>
</tbody>
</table>

Source: Author's computation
Note: The null hypothesis of no causal relationship between economic output and human capital (and between human capital and economic output) is rejected at least at 1% level. *** indicates a significant p-value at 1%. Output → S shows causality running from economic output to human capital. S → Output presents causality running from human capital to total output. Skilled (S) employment is a proxy for Human capital.

The results indicate that the null hypothesis of no Granger causality will be rejected as all coefficients are different from zero. The alternative hypothesis is accepted, implying that there is bidirectional causality between economic output and human capital for all panels at all four lags. This is in line with findings by Mankiw et al., (1992:408) and Pelinescu (2015:184) of a positive and statistically significant relationship between GDP per capita and the innovative capacity of human capital.
Similarly, the results presented in TABLE 8 indicate bidirectional causality between economic output and total employment (empl_t) for all panels of the four lags. The p-values of the Z-bar and Z-bar tild statistics are statistically significant at one per cent level. This led to the rejection of the null hypothesis of no Granger causality running from output to empl_t. The null hypothesis of no Granger causality running from empl_t to output is rejected. The results confirm that total output is a causal effect for employment and that employment also propels economic output.

**TABLE 8: Causality between Economic output and Total employment**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lag length</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>6.0052</td>
<td>58.0471***</td>
<td>47.4016***</td>
<td>output → employ_t</td>
<td>Bidirectional</td>
</tr>
<tr>
<td>1</td>
<td>3.8690</td>
<td>33.2725***</td>
<td>26.7360***</td>
<td>employ_t → output</td>
<td>Causality</td>
</tr>
<tr>
<td>2</td>
<td>9.2998</td>
<td>119.7251***</td>
<td>46.0564***</td>
<td>output → employ_t</td>
<td>Bidirectional</td>
</tr>
<tr>
<td>2</td>
<td>3.5145</td>
<td>24.8397***</td>
<td>8.3397***</td>
<td>employ_t → output</td>
<td>Causality</td>
</tr>
<tr>
<td>3</td>
<td>12.2751</td>
<td>186.3123***</td>
<td>44.5608***</td>
<td>output → employ_t</td>
<td>Bidirectional</td>
</tr>
<tr>
<td>3</td>
<td>5.7083</td>
<td>54.4017***</td>
<td>11.5895***</td>
<td>employ_t → output</td>
<td>Causality</td>
</tr>
<tr>
<td>4</td>
<td>15.4013</td>
<td>264.4510****</td>
<td>43.6025***</td>
<td>output → employ_t</td>
<td>Bidirectional</td>
</tr>
<tr>
<td>4</td>
<td>9.5610</td>
<td>128.9857***</td>
<td>19.9928***</td>
<td>employ_t → output</td>
<td>Causality</td>
</tr>
</tbody>
</table>

Source: Author's computations
Note: The null hypothesis of no causal relationship between economic growth and employment (and between employment and economic growth) is rejected at least at 1% level with *** indicating a significant p-value at 1. Output → employ_t shows causality running from economic output to employment. Employ_t → output presents causality running from employment to total output.

In conclusion, results from TABLE 7 confirm a bidirectional causal relationship between total output and human capital in the formal employment sector. This suggests that a change in total output predicts a change in the skilled cohort of formal employment and also a change in the skilled cohort of formal employment will cause a change in total output. Similarly, TABLE 8 shows that on average a change in total output predicts a change in total employment while a change in total employment is an indicator of a change in total output in South Africa's 269 municipalities between 1993 and 2016. The results are suggestive of endogeneity between the key variables.
4.5 ESTIMATION RESULTS AND DISCUSSION

The presence of endogeneity therefore weakens the logic of relying on the results from the FEM as guided by the Hausman test. In this case, another estimation technique (dynamic panel model) is considered. A system generalised method of moments is best suited to deal with heterogeneity, heteroscedasticity and potential endogeneity issues. Each estimator has two regression results, for human capital variables at level and the different shares of skills of total employment.

4.5.1 Total output (economic output) and output growth (economic growth)

This section discusses the estimations of total output and output growth in level terms where the skill quality embedded in the labour force is used as a proxy for human capital in this study. In this regard, the formal employment sector has been divided into three constituent elements (skilled (s), semi-skilled (ss) and low-skilled (ls)) in order to clearly determine the contribution of each skill level to the economy. TABLE 9 presents the estimation of the three models (Pooled OLS, FEM and a two-step System GMM) where total output is the dependent variable. The data is in logarithm form for both actual values and shares of each of the human capital proxies. For this study, the variables of interest are the total output, proxies of human capital (s, ss and ls) as well as shares of each skill level in formal employment (sh_s, sh_ss and sh_ls).

The overall performance of the models displayed in TABLE 9 is largely satisfactory with most of the signs of the coefficients in harmony with theoretical expectation of the catalytic influence of human capital on economic output and growth (Lucas, 1990:93 and Mankiw et al., 1992:408)). A quick glance over the results shows that most of the variables are statistically significant at one per cent level. Another observation is that skilled employment (s) is consistently statistically significant (except for the FEM) and with a positive effect across all models. This confirms that the employment of high quality skills bodes well for total output (Bayraktar-Sağlam, 2016:271). Results from the pooled OLS and FEM models are consistent with pairwise correlation in that semi-skilled employment is the highest contributor to total output. The high R-squares scored by the OLS and FEM, imply that the explanatory variables are responsible for significant changes in total output. However, the validity of the moment conditions of the GMM estimators is weakened by the presence of autocorrelation. The p-value of 0.000 implies that the null hypothesis that suggests autocorrelation is accepted.
Upon estimating both FEM and REM (results for REM are presented in TABLE 12(a) and (b) of the Appendix), the Hausman test suggests the use of FEM. However, the results from the Dumitrescu and Hurlin (2012) panel causality test confirmed the existence of bidirectional causality – a possibility of endogeneity. In this regard, Yakovlev (2007:329) commends a GMM application as a more robust and efficient estimator than the FEM. System GMM also introduces instrumental variables to deal with endogeneity. Furthermore, Nayan et al., (2013:45) concur that for robust estimation, system GMM is the superior estimator.

### TABLE 9: Estimations of Total Output and Human Capital variables and shares of Employment in South Africa from 1993 to 2016

<table>
<thead>
<tr>
<th>Equation</th>
<th>3.3</th>
<th>3.10</th>
<th>3.4</th>
<th>3.11</th>
<th>3.9</th>
<th>3.12</th>
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</thead>
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<tr>
<td></td>
<td>Level</td>
<td>Shares</td>
<td>Level</td>
<td>Shares</td>
<td>Level</td>
<td>Shares</td>
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<tr>
<td>Output_L1</td>
<td>0.199***</td>
<td>0.213***</td>
<td>0.038</td>
<td>0.161***</td>
<td>0.055***</td>
<td>0.046***</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.004)</td>
<td>(0.024)</td>
<td>(0.022)</td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td>S</td>
<td>0.340***</td>
<td>0.263***</td>
<td>0.080**</td>
<td>0.312***</td>
<td>0.059***</td>
<td>0.019***</td>
</tr>
<tr>
<td></td>
<td>(0.007)</td>
<td>(0.010)</td>
<td>(0.036)</td>
<td>(0.035)</td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td>Ls</td>
<td>-0.169***</td>
<td>-0.009*</td>
<td>0.125***</td>
<td>0.174***</td>
<td>-0.002***</td>
<td>0.024***</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.005)</td>
<td>(0.023)</td>
<td>(0.021)</td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td>Capital</td>
<td>0.587***</td>
<td>0.799***</td>
<td>0.312***</td>
<td>0.396***</td>
<td>0.070***</td>
<td>0.079***</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.015)</td>
<td>(0.015)</td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td>empl_inf</td>
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<td>-0.129***</td>
<td>0.046***</td>
<td>0.179***</td>
<td>0.005***</td>
<td>0.019***</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.002)</td>
<td>(0.009)</td>
<td>(0.007)</td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td>empl_f</td>
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<td>-0.006***</td>
<td>0.017***</td>
<td>0.013***</td>
<td>0.000***</td>
<td>0.000***</td>
</tr>
<tr>
<td>Year</td>
<td>0.011***</td>
<td>-0.006***</td>
<td>0.017***</td>
<td>0.013***</td>
<td>0.000***</td>
<td>0.000***</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td>Observations</td>
<td>35 355</td>
<td>35 355</td>
<td>35 355</td>
<td>35 355</td>
<td>33 861</td>
<td>33 861</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.943</td>
<td>0.925</td>
<td>0.782</td>
<td>0.798</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Instruments</td>
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<td>-</td>
<td>-</td>
<td>1.5e-03</td>
<td>1.5e+03</td>
<td>-</td>
</tr>
<tr>
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<td>-</td>
<td>-</td>
<td>0.000</td>
<td>0.000</td>
<td>-</td>
</tr>
<tr>
<td>Sargan p-value</td>
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<td>-</td>
<td>-</td>
<td>0.259</td>
<td>0.257</td>
<td>-</td>
</tr>
</tbody>
</table>

Source: Author's computations
Notes: Dependent variable is total output. Robust standard errors are in parentheses. ***, ** and * indicate that coefficients are significant at 1%, 5% and 10%, respectively. Standard errors are in parentheses. All variables are in logarithm.

The lagged dependent (Output_L1) coefficient in Table 9 is positive and statistically significant at one per cent level showing the dynamic nature of total output. This suggests that municipalities record positive total output despite the different levels. However, the lagged dependent (g_L1) coefficient of output growth (in Table 14 of the appendix) is statistically significant at one per cent level and negative (indicating that the growth path of municipalities
is moving in the same trajectory). Model 3 in TABLE 9 shows that all p-values of the three different skill levels (s, ss, ls) are statistically significant below 0.05. Therefore, all the three null hypotheses will be rejected and alternative hypotheses accepted. This shows that all the three different skill levels have an impact on economic output. However, the coefficients of the three different skill levels will inform if each of the skill levels has a negative or positive impact on economic output.

In line with theory, the system GMM model shows the coefficient for skilled employment as statistically significant at one per cent level and with an overall positive effect on the total output. Holding other variables constant, a one per cent increase in skilled employment (s) will boost total output by 0.055 per cent. This implies that municipalities that employ skilled labour will record a higher total output. On the contrary, the semi-skilled and low-skilled employment are having a negative contribution to total output even as they are statistically significant. This shows that a one per cent increase in semi-skilled and low-skilled employment will reduce total output by 0.059 and 0.002 per cent, respectively. Similarly, TABLE 14 of the appendix shows that at the level, skilled employment has the highest contribution to economic growth (g) compared to a negative effect of semi-skilled employment. A one per cent increase in skilled employment will increase output growth by 0.043 units, ceteris paribus. However, low-skilled employment begins to show a positive effect on growth over time as one per cent increase contributes 0.033 units to output growth, a notable improvement from a reduction (-0.002) reported in TABLE 9. This shows that the effect of low-skilled employment is realised on the growth rate of output rather than on level production (total output).

On the structure of employment, TABLE 9 shows that the skilled share of employment is reported as statistically significant at one per cent level. A one per cent increase in the skilled share of employment, ceteris paribus, will propel total output by 0.046 per cent. Similarly, in growth terms (TABLE 14 of the appendix) a one per cent rise in the skilled share of employment will increase output growth by 0.035 per cent when all other things remain constant. The contribution of the semi-skilled share of employment to total output (TABLE 9) and output growth (TABLE 14 of the appendix) is not consistent. A one per cent increase in the semi-skilled share of employment will increase total output by 0.019 per cent but reduce output growth by 0.034 per cent if all other things remain constant. The low-skilled share of employment has a positive contribution to both total output (0.024 per cent) and output growth (0.058 per cent).
This suggests that while additional low-skilled employment has a muted immediate effect on the level of production (total output), the increase of the low-skilled share of employment will increase output growth over time. The results show that labour-intensive sectors that easily attract low-skilled employees are likely to record low production levels but over time the share of low-skilled employment will have a positive contribution to economic growth. This sentiment is further reiterated by TABLE 15 of the appendix which shows the structure of the economy by industry, using the data from the study. The table shows that the highest share of low-skilled employment is in the agriculture, forestry and fishing industry (agriculture). However, the agriculture industry’s total output is the least compared to other industries even though recording a slight improvement in terms of its contribution to output growth. This suggests that the agriculture industry is under-utilised, with more potential for growth despite having the least share of skilled and semi-skilled employees. In line with Sampath’s (2014:444) view, structural transformation of the agriculture industry will help refine its ability to upgrade production, with technological change at the centre of the process. However, Pivoto et al., (2018:21) found that factors that limit smart-farming include the “integration of available systems in the market as well as the education, ability and skills of farmers to understand and operate farming tools”.

4.6 CONCLUSION

System GMM results largely show a positive and statistically significant relationship between the total output and skilled employment. Skilled employment contributes 0.055 per cent to total output while a share of skilled employment is reported to contribute 0.046 per cent to total output. Semi-skilled and low-skilled employment are reported to have a negative impact on total output. The negative sign for semi-skilled employment indicating a negative contribution to total output was not in line with the pairwise correlation outcome. This suggests that semi-skilled employment is not adequately equipped to make a value generating effect to total output. A similar contribution is reported for employment shares. Overall, the results suggest that investment in high-end skill programmes to fully equip labour would bode well for the total output and output growth across municipalities in South Africa.
CHAPTER 5

5 CONCLUSION

5.1 INTRODUCTION

This study investigates the impact of human capital on total output and economic growth across municipalities in South Africa. Empirical literature informed that educated labour tends to have a high contribution to economic output. Human capital was proxied by different skill levels of formal employment. For the purpose of this study, human capital was defined as elements embodied in human beings that boost the quality of labour provided by the workforce through their skills and knowledge (Kleynhans, 2006:55).

Theoretical literature suggests that labour embedded with educational elements enhances productivity (Lucas, 1990:93 and Mankiw et al., 1992:408)). This also suggests social returns both for skilled individuals as well as economy wide spill-overs including the readiness to cooperate in democratic institutions and social cohesion (Blundell et al., 1999:14). Empirical literature is, however not conclusive on the relevance of human capital on economic growth. An increasing number of studies highlight the value generating quality embedded in educated and skilled labour. However, other studies have questioned the role and the magnitude of the effect of human capital on economic growth.

To address the objectives of the study, static panel data models (OLS and FEM) were run. Furthermore, on detecting endogeneity through the Dumitrescu and Hurlin test for Granger causality, a dynamic panel model (system GMM) was used. To prove the validity of the instruments used in the system GMM estimator, a Sargan test was done. The outcome shows that skilled employment makes a significant contribution to total output compared to semi-skilled and low-skilled employment. The second section of this chapter presents the summary of findings of the study which addresses the objectives outlined earlier as well as answering the research question. The third section proposes policy recommendations in-line with the findings of the study. The last section presents the limitations of this study as well as suggested areas of future research.
5.2 SUMMARY FINDINGS

The results from the study give an answer to the research question: What is the impact of human capital (skilled employment) on economic output and growth across municipalities in South Africa? The findings show that skilled employees have a positive effect on both economic output (0.055 per cent) and economic growth (0.044 per cent). These results concur with empirical findings by Pegkas and Tsamadias (2014:429) that education (investment embodied in human beings) increases labour productivity and therefore has a positive effect on economic output both at level and growth rate. This shows that on average, skilled employment in different economic sectors across municipalities in South Africa yields a higher value than semi-skilled and low-skilled employment. These findings address the first objective of the study, confirming the positive effect of human capital in the form of skilled employment on economic output and economic growth.

The second objective of the study seeks to establish if there is a causal effect between skilled employment and total output as well as between skilled employment and total employment has been addressed. The findings confirmed bidirectional causality between economic output and human capital as well as between economic output and total employment. Results from the Granger causality test informed that higher levels of economic output predict demand for skilled employment, indicating that as the economy grows, the need for skilled employees to facilitate the adoption of new technologies will increase. Also, an increased number of skilled employment bodes well for total output and total employment.

5.3 POLICY IMPLICATIONS AND RECOMMENDATIONS

Summary statistics of total employment show that the semi-skilled cohort has the highest number of people employed followed by the shares of low-skilled and the skilled employees. This shows that the economic structure of municipalities in South Africa is more likely to attract the semi-skilled and low-skilled labour than the skilled. This is also reflected in government initiatives like the public works and infrastructure development programmes. However, the service sector continues to grow as GDP composition by sector (Statistics South Africa, 2016) compared to secondary and primary sectors. This structural shift requires medium to high skilled employees to participate in value-generating economic activities in different economic sectors.
Empirical findings from this study inform that skilled labour has the highest contribution to total output (even though with fewer employees) compared to semi and lower-skilled labour. In line with this, Ghalandarzehi and Safdarie (2012:171) argue that a positive relationship between human capital and economic growth is mainly witnessed when the economic structure of the country is able to attract, employ or absorb and retain the skilled labour. In line with the third objective, it is recommended that the government implement skills development policies (training the workforce on scarce competitive skills) in order to upwardly shift a significant share of the semi-skilled and low-skilled employees to the highly skilled cohort. The initiative by government to revitalise Technical Vocational Education and Training colleges is applauded if the quality of training meets the requirements of potential employers in different industries. This will ensure the realisation of one of the identified strategic interventions (improving skills and human capital formation) to develop a more competitive and diversified economy (National Development Plan, 2011).

Following the progress on the Millennium Development Goal 2 of universal primary education, it is recommended that the government should also target education spending on medium and high skills to ensure progression beyond primary education. The implementation of free higher education to deserving beneficiaries is welcome as an increased number of people will progress beyond primary education.

5.4 LIMITATIONS AND AREAS OF FURTHER RESEARCH

The data of the study mainly covered six economic sectors (Agriculture, Mining, Manufacturing, Wholesale and retail trade, Catering and accommodation, Transport, storage and communication, and Finance, insurance, real estate and business services). It is possible that the use of data for all sectors may come to another conclusion. Also, this study was investigating only employed labour and not the entire labour force. Another area of research may be to include the unemployed skilled labour in order to appreciate forgone economic value. As a result of limited data prior to 1993, the study could not assess if the effect of skills on economic growth was the same prior to the democratic government.

Pelinescu (2015:185) highlights a lack of a unanimous conclusion on the proxy that best articulates the impact of human capital on economic growth. The author discusses a number of empirical findings that reach different conclusions on the impact of human capital on
economic growth. Future research may look into constructing more comprehensive measures of human capital in order to give a conclusive empirical view.

5.5 CONCLUDING REMARKS

In line with theoretical literature and a number of empirical findings concluding that skilled labour (with an educational element) has a higher value generating effect, this study reports that human capital (skilled labour) is found to have a positive contribution to economic output and growth across municipalities in South Africa between 1993 and 2016. The government is encouraged to provide training programmes that will up-skill the labour force in order to equip people with critical skills that will render them ready to participate in innovative economic activities.
REFERENCES


### TABLE 10(a) Heterogeneity F-Test for OLS

<table>
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<tr>
<th>F(  6, 35348)</th>
<th>=90643.38</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prob &gt; F</td>
<td>= 0.0000</td>
</tr>
</tbody>
</table>

### TABLE 10(b) Heterogeneity Test for REM

Breusch and Pagan Lagrangian multiplier test for random effects

\[
\text{output}_{\text{log}}(\text{mniid},t) = \text{Xb} + u(\text{mniid}) + e(\text{mniid},t)
\]

Estimated results:

<table>
<thead>
<tr>
<th>Var</th>
<th>sd = sqrt(Var)</th>
</tr>
</thead>
<tbody>
<tr>
<td>output</td>
<td>2.582385</td>
</tr>
<tr>
<td>e</td>
<td>.0212672</td>
</tr>
<tr>
<td>u</td>
<td>.1158521</td>
</tr>
</tbody>
</table>

Test: \( \text{Var}(u) = 0 \)

\[\text{chibar}^2(01) = 2.5e+05\]

Prob > chibar2 = 0.0000

### TABLE 11 Heteroscedasticity Test

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity

Ho: Constant variance

Variables: fitted values of output_log

\[\text{chi}^2(1) = 1358.15\]

Prob > chi2 = 0.0000
### TABLE 12(a) Random Effects

```
.xtreg output_log s_log ss_log ls_log empl_inf_log capital_log year, re vce(robust)
Random-effects GLS regression Number of obs      = 35355
Group variable: mniid Number of groups   = 1497

R-sq: within =  0.7743 Obs per group: min = 1
between = 0.9205 avg = 23.6
overall = 0.9155 max = 24

Wald chi2(6) = 15072.92 Prob > chi2 = 0.0000
corr(u_i, X) = 0 (assumed)

(Std. Err. adjusted for 1497 clusters in mniid)

| outcome         | Robust | Std. Err. | z     | P>|z| [95% Conf. Interval] |
|-----------------|--------|-----------|-------|---------|------------------------|
| output_log      | .1789903 | .0163551  | 10.94 | 0.000   | .1468349 - .2109458    |
| s_log           | .1641163 | .0313459  | 5.24  | 0.000   | .1026794 - .2255531    |
| ss_log          | .0387207 | .0182287  | 2.12  | 0.034   | .0028872 - .0745543    |
| ls_log          | .023965  | .007101   | 3.37  | 0.001   | .0100474 - .0378826    |
| empl_inf_log    | .3490143 | .0118603  | 29.43 | 0.000   | .3257685 - .37226      |
| capital_log     | .0156364 | .0007785  | 20.08 | 0.000   | .0141105 - .0171623    |
| _cons           | -29.46525 | 1.608014  | -18.32 | 0.000 | -32.6169 - -26.3136    |
| year            | .0104613 | .000619   | 16.90 | 0.000   | .009248 - .0116746     |
| capital_log     | .4584276 | .0109526  | 41.86 | 0.000   | .4369608 - .4798943    |
| empl_inf_log    | .2013018 | .0054763  | 36.76 | 0.000   | .1905685 - .2120352    |
| output_log      | .1415883 | .028143   | 7.80  | 0.000   | .106287 - .1771479     |
| ss_log          | .3757898 | .0305551  | 12.38 | 0.000   | .3162948 - .4352847    |
| sh_s_log        | .1415883 | .018143   | 7.80  | 0.000   | .1060287 - .1771479    |
| sh_ss_log       | .2013018 | .0054763  | 36.76 | 0.000   | .1905685 - .2120352    |
| _cons           | -79.46525 | 1.608014  | -18.32 | 0.000 | -92.6169 - -15.3136    |

Rho    .84489976 (fraction of variance due to u_i)

```

### TABLE 12(b) Random Effects – Shares

```
.xtreg output_log sh_s_log sh_ss_log sh_ls_log empl_inf_log capital_log year, re vce(robust)
Random-effects GLS regression Number of obs      = 35355
Group variable: mniid Number of groups   = 1497

R-sq: within = 0.7947 Obs per group: min = 1
between = 0.9051 avg = 23.6
overall = 0.8984 max = 24

Wald chi2(6) = 17847.75 Prob > chi2 = 0.0000
corr(u_i, X) = 0 (assumed)

(Std. Err. adjusted for 1497 clusters in mniid)

| outcome         | Robust | Std. Err. | z     | P>|z| [95% Conf. Interval] |
|-----------------|--------|-----------|-------|---------|------------------------|
| output_log      | .2692763 | .0172139  | 15.64 | 0.000   | .2355378 - .3030149    |
| sh_s_log        | .3757898 | .0305551  | 12.38 | 0.000   | .3162948 - .4352847    |
| sh_ss_log       | .1415883 | .018143   | 7.80  | 0.000   | .106287 - .1771479     |
| sh_ls_log       | .2013018 | .0054763  | 36.76 | 0.000   | .1905685 - .2120352    |
| empl_inf_log    | .4584276 | .0109526  | 41.86 | 0.000   | .4369608 - .4798943    |
| capital_log     | .0104613 | .000619   | 16.90 | 0.000   | .009248 - .0116746     |
| _cons           | -17.05353 | 1.608014  | -10.32 | 0.000 | -19.45759 - -14.64946  |
| year            | .0104613 | .000619   | 16.90 | 0.000   | .009248 - .0116746     |
| capital_log     | .4584276 | .0109526  | 41.86 | 0.000   | .4369608 - .4798943    |
| empl_inf_log    | .2013018 | .0054763  | 36.76 | 0.000   | .1905685 - .2120352    |
| output_log      | .1415883 | .018143   | 7.80  | 0.000   | .106287 - .1771479     |
| ss_log          | .3757898 | .0305551  | 12.38 | 0.000   | .3162948 - .4352847    |
| sh_s_log        | .1415883 | .018143   | 7.80  | 0.000   | .106287 - .1771479     |
| sh_ss_log       | .2013018 | .0054763  | 36.76 | 0.000   | .1905685 - .2120352    |
| _cons           | -27.05353 | 1.608014  | -16.90 | 0.000 | -30.45759 - -23.64946  |

Rho     .8878668 (fraction of variance due to u_i)

```

### TABLE 13(a) Hausman Test – RGVA

<table>
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<tr>
<th></th>
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<th></th>
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<td>(B)</td>
<td>(b-B)</td>
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<td>.020797</td>
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<td>.0156364</td>
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</table>

b = consistent under Ho and Ha; obtained from xtreg
B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic
\[
\text{Prob}>\chi^2 = 0.0000
\]
\[
\chi^2(6) = (b-B)'[(V_b-V_B)^{-1}](b-B)
\]
\[
= 207.10
\]

### TABLE 13(b) Hausman Test – RGVA

<table>
<thead>
<tr>
<th></th>
<th>Coefficients</th>
<th></th>
<th></th>
<th>sqrt(diag(V_b-V_B))</th>
</tr>
</thead>
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<tr>
<td></td>
<td>(b)</td>
<td>(B)</td>
<td>(b-B)</td>
<td>S.E.</td>
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<td>.2692763</td>
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</table>

b = consistent under Ho and Ha; obtained from xtreg
B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic
\[
\text{Prob}>\chi^2 = 0.0000
\]
\[
\chi^2(6) = (b-B)'[(V_b-V_B)^{-1}](b-B)
\]
\[
= 7145.35
\]
### TABLE 14: Estimation of Output Growth model with Human Capital variables and shares of Employment in South Africa from 1993 to 2016

<table>
<thead>
<tr>
<th>Variables</th>
<th>Equation</th>
<th>Model 1 (OLS)</th>
<th>Model 2 (FEM)</th>
<th>Model 3 (SYSGMM)</th>
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<td></td>
<td>Equation</td>
<td>3.13</td>
<td>3.16</td>
<td>3.14</td>
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<td></td>
<td></td>
<td>Level</td>
<td>Shares</td>
<td>Level</td>
</tr>
<tr>
<td>S</td>
<td></td>
<td>0.006***</td>
<td>0.009***</td>
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<td></td>
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<td>(0.000)</td>
<td>(0.004)</td>
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<tr>
<td>Ss</td>
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<td>-0.004**</td>
<td>0.015***</td>
<td>0.005</td>
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<td>(0.002)</td>
<td>(0.005)</td>
</tr>
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<td>K</td>
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<td>-0.005***</td>
<td>-0.000</td>
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<td>(0.001)</td>
<td>(0.004)</td>
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<td>empl_inf</td>
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<td>-0.003***</td>
<td>0.028***</td>
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<td>(0.000)</td>
<td>(0.003)</td>
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<tr>
<td>g_L1</td>
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<td>0.002***</td>
<td>-0.011***</td>
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<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.002)</td>
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<tr>
<td>empl_f</td>
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<td>-0.003***</td>
<td>-0.001***</td>
<td>-0.002***</td>
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<tr>
<td></td>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td>Year</td>
<td></td>
<td>-0.003***</td>
<td>-0.001***</td>
<td>-0.002***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
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<tr>
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<td>R-squared</td>
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<td>0.023</td>
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<tr>
<td>AR (2)</td>
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<td>0.000</td>
<td>0.000</td>
<td>-</td>
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</tbody>
</table>

Source: Author’s computations

Note: Dependent variable is total output growth (g). Robust standard errors are in parentheses. ***, ** and * indicate the coefficients are significant at 1%, 5% and 10%, respectively. Standard errors are in parentheses. All variables are in logarithm form.

### TABLE 15: Estimation of Output Growth model with Human

<table>
<thead>
<tr>
<th>Industry</th>
<th>Mean Output</th>
<th>Mean Output</th>
<th>Mean Skilled</th>
<th>Mean Semi-skilled</th>
<th>Mean Low-skilled</th>
<th>Mean Sh_S</th>
<th>Mean Sh_SS</th>
<th>Mean Sh_LS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>216.892</td>
<td>0.014</td>
<td>183.034</td>
<td>1564.226</td>
<td>2314.782</td>
<td>0.046</td>
<td>0.376</td>
<td>0.449</td>
</tr>
<tr>
<td>Mining</td>
<td>872.369</td>
<td>0.007</td>
<td>158.171</td>
<td>1317.557</td>
<td>349.925</td>
<td>0.126</td>
<td>0.626</td>
<td>0.238</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>1185.770</td>
<td>0.025</td>
<td>875.231</td>
<td>3085.492</td>
<td>1098.228</td>
<td>0.088</td>
<td>0.470</td>
<td>0.203</td>
</tr>
<tr>
<td>Retail</td>
<td>1153.220</td>
<td>0.033</td>
<td>1397.978</td>
<td>4004.778</td>
<td>1313.769</td>
<td>0.111</td>
<td>0.385</td>
<td>0.151</td>
</tr>
<tr>
<td>Transport</td>
<td>681.922</td>
<td>0.042</td>
<td>405.319</td>
<td>1010.833</td>
<td>235.583</td>
<td>0.121</td>
<td>0.484</td>
<td>0.118</td>
</tr>
<tr>
<td>Finance</td>
<td>1541.112</td>
<td>0.048</td>
<td>2393.447</td>
<td>3689.073</td>
<td>1055.030</td>
<td>0.215</td>
<td>0.531</td>
<td>0.181</td>
</tr>
</tbody>
</table>

Mean averages for a period between 1993 and 2016. Sectors: Agriculture, forestry & Fishing; Mining & quarrying; Manufacturing; Wholesale & retail; Transport, Storage & communication; Finance, insurance & real estate.
**Pooled OLS Results**

The Pooled OLS results on output are consistent with the pairwise correlation where a significant contribution to total output is recorded as sourced from the semi-skilled, followed by the skilled and to a lesser extent the low-skilled employment. The R-squared scored 94 per cent for the OLS estimator, implying that the explanatory variables are responsible for 94 per cent of the changes in total output.

**Random Effect Results**

Results from the REM (presented in the appendix as TABLE 12(a) and (b)) show that skilled and semi-skilled employment is associated with higher levels of total output. A one per cent rise in skilled and semi-skilled employment will increase total output by 0.18 and 0.16 per cent respectively, when all other variables remain constant. With regards to shares of total employment, the semi-skilled share has the highest contribution of 0.38 per cent to total output. The outcome shows that the skilled share of employment will contribute 0.28 per cent, while the low-skilled cohort will increase the total output by a muted 0.14 per cent.