Title

The role of innovation in an emerging market: Evidence from South Africa

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DECLARATION

I, Buyisiwe Mpofana, declare that this research article is my own work except as indicated in the references and acknowledgments. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration in the Graduate School of Business Administration, University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in this or any other university.

Buyisiwe Lynette Mpofana

Signed at …Johannesburg……

On the ……28…….. day of ……February…… 2019…..

DEDICATION

To my son who is my pillar of strength.

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I would like to acknowledge God Almighty for providing me with the opportunity to do this program and seeing me through every challenge.
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ABSTRACT

South Africa's high unemployment rate threatens to destabilise the country. This is evidenced by the increasing frequency of service delivery protests that are often characterised by conflict and violence. This combination of factors has the potential to trigger national chaos if an immediate and long term solution is not sought.

Innovation has played an important role in improving the economies of countries like China, the United States of America and even some European nations. They have leveraged ideation to stimulate economic growth and widen employment options. South Africa has experienced the effects of a stagnant economy for some years now. The country's policies have seen little change since the global financial crisis in 2008. A number of factors that have impacted the country's growth such as political uncertainty, a volatile industrial labour market, and unstable global commodity prices.

South Africa is ranked low on the Global innovation index and is thus described as 'not being very innovative'. The study examined the role played by innovation in improving economic growth as well as reducing unemployment. The results show that there is an inextricable link between the Gross Domestic Product (GDP), innovation and unemployment levels. The significance of these relationships, however, is not in isolation of other variables like human capital, wages, business cycle and capital formation.

Keywords: Innovation, economic growth, employment, relationship

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Definitions

Gini coefficient measures relative wealth (WorldBank, 2018).
"**GNI** is the total market value of all final goods and services produced in a given year by the residents or registered business from a particular country anywhere in the world" (van Rensburg, McConnell, & Brue, 2015).
GNI per capita is gross national income divided by mid-year population. GNI per capita in US dollars is converted using the World Bank Atlas method (WorldBank, 2018).
"**Gross Domestic Product** is the measure of total market value of all final goods and services produced in a given year within the borders of the country in a selected interval in time often a year" (van Rensburg et al., 2015).
Luddites are members of English workers who destroyed machinery, especially in cotton and woollen mills, which they believed was threatening their jobs (1811–16) (Clancy, 2017).
The OECD forum has about 35 member countries. The main purpose of this forum is to promote economic growth.
Okun coefficient indicates the cost of unemployment in terms of output growth.
Technological progress is the growth rate of the state of technology in percentage term(Dasher, Harada, Hoshi, Kushida, & Okazaki, 2015).
Technological unemployment is unemployment caused by introduction of technology or as a result of technical change (Danaher, 2017).
Unemployment is when an individual of working age is not able to get a job but would like to be in full-time employment. They have to be actively seeking for employment (van Rensburg et al., 2015).

Abbreviations

BRIC-Brazil Russia India and China

HDI- Human Development Index

GDP- Gross Domestic Product

GEM- Global Entrepreneurship Monitor

GNI- Gross National Income

GNP- Gross National Product

ICT- Information Communication and Technology

IMF- International Monetary Fund

IPAP- Industrial Policy Action Plan

NDP- National Development Plan

OECD- Organization for Economic Cooperation and Development

R&D- Research and Development

SA- South Africa

TEA- Total Early-stage Entrepreneurial Activity

TFP- Total Factor Productivity

1. INTRODUCTION

"Innovation and new product development do not work the same way in emerging markets as in the U.S. or other developed markets."

Kevin Ruffe, Vice President IT Innovation, Johnson & Johnson

There is a considerable gap between developed and developing countries with regards to economic growth. South Africa is classified both as an emerging and developing economy. The main challenge it faces is a stagnant economy, a situation that is not unique to South Arica, but also experienced by other emerging and developed economies, as a result partly of globalization (Cerny, 1995). Even though South Africa's Gross Domestic Product increased by 1.3% in 2017 compared to 2016 and the real GDP was up 3.1% quarter on quarter, the growth is still low. In the first quarter of 2018, it fell by 2.2% (StatsSA, 2018a).

With the rise of globalization, emerging markets are finding themselves under pressure and consequently forced to be more innovative in order to remain competitive (Gorodnichenko, Svejnar, & Terrell, 2009). Globalization not only creates pressure to perform but also provides opportunities for local firms to innovate and improve. With a population of about 57 million, there is only a handful of people contributing to the growth of the South African economy through productivity. The unemployment rate is at double digits of 26.7% with a majority relying on unskilled labour (NDP, 2012).

In South Africa Research and Development (R&D) spend is not increasing, even though it finds its value in the identification and promotion of innovations to produce new products and services. "R&D has a large effect on both output and TFP at the state level in the long run" (Blanco, Gu, & Prieger, 2016).

The cultural impediments that influence spending on new ideas cuts across most South African institutions. These barriers hamper the development of new ideas and innovation that can help to change the fundamentals of the South African economy, stimulate growth and employment (Petrakis, Kostis & Valsamis, 2015). It has been

argued that developed countries, on the other hand, examples being Japan, South Korea, US, and Europe, have favourable cultures towards innovation that influence corporate spending on R&D, investments in new ideas, which potentially can kick start economic growth, increase employment and reduce commodity prices.

The current generation has an important responsibility to ensure that they create new opportunities in the fields of renewable resources and environmentally friendly technologies (Weaver, Jansen, Van Grootveld, Van Spiegel, & Vergragt, 2017).

Formal South African education does not engender innovation in a manner that allows school going children to be entrepreneurial and creative. The education system is designed for the traditional orthodox way of thinking that leans towards non-creative and methodical subjects (Isabirye & Dlodlo, 2014).

It is in this context, that an action to elicit the challenges and contributions to South African unemployment must be sought so that appropriate inventions and solutions can be encouraged. Developed economies have used multiple layers and interventions such as cultural inculcation, investment in R&D, education to stimulate and democratise innovation. This has created the multiplier effect of growth and employment in those economies.

1.2 Problem statement

As a developing country, South Africa faces a number of challenges including pressures to improve its GDP. With a population of about 57 million, inequality remains the biggest challenge for the country. The richest 1% of South Africans own 40% of the country's wealth (Quintal, 2017). In 2015 unemployment in South Africa remained high at around 25% or 33% on a broad measure including discouraged job seekers (Bold & Harris, 2018). With the high levels of unemployment, few people contribute to the growth of the economy.

Current literature has identified a number of factors that contribute to economic growth and development. For instance, Solow's growth model identifies innovation as an asset that can push realistic growth in an economy. Solow indicates that innovation

has the highest contribution to economic growth, of about 85%. The other factor inputs only contribute about 15% (Oluwatobi, Efobi, Olurinola, & Alege, 2015). The measure is based on the number of scientific and technical journal articles issued. Innovation can play an important role when it comes to creating employment through increased productivity. Although innovation can take several forms, in this study, specific focus is taken on the innovation that improves employment, and at the same time contributes to economic growth. Therefore, patents registrations and intellectual rights in the South African Database are noted as the most basic form of innovation that can foster growth.

In sum, the present study seeks to answer the following;

1. Firstly, is there a relationship between unemployment and innovation?
2. Secondly, is there a relationship between unemployment and economic growth? It also attempts to understand the relationship between innovation and economic growth.
3. Lastly, factors that underpin the lack of innovation in South Africa.

1.2.1 Consequences of this problem

If South Africa does not do anything to stimulate innovation, it risks slow economic growth while developed countries expand on the back of innovation. This has rippling consequences on the country.

1.2. 2 Sources of Data

To translate the practical issue or problem into an answerable question, data was collected from DataStream. Simultaneous linear regressions were performed to measure the relationship between innovation and unemployment. Also to measure the relationship between innovation and economic growth and the relationship between unemployment and economic growth.

1.3 Project Scope

1.3.1 Project Objectives

The objective of this research is to highlight the role of innovation in an emerging economy. The aim of the research is to understand the factors impacting innovation in South Africa to the extent to which they influence economic growth and employment

1.3.2 Project delineations and limitations

The research will not cover any other emerging economies besides South Africa. Time was a constraining factor to the research but did not affect the quality of the work to any marked degree.

2. APPLICATION OF PRIOR RESEARCH- Literature review

2.1 Introduction

This section of the study discusses and explores different economies and concepts such as innovation. It also looks at existing research on the relationship between innovation and unemployment. The relationship between economic growth and unemployment was investigated as well as the link between innovation and economic growth. Other literature given attention were the concepts of Okun's Law as well as the Total Factor Productivity Theory.

2.2 Emerging Economies and innovation

Countries are grouped on the basis of the income they generate. This is often referred to as Gross National Income per capita. This GNI per capita can be categorised as high, upper-middle, lower-middle, and low. It is valued annually in US dollars using a three-year average exchange rate (Fantom & Serajuddin, 2016).

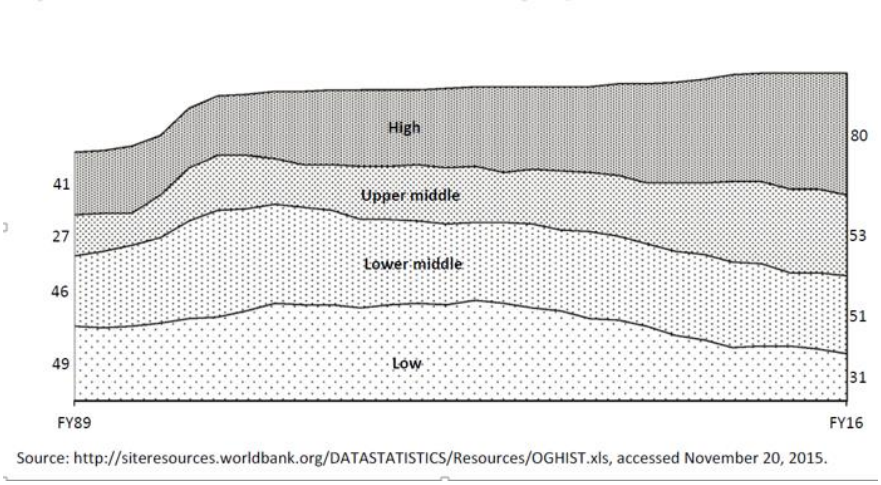


Figure 1: Number of countries in each classification group, FY89-FY16

The graph above, figure 1, indicates a number of countries in each economic income class. There are 80 countries which fall under the category of high-income, also known as **developed countries**. These are mostly the Western countries and most of them are members of the Organization for Economic Cooperation and Development (OECD). These developed countries are characterised by their high GDP per capita. Another characteristic of these nations is that their standard of living is high and they have low unemployment rates. The United States has an unemployment rate of 3.9%. In July 2017, its unemployment rate was 4.3% (Dritsakis & Klazoglou, 2018). On the other hand, South Africa's unemployment rate is currently at 26.7%.

A study conducted by Fernández-Serrano, Berbegal, Velasco, and Expósito (2018) exhibited how nine countries with technical efficiency of 1 are able to maximise their GDP per capita to improve their entrepreneurship quality ratio, Total Early-stage Entrepreneurial Activity and cultural dimension levels (Fernández-Serrano, Berbegal, Velasco, & Expósito, 2018). It also pointed out how the highly developed countries are characterised by a high entrepreneurship tradition, according to the GEM reports. Norway appears to be the most influential peer in the sample as 12 countries have it as a reference peer, followed by Singapore and Switzerland with 10 and the USA with 8 (Fernández-Serrano et al., 2018). The developed nations tend to have a culture that fosters innovation. The corporate culture of developed countries is the main driver of radical innovations. Companies in the countries that are leading innovators are competitive and have the highest global market share (Tellis & Chandy, 2009).

Transitioning economies are those countries that are classified somewhere between developed and developing countries. They have upper middle GNI per capita. An example of such countries is China. China is the fastest growing transitioning economy as it is moving from being a developing country to a developed economy (Child & David, 2001). The country is highly involved in international trade and investments. Although it is the second largest economy, the majority of its population still lives in poverty. Most of its business affairs are run by the state. In 1979, China changed its policies. It transitioned from a government-controlled economy to a market-driven economy. For the past 20 years, its real GDP has grown by 9% on average. The

country was able to secure more than 26,140 foreign investment projects in the year 2001 and had $69.2 billion contract value worldwide (Luo, Zhou, & Liu, 2005). A view held by some researchers seems to contradict published data on China's economic growth. An article by Rawski (2001) claims that between 1997 and 2001, the Chinese economy might have only grown by 2% or less per year and not 7.1% as was officially reported. Other researchers, in particular, Adams and Chen (1996), Maddison and Wu (2007) share the same view (Clark, Pinkovskiy, & Sala-i-Martin, 2017).

Modernization theory states that as a nation develops economically and socially, it will eventually become a democracy (Guo & Stradiotto, 2018). The economies in the transitioning phase are unwilling to wait, that is, they do not wait for foreign investment or parent international companies to open up opportunities for them to be innovative. The businesses in these economies are involved in entrepreneurial activities and they do not wait for the government to assist and promote innovation. They use disruptive innovation to promote productivity, competitiveness and this results in their success. They are growing rapidly. They are competitive and generating a number of jobs. The leaders of these economies are focused on sustainable solutions. For example, China is not classified as a developed nation as it is still perceived as undemocratic without an aptitude for the rule of law. The fact that China has not transitioned to become a democratic nation, is in direct contradiction with the Modernization Theory.

Emerging Markets: The term "emerging markets" was created by Antoine van Agtmael (1981). The World Bank's definition of developing countries is; countries with low to lower middle per capita income of less than $4,035 (Amadeo, 2018). Emerging economies account for about 30% of world GDP (Bekaert & Harvey, 2017).

The characteristics of emerging markets are that they have lower-than-average per capita income. They grow rapidly and have high volatility making them vulnerable to commodities swings, such as those of oil and food (Amadeo, 2019). They are susceptible to volatile currency swings as well, but this is as a result of exhaustible commodity dependency. Their capital markets are less developed with no solid track record of foreign direct investment. Lastly, they have an above-average return for investors. Emerging markets still possess great opportunities for growth and returns

for international businesses. Laperche and Gilliane (2012) state that the primary aim of companies in emerging markets is to reduce costs, improve access to markets, be closer to scientific and technological resources, and benefit from production resources and government subsidies.

Examples of emerging countries include African and some Asian countries. BRIC countries are the fastest and largest developing economies. South Africa falls under the developing economies with the middle high-income population. Even though it is classified by the World Bank as a middle-income economy, South Africa has a dual economy. It has one of the highest inequality rates in the world, caused by injustices and colonization that happened in the past (Creamer, 2018). In 2014, SA's Gini coefficient was at 0.65 based on expenditure data only and when basing it on income data alone it was 0.69. Income data includes salaries, wages, and social grants. Comparing total expenditure between South Africa's poorest and wealthiest 20%, the poorest spend less than 3% whilst the wealthiest spend 65% (WorldBank, 2018).

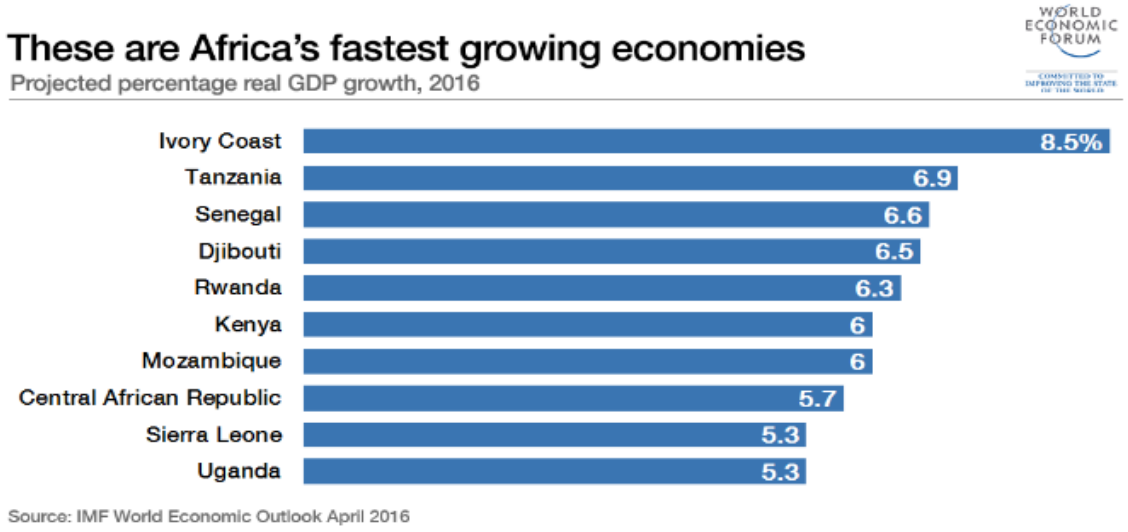


Figure 2: Africa's fastest-growing economies

Figure 2 above indicates that compared to other emerging markets, South Africa is still far behind. It has stagnated in its growth and has been overtaken by countries like Ivory Coast, Tanzania, and Rwanda. Although South Africa has been considered the African hub, it is struggling to improve its economy. From the article written by the

International Monetary Fund, in 2016 Ivory Coast was rated as Africa's fastest growing economy with a growth rate of 8.5 %. The country had invested in infrastructure. The government is working on bridging the gap between the poor and the wealthy (Nurse & Scott, 2017).

Innovation is used by entrepreneurs as a tool to exploit opportunities to develop new products and services (Venter et al., 2015). For innovation to flourish, the need must meet opportunity (Petrick & Juntiwasarakij, 2011). According to Fernandez-Serrano et al. (2018), entrepreneurship promotes employment opportunities, technical innovation level, and it improves economic growth (Fernández-Serrano et al., 2018). It is important for a country to be innovative to improve its economy. What developed countries have in common is their ability to innovate. They have created successful businesses and have been able to reach not only local markets but extended their services to foreign countries. They have been at the forefront of internationalization. There are different types of innovation and these include, amongst others, disruptive innovation; radical innovation; frugal innovation and reverse innovation.

Disruptive innovation is a concept first introduced by Christensen & Bower (1995). This type of innovation helps create new markets. It occurs when smaller businesses with fewer resources are able to challenge the bigger ones by offering their products or services at lower prices. They target the segments that were previously ignored by the bigger companies. The newcomers then move upmarket and target the incumbents' mainstream customers. Once the mainstream customers adopt the new entrant's products, that is when disruption occurs (Christensen, Raynor, & McDonald, 2015). Examples of such companies are Uber and Airbnb. These companies have changed the conventional way of operating in the transport and hospitality industry respectively. Uber operates in about 64 countries. It has created employment for 1.1 million drivers (Leighton, 2016).

Radical innovation brings together different markets, it creates new ones and is able to destroy old ones. Organisations and countries can use radical innovation as an important driver for growth, success, and wealth of firms and nations (Tellis & Chandy, 2009). Norman (2014) found that there was no design research done for all radical

innovations. There was no careful analysis of the needs of the customers and the society at large (Norman & Verganti, 2014). Some of the examples of radical innovations are Facebook and Twitter. These innovations have come about because those who created them thought they were interesting things to try (Norman & Verganti, 2014). For example, Facebook changed the way people communicate, they no longer require the post office to send letters to people around the world. Facebook provides instant communication, cheaper. They have created global employment through entrepreneurship to the value of USD 227bn and 4.5 Million jobs globally (Deloitte, 2015).

Besides the invention of completely new products, innovation can also be incremental. **Incremental innovations** involve refining and improving existing products, services, processes or technology. These do not make the current product obsolete as in a radical transformation of products. Radical innovation disrupts existing technological ways and alters the value of an existing knowledge base (Zalewski & SkawiŃska, 2009). A critical feature of innovation is that it must be implemented or commercialised (Sennes & Filho, 2012).

Other types of innovation are **frugal and reverse innovation. Frugal innovation** occurs when an organisation or a country utilize limited resources to innovate. It is the development of products and services targeted at the low-income market segment. They are affordable innovations targeted at resource-constrained consumers in emerging markets (Zeschky, Widenmayer, & Gassmann, 2015). Examples of frugal innovations include China's BYD lithium-ion batteries, India's TATA Nano car, M-PESA mobile money from Kenya, etc.

Reverse innovation arises when product development is done in emerging markets and sold in developed countries. It is an innovation process used by a lot of multinational companies where they create innovative products and services in emerging countries. The technology and knowledge are then transferred to developed countries (Govindarajan & Ramamurti, 2011). Some examples of such innovations include General Electric's ultra-low-cost portable EKG machine for rural India, the benefit of this product is its long battery life (Govindarajan & Euchner, 2012). These

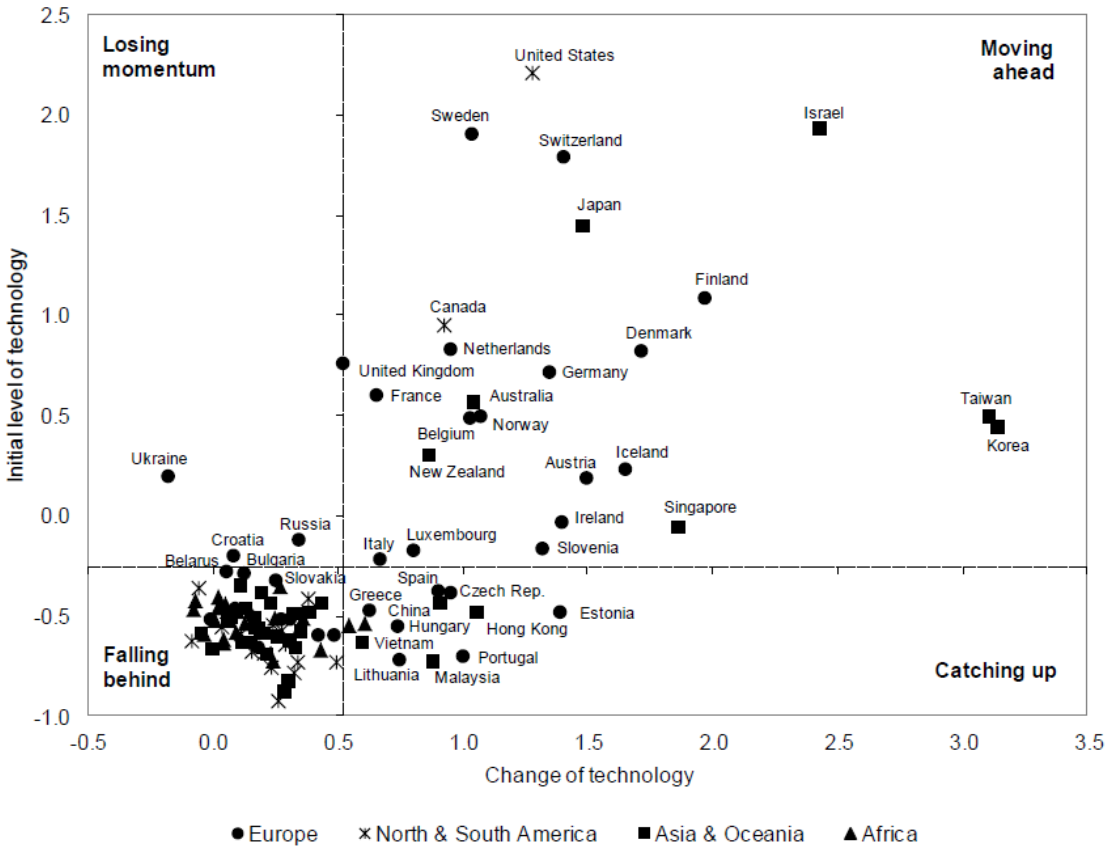
last two types of innovation are critical for countries like South Africa to use the few resources it has and be innovative.

The changes in markets require that both companies from Western and emerging countries exert more effort if they want to be successful. They have to appeal not only to the high-income consumers but to the rising middle classes and also the consumers in villages. They need to rethink how they produce products and distribution systems (Woolridge, 2010).

2.3 Global landscape of innovation with specific examples of emerging economies

Technological innovation is a process that is made up of different steps. These steps entail conducting research, identification, and evaluation of opportunities that benefit social and economic welfare (Kuratko & Hoskinson, 2016). On a study by Romer (1986), one of the main drivers of economic growth is the technical progress (Zalewski & SkawiŃska, 2009). Economic growth, inflation, foreign investments, imports, and exports are some of the macroeconomic indicators used to measure the economic performance of the countries (Yilmaz, 2018). When it comes to the technological innovation process, there are a couple of environmental factors that are influential, namely; the degree of competition, availability of financial resources, manufacturing intensity and the size of the market. Other factors include legislation, social norms, and willingness of society to build the infrastructure (Zalewski & SkawiŃska, 2009). For example, what makes the OECD members countries have high economic growth is their ability to be innovative and use the technology to grow their economy.

Looking at a study conducted on the impact of Chinese imports on innovation, the researchers concluded that faster technical change due to both innovation and the adoption of new technologies influenced an increase in Chinese trade (Bloom, Draca, & Van Reenen, 2016).



Source: (Fagerberg & Srholec, 2015)

Figure 3: Technological capability

Figure 3 shows the technology adaptation by countries. Most of the countries in the top right quadrant are moving forward in terms of technology. Emerging markets, usually found in the third quadrant, are “falling behind” technologically, i.e., they combine a low initial level with below average performance. Many countries in Africa, Latin-America, Asia, and some previously socialist countries, fall within this category (Fagerberg, Srholec, & Verspagen, 2010). The ICT industry in South Africa is one of the fastest growing industries. This industry has opened a number of opportunities for businesses and has been able to reach even the previously under-served areas such as the rural areas.

Innovation in the telecommunications sector, for example, can be key to sustainable national development for South Africa as it is able to give access and democratise

innovation in the rural areas where the availability of road infrastructure, rail, and stable power supply is limited (Pieterse, 2002). About 60% of the South African population has access to the internet and this can be an opportunity to leverage to create new ideas for entrepreneurship. Phone users in developing regions spend about five times or more on communications on a per-user basis compared to disposable income and compared to those in developed countries (Lincoln, 2007). A study done by Lee, Levendis and Guitierrea (2011) on telecommunications and economic growth, an empirical analysis of sub-Saharan Africa, found that the contribution of mobile cellular phones to economic growth has been growing and has a great impact especially in areas where there are no or few landline services (Lee, Levendis, & Gutierrez, 2012).

The banking industry has transformed drastically due to the use of ICT services. They have managed to reach the previously unbanked regions such as the rural areas where there is no physical infrastructure of the bank. With the use of mobile phones, people are able to send and receive money. In Kenya, the use of M-Pesa mobile money has had a great impact on the development of the country. Introduction of this service in South Africa did not have the same positive results as in Kenya, this is mainly due to the fact that South Africa's banking industry is highly developed and the country already has similar products and services such as Shoprite Money Market, E-wallet, etc.

Ethiopia has the Reppie project which turns waste into electricity. They have built the first in Africa waste-to-energy plant. Some European countries already have these plants. This type of innovation not only helps provide about 30% of electricity to the households, but it also helps reduce the air pollution and diseases associated with waste sites (Taylor, 2018). Witness Estonia has embraced the use of its ICT even when providing civil services. The state was the first to use internet voting during their national election in March 2007(Lincoln, 2007).

2.4 Relationship between innovation and unemployment

A study done on four European countries looking at the link between employment and product innovation found that there is a positive relationship between employment and innovation. An increase in sales growth as a result of new products by 1% resulted in an increase in gross employment by 1% (Harrison, Jaumandreu, Mairesse, & Peters, 2014). However, the employment rate is not the inverse of the unemployment rate as people who are unemployed include people who are economically inactive. So, an increase in sales growth due to new products does not mean a reduction in unemployment. The rise in unemployment also depends on the type of sector and the wages paid to the labour force. Unemployment can increase due to either cyclical or structural reasons. On a paper by Hall (1969), he observed that there was a rise in unemployment with structural changes in the economy that has lowered employment in high wage sectors and increased in low wage sectors (Summers, Abraham, & Wachter, 1986).

Unemployment is an economic risk. The existence of unemployment means there are inefficiencies in the labour market and this means that there is an underutilisation of productive capacity (Gangl, 2017). Process innovation and introduction of new technologies can have a negative and positive effect. This is based on a survey done by Chennells and Reenen (2002), which focused mainly on the effect of technological change on skill and pay structure of labour (Chennells & Van Reenen, 2002). Process innovation tends to increase unemployment. This is due to an introduction of machinery and equipment which can replace labour. It allows the production of the same amount of outputs with fewer inputs and this is normally the workers. On the other hand, product innovation creates jobs through the creation of new products and new markets (Vivarelli, 2015).

Methods of producing existing products are improved through technical change. Improvements in productivity as a result of both process innovations and productivity trend imply a reduction in unit costs. The reduction in cost could lead to lower prices and which in turn lead to an increase in output and employment (Harrison et al., 2014).

Introduction of machinery came with its own negativities. During the eighteen to the nineteenth century, the Luddites destroyed machines as they perceived the machines as taking away their employment. Halfway through the nineteenth-century economists such as Karl Marx came up with a theory called “compensation theory”. The theory consists of different market compensation mechanisms. The mechanisms are caused by technological change. This was to counter the effect of process innovation which causes loss of employment. The theory claimed that process innovation also creates new jobs in capital sectors where the new machines are produced. When production costs reduce, prices decrease. The decrease in prices results in an increase in product demand and the overall impact is that employment increases (Vivarelli, 2014).

The impact of technological change or innovation on unemployment had sparked some debates. There were differing views about whether technological change reduces or increases unemployment. One view is from Say’s Law of Markets. Say claims that technological change does not increase unemployment, supply creates its own demand. Classical economists believe the economy is self-correcting, which means that recessions and depressions are short-lived and self-correcting when the economic system is operating at its maximum utilisation of resources. Any technological displacement is short run in nature. The economy needs no intervention from the government.

The Keynesian model argues that the economic system will sometimes fluctuate to a point where government intervention will be required as it will not be able to self-correct. This came about during the Great depression period when many businesses failed and unemployment increased (Tobin, 1975).

Other major theoretical arguments contended that technological change could lead to a lasting rise in the aggregate level of unemployment (Blaug, 1997). Classical economists such as David Ricardo held a view that technological change could create unemployment if the new machines were financed through circulating capital. The displacement of workers was later called ‘technological unemployment’ (Eltis, 1985). Karl Marx’s argument was that a constantly changing organic structure of capital led to a constantly rising industrial number of unemployed people. Therefore, classical

economics holds true in the short term and the Keynesian model holds true in the long run. If there is no intervention in the economy, in the long run, that is no investment in capital goods, this may result in the rise of unemployment. Net unemployment will increase if there is continuous technological change (Woirol, 1996). On a study of 21 industrial countries during the period from 1985 to 2009, issued patents were used as innovation indicators. The patents were used to assess the impact of innovation on the aggregate unemployment rate. The results from the study showed that technological change can increase unemployment even though the impact is not seen in the long run (Vivarelli, 2015).

2.5 Relationship between unemployment and economic growth

If the Total Factor Productivity (TFP) of labour-intensive subsectors such as manufacturing sectors decline, it affects their ability to create jobs. These sectors tend to create jobs for largely unskilled and semi-skilled labour force (Tsebe & Biniza, 2015). This, in turn, creates challenges for the state as it tries to reduce poverty and inequality (Tsebe & Biniza, 2015). This decline has a great impact on South Africa's high unemployment rate.

Total Factor Productivity is part of output not explained by the number of inputs used in production. It is measured by how efficiently and intensely the inputs are utilized in production (Comin, 2010). According to Solow (1957), TFP growth is usually measured by the Solow residual. The Solow residual is then defined through the following equation:

$$gY - x * gK - (1 - x) * gL$$

Where gY stands for the growth rate of aggregate output, gK the growth rate of aggregate capital, gL the growth rate of aggregate labour, and x the capital share. The Solow residual accurately measures TFP growth if there is perfect competition in factor markets, and the growth rates of output and the inputs are measured accurately. TFP is one of the measures of economic growth. It plays a critical role in economic instabilities, economic growth and cross-country per capita income differences. TFP

has a strong correlation with output and hours worked during business cycle incidences (Klenow & Rodriguez-Clare, 1997).

Klenow and Rodriguez-Clare (1997) and Hall and Jones (1999) state that the large differences in TFP between countries result in an income per capita gap between rich and poor countries (Beugelsdijk, Klasing, & Milionis, 2018). TFP is different across different countries. This is due to differences in the physical technology used by countries. It can also be as a result of how efficiently they use technologies (Beugelsdijk et al., 2018).

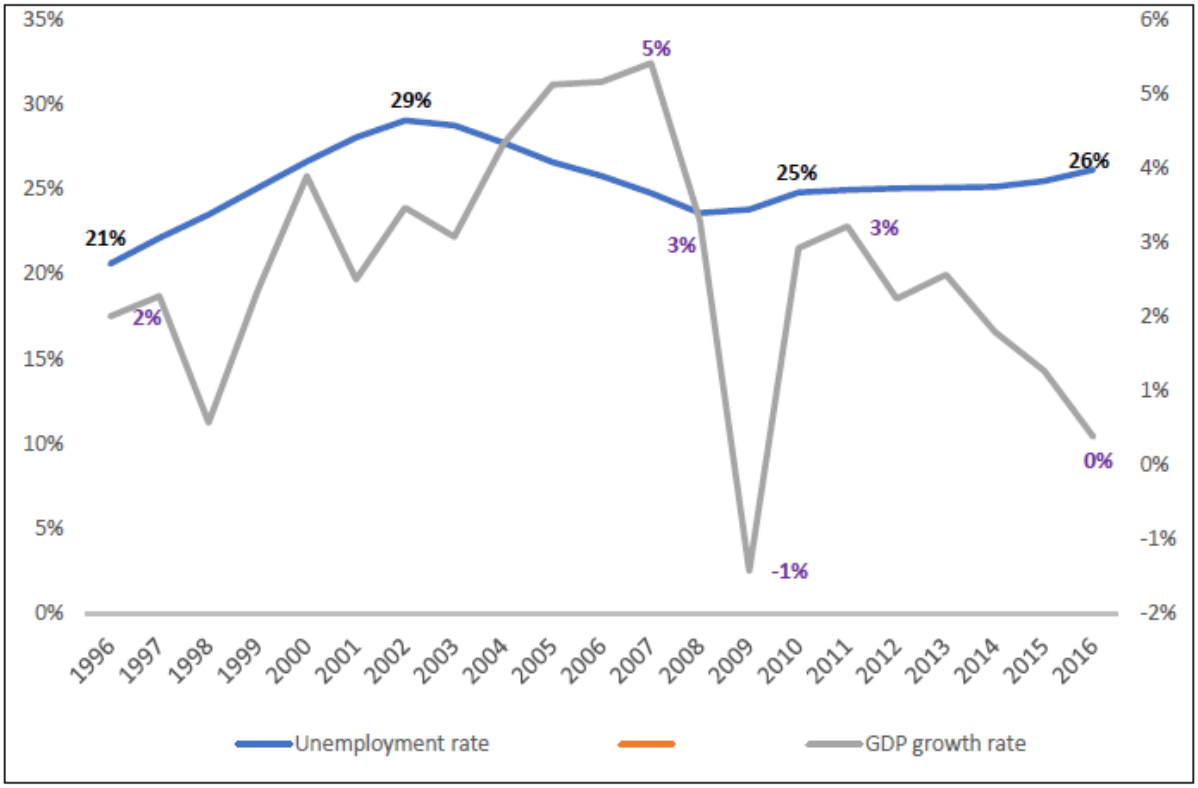
A study done by Comin, Hobijn, and Rovito (2006) revealed that the differences in technologies used amongst different countries were four times larger than income per capita differences. The study measured adoption of about 75 different technologies (Comin, 2010). The study further revealed that technology is positively correlated to income per capita. So the differences in TFP is related to cross-country variation in physical technology (Klenow & Rodriguez-Clare, 1997).

From the research, there is a link between highly developed nations and low unemployment rate. Low unemployment rate means high economic growth. In all this innovation plays a huge role in achieving the required economic growth.

Okun's Law is commonly measured by the correlation between variations in unemployment and real output over the business cycle (J. Lee, 2000). According to Okun (1970), there is a one to three percentage relationship between the unemployment rate and output (J. Lee, 2000). When the unemployment rate changes by 1% point, this results in about 3% change in output in an inverse direction (J. Lee, 2000).

To measure the cost of high unemployment, policymakers use this law as the benchmark. Okun (1970) suggested two different ways to measure this estimation, a first-difference and a "gap" model (Prachowny, 1993). In the recent economic developments, economists like (e.g. Bean 1994; Blanchard and Summers 1986; and Layard, Nickell and Jackman 1994) challenged the one to three ratios. They regard these developments as structural rather than related to the cyclical occurrence (J. Lee,

2000). They regard European unemployment as structural rather than cyclical. The European unemployment rate was more than twice that of the U.S. during the past decade (J. Lee, 2000). This is due to the rigidity of their labour markets. That is the reason why their employment is poor. Nickell (1997), and Nickell and Bell (1996) indicate that “the downward inflexibility of real wages was due to high unionization, generous long-term unemployment benefits, and poor educational standards at the lower end of labour markets.” (Prachowny, 1993). Further to this, Ljungqvist and Sargent (1996, 1998) concluded that Europe's welfare and social insurance programs made people uncomfortable with a changing economy as industries moved from manufacturing to service and use of new technologies (Prachowny, 1993).



Source: Statistics South Africa (2017)

Figure 4: Unemployment rate and economic growth in SA (1996 – 2016)

From figure 4 above, South African GDP decreased and the unemployment rate increased.

The consequence of the Okun coefficient on the business cycle is as a result of the labour market to the product market level of movement (Silvapulle, Moosa, & Silvapulle, 2004). Okun's coefficient assists macroeconomic policy in determining the required growth rate as a prescription for reducing unemployment (Moosa, 1997). Policymakers can use Okun's law to develop appropriate policies during economic turmoil. The law helps with an understanding of how different markets adjust during these economic shocks (Pereira et al, 2009).

Nah (1987) compared three economies, the USA, Japan, and Korea. He proved that Okun's law can be applied to a developing economy as well as developed economies. Using three different methods, Okun coefficients came out as significant statistically speaking, and have similar values in each country. This fact shows there exists some consistency between production growth and unemployment in developing economies as well as developed economies. Korean Okun coefficient is from 11.9 to 15.4. The output growth rate of Korea is responsive to the unemployment rate change. However, the unemployment rate change in Korea is unresponsive to the output growth rate. This implies that the unemployment rate does not increase much in the recession period, but output loss does. Therefore, demand management policy in the Korean economy is effective in improving growth rate, but ineffective in reducing unemployment (Nah, 1987).

Evidence from South African data revealed that Okun's law is only significant during recessions (Phiri, 2014) The results showed a 1% increase in output gap related to a 0.18% decrease in cyclical unemployment (Phiri, 2014). This is based on a study by Geldenhys and Marnikov (2007) where they used Lee's (2000) estimation technique (Phiri, 2014).

2.6 Innovation and economic growth

Over the past three decades, Turkey's economic structure has changed significantly. Technology has become a crucial endogenous variable in the aggregate production function. The country invested in new technology and this resulted in high productivity rates and rapid positive economic growth (Adak, 2015). "Product and process

technology pervade modern economic life and affect regions in subtle as well as in direct ways. Most importantly, entrepreneurship is the fundamental avenue by which technological change enters the economy and provides new jobs and economic growth" (Malecki, 2018).

More than two decades ago, Japan's economy slowed down as it failed to transform its economic system. It had to move towards innovation that would influence economic growth (Dasher et al., 2015). An example of an innovation-based economic system that is considered to be successful is Silicon Valley (C.-M. Lee, 2000). Silicon Valley ecosystem is considered to be successful. It is highly conducive for entrepreneurship (Dasher et al., 2015).

Some emerging economies' technological capabilities have improved significantly. They have managed to catch up with industrialised countries in some industries. Since 2000, China and India have greatly increased the number of patent applications. China is experiencing a number of rapid structural changes and industry upgrading (Fu, Pietrobelli, & Soete, 2011). The impact of this is the increase in exports of technological innovations and in turn boost the economy of this country.

Solow (1956, 1957) was the first to develop the neoclassical model of economic growth. The theory suggests that to achieve a steady economic growth rate, three driving forces are required which are labour, capital, and technology. Technological change has a big impact on economic growth (Serletis, 2007).

Blankley and Moses (2009) conducted a survey to test South Africa's innovation activities against European countries. The results of the study revealed that 54.8% of South Africa's industrial enterprises were innovative compared to 49.3% of service enterprises. German industry came at 72.8% and Bulgarian services at 12.7%. The study also discovered that South Africa was higher than the EU-27 averages of 41.5% for industry and 37.0% for services. South Africa had the sixth highest rate of innovation in industrial enterprises and the fifth highest rate of innovation in service enterprises. Both industrial and service enterprises need to be innovative. Service

sectors are crucial when it comes to the transfer of technology and the facilitation of business in both developed and developing economies (Blankley & Moses, 2009).

2.7 Conclusion

Literature suggests that there is a relationship between innovation and economic growth. However, it suggests that different types of innovation can have different impacts. An important assertion of the literature is a pivotal contribution that innovation can transition an emerging economy to a developed economy. The examples of Japan and China amplify this assertion.

Importantly for South Africa, the level of innovation and innovation culture has been influenced by the country's own circumstances and this underpins the limited contribution of innovation to economic growth and employment. The culture affects education, skills, training, knowledge transfer, entrepreneurship and has not created the necessary enabler to trigger innovation that would have the desired impact on the economy in terms of growth and reducing unemployment.

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3. DATA COLLECTION AND ANALYSIS

3.1 Introduction

The purpose of the study is to examine the role of innovation in an emerging market focusing on South Africa as a case study. The investigation addresses the research questions mentioned in Chapter One. This chapter describes and explains the selection of the data sources, research design, and measures used in manipulating data to give results. In addition, the rationale for the selection of the variables, data analysis and problems with the data are discussed.

3.2 Selection of the sample

The collection of the sample is for the period between 2008 and 2018. Quarterly data is used. Ideally, the sample should be of scientific and statistical significance (Lenth, 2001). Studies that average observations across longer periods generally report larger effects (Valickova, Havranek, & Horvath, 2015).

3.3 Data source

Data used in this study is secondary economic data which was sourced from archival sources such as DataStream. DataStream is a reputable data source.

EViews statistical package was used to analyse the data.

3.4 Research design

The scope-breadth and depth of the research is statistical, using samples. Quantitative method is used to analyse the data. The time dimension of the research is longitudinal. The data type which will be used is time series data.

This research is predominately based on quantitative data in terms of its analysis and content. In the view of the researcher, the elements of this study are best described,

hypothesis framed, conclusions drawn as reliable and as best as it can be from the available data on a quantitative approach standpoint. This is largely because the data is dispersed across industries, different time periods and other numeric measurements.

3.5 Measure used

The study tests whether a reduction in the unemployment rate results in an increase in economic growth. It also tests the relationship between unemployment and innovation. It further tests the relationship between innovation and economic growth.

There are various measures of economic growth such as GDP, GNI and labour productivity. Labour productivity improves GDP as more products are produced by the economy when labour productivity increases. Labour productivity output relies on the number of people employed. It does not measure output based on labour alone. It takes into consideration new technology, capital investment, health and skills of workers and the use of more efficient management and production practices. Therefore, labour productivity was not used as the measure of economic growth as it is a partial productivity measure (Attar, Gupta, & Desai, 2012).

Other indicators of economic growth are Human development index (HDI) and OECD Better life index. HDI takes into consideration three basic dimensions which are related to human development and those are health, education and material well-being. The index has shown a relevant relationship with economic growth (Suri et al. (2011)), (Blanco, Martínez, & Notario, 2017). It is an alternative to GDP which is the unidimensional measure of development. However, it is still unable to include ecological considerations (Sagar & Najam, 1998). The OECD Better Life Index combines a country's well-being outcomes through the weights defined by online users. The drawback with this measure is that different regions have different aspects that matter to them (Balestra, Boarini, & Tosetto, 2018).

Therefore, for the purpose of this study GDP is used as the measure of economic growth. The benefit of using GDP is that an economy can be represented by a single

number. It is easy to understand. It is linked to the country's productivity. GDP information is used by governments to formulate policies. They invest a lot of time calculating and forecasting GDP. All countries use GDP as it is standardized through the United Nations System of National Accounts. Countries are compared using the value of GDP (Van den Bergh, 2009).

The following variables are used to test the relationships: Growth measured by GDP, unemployment rate, human capital - change in this variable is a crucial indicator of how the economy is advancing or degrading. Human Capital is a measure of the skills, education, capacity, and attributes of labour which influence their productive capacity and earning potential. According to the OECD, human capital is defined as: the knowledge, skills, competencies and other attributes embodied in individuals or groups of individuals acquired during their life and used to produce goods, services or ideas in market circumstances (Pettinger, 2017).

Capital Formation is an indicator of general investment in the economy, wage growth is another indicator of economic advancement, innovation indicators (patent and intellectual property rights registered) and business cycle indicator. The business cycle refers to the fluctuations in the economy in terms of output and growth. It is measured by changes in real GDP from one quarter to the next. The Composite Business Cycle Indicator is a crucial variable when understanding factors that influence the entire economy. The lagging business cycle indicator is a composite index comprising of time series, which tend to shift direction following a change in direction of the business cycle. The components of the Composite Lagging Indicator are employment in non-agricultural sectors; the total number of hours worked by production workers in the construction sector; the physical volume of mining production of building materials; value of unfilled orders as percentage of sales in manufacturing; the value of fixed investment in machinery and equipment; the value of non-residential buildings completed; the value of industrial and commercial inventories at constant prices and labour costs per unit of physical volume of manufacturing production. All these components have equal weighting in the index. Change in this variable is a crucial indicator of how the economy is advancing or degrading.

When there is economic expansion this means that there is economic growth in terms of, confidence, low unemployment (employment increases), prices rise, and increases in investment. Peak refers to an economy that is producing at its maximum. Demand exceeds supply and the economy begins to overheat (unsustainable growth). Recession is when the GDP growth rate slows down. This is characterised by fear and panic - financial crises, demand, and spending fall, business profit decline. Unemployment rises (employment drop) and investment and prices fall. The trough is the lowest point in GDP. The decline in growth curbs. It requires fiscal and monetary intervention by the government. According to the World Bank, the following are the possible causes of unemployment in South Africa: output and employment; LFP growth rates; labour demand-supply mismatch; wages and employment; the role of trade unions and bargaining councils; labour regulation and the nature of economic growth (Bhorat, 2007).

To test the relationship between employment and innovation and innovation and economic growth, simultaneous linear regression equations are used. Independent variables are used to predict the value of a dependent variable.

Limitations with using the GDP as a measure of economic growth is that it does not take into consideration the well-being, sustainability of the environment and social progress (Stiglitz, Sen, & Fitoussi, 2009). In some countries, there is a big gap between GDP and GNI. GNI will be much higher than GDP in countries that receive large amounts of foreign aid. The challenge with GNI is that some wealthy people hide their true wealth to avoid higher taxation. GDP's predecessor GNP was developed during the Great Depression in the 1930s to understand the American economy. Simon Kuznets, the Russian-American economist used the single number to measure economic production data. The idea was that the number will fluctuate up and down in good times and bad times respectively. People in wealthy nations no longer consider growth as improving people's lives (O'Neill, 2014).

Statistical analysis such as correlation analysis was also used to test validity of the research. This was used to assess how strong the relationship between two variables. Validity of the research tests how true the results are and it helps to trust that the

conclusions are accurate. Reliability has to do with data collection techniques and analysis that if repeated, they would generate the same results.

To ensure the reliability of the data, stationarity test was done. It is important to do the stationarity test before running regression analysis. Augmented Dickey-Fuller (ADF) unit root test is one of the methods used to test if the time series is stationary. A non-stationary time series has a unit root, which must be removed to make the time series stationary. In time series analysis, a stationary test is important, as a series that is non-stationary will give invalid results on the regression model (Brooks, 2014).

The hypotheses for the test:

H_0: The null hypothesis for this test is that there is a unit root.

H_1: The alternate hypothesis, the time series is stationary.

If the data is non-stationary it can cause odd behaviour. T-ratios will not follow a t-distribution or high r-squared values assigned to variables that are not correlated.

$\Delta Yt = \propto + \delta Y_{t-1} + \varepsilon t$

H_0: $\delta = 0$

H_1: $\delta < 0$

Stationarity occurs when the joint probability of a series does not change over time. The mean and variance remain constant over time. There is no trend in the series. Represented by the below equation:

$$F(Yt) = F(Yt + k)$$

F is a joint probability distribution.

The use of both stationarity and unit root tests is known as confirmatory data analysis (Gelo, 2009).

The following process was followed to determine stationarity:

(1) Run the ADF test

(2) Find critical values from Fuller's Table

(3) Compare the values (ADF and Critical Value):

- The null hypothesis (H_0): $X_t \neq I(0)$
- If DF and ADF < critical values from Fuller's table, then (H_0) is rejected. This means the series is stationary.

ADF test equation:

$$(\text{ADF})\ \Delta X_t = a + bX_{t-1} + \sum_{i=1}^{\gamma} c\Delta X_{t-1} + \varepsilon_t$$

Where a, b and c are estimated and white noise is represented by ε_t.

Regression model

The dependent variable is the GDP, which is measuring economic growth. The independent variables are the unemployment rate and sample innovation index. The dependent variable is the value we want to explain or forecast. Its value depends on something else. It is represented by GDP in the linear regression equation.

Independent Variable is the variable which explains the dependent variable. Its values are independent. The three equations below represent the three relationships which are being investigated.

Equation1: $\text{UNEMP} = \beta_0 + \beta_1\text{Patent} + \beta_2\text{Intl\_pty} + \beta_3\text{HCAP} + \beta_4\text{Wages} + \beta_5\text{CAPFM} + \beta_6\text{BSCLE} + \beta 7\text{dummy}_0 + \beta_8\text{dummy}_1 + \varepsilon$

Equation2:

$\text{GDP} = \beta_0 + \beta_1\text{Unemp} + \beta_2\text{Patents} + \beta_3\text{HCAP} + \beta_4\text{Intl\_pty} + \beta_5\text{Wages} + \beta_6\text{CAPFM} + \beta_7\text{BSCLE} + \beta_8\text{dummy}_0 + \beta_9\text{dummy}_1 + \varepsilon$

Where:

$UNEMP$	Dependent variable-Unemployment
GDP	Dependent variable-Gross Domestic Product
β_0	Constant
$\beta_1 Patent$	Independent variable – Patents issued
$\beta_2 Intl\_pty$	Independent variable – Intellectual Property
$\beta_3 HCAP$	Independent variable – Human Capital
$\beta_4 Wages$	Independent variable – Wages
$\beta_5 CAPFM$	Independent variable – Capital Formation
$\beta_6 BCL$	Independent variable – Business Cycle
$\beta_1 Unemp$	Independent variable –Unemployment
β_0	Constant or intercept
ε	Error term
$\beta dummy_0$ & $\beta dummy_1$	Dummy variable that equals 1 for each year after growth and 0 before growth

The seemingly unrelated regression (SUR) framework initially proposed by Zellner (1962) is deemed appropriate to answer the objectives of this study which looks into running two regressions at once. Given that the two equations use the same regressors, there is a higher chance that the residuals are contemporaneously correlated. SUR addresses this by taking care of the contemporaneous correlation of the idiosyncratic term. This has been used widely in finance where the requirement is to model several closely related variables over time. It can also be noted that SUR is so called because the dependent variables may seem unrelated across the equations

at first sight, but a more careful consideration would allow us to conclude that they are in fact related after all. There is no relation between equations in the Seemingly Unrelated Regression method. What is intended with the correlation state of regression models within the equation system, is indicating whether the error terms are correlated or not related to the models in question.

SUR modelling:

LUNEMP = C(1) + C(2)*LPATENT + C(3)*LINTL_PTY + C(4)*LHCAP+ C(5)*LWAGES + C(6)*LCAPFM + C(7)*LBSCLE

LGDP=C(11)+C(12)*LUNEMP+C(13)*LPATENT+C(14)*LHCAP+(15)*LINTL_PTY+ C(16)*LWAGES + C17)*LCAPFM + C(18)*LBSCLE

3.6 Data analysis

To analyse the data EViews was used to generate the results. EViews is a statistical package for Windows. It is used mainly for time-series oriented econometric analysis.

3.7 Problems with the data

Data was collected from different sources and some data periods were missing for some indicators. The time period is short, however, the analysis is based on a higher number of observations. GDP does not measure social costs, environmental impacts, and income inequality. It is only concerned with market transactions. There are still no clear alternative measures to GDP that can incorporate all the factors omitted by the GDP (Robert et al., 2014).

3.8 Conclusion

The methodology as applied in the view of a researcher is able to derive the appropriate foundations to form a conclusion.

4. Results and Analysis

4.1 Introduction

This chapter looks at the results of the relationship between innovation and economic growth using GDP as the measure. Also, the impact of innovation on South African employment. As indicated in the previous chapter, data was collected from DataStream. EViews was used to analyse the data. The following variables will be used to test the relationships. Growth; which is measured by GDP; unemployment levels; human capital - change in this variable is a crucial indicator of how the economy is advancing or degrading, capital formation, an indicator of general investment in the economy; wage growth another indicator of economic advancement and innovation indicators (patent and intellectual property rights registered).

4.2 Graphical presentation of the sample

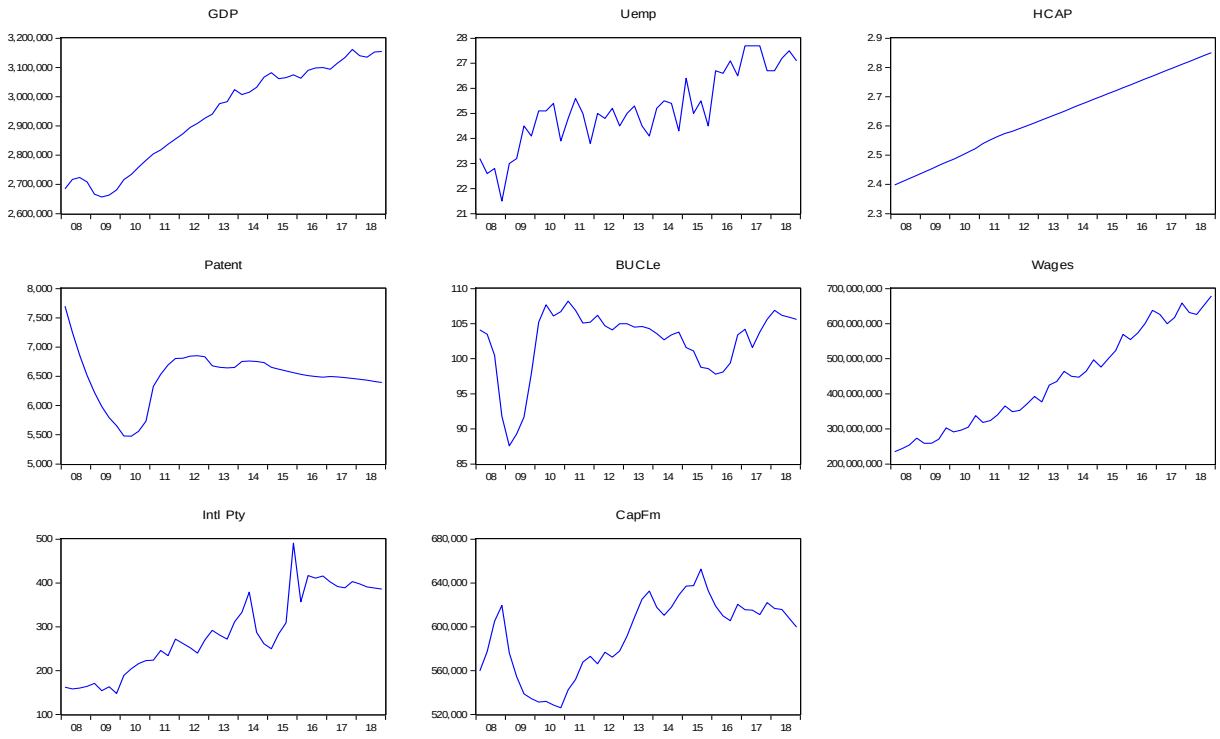

Figure 5: Graphical presentation of the variables

Figure 5 indicates a graphical representation of the sample. Economic growth in terms of GDP shows an upward growth trend for South Africa. The business cycle was lowest in 2008; that is when there was a global financial crisis. Intellectual property licenses issued in 2015 were the highest. South Africa came second in the Global Innovation Index in 2015. Growth in human capital seems to have greatly improved from the year 2000 onwards, compared to the previous years.

Like the human capital graph above, wages also increased almost exponentially from the year 2000 onwards. In 1985 COSATU called for “a legally enforced national minimum living wage”. While the Freedom Charter of 1955 called for a “national minimum wage”. It was only in the African National Congress’ 2014 Election Manifesto that the party decided, under pressure from COSATU, to include an investigation into the introduction of a national minimum wage. In the President’s State of the Nation Address in July 2014, he spoke of the need to explore minimum wages in the context of the triple challenges of unemployment, poverty, and inequality (Cottle, 2015). Between 2008 and 2009, unemployment grew almost exponentially, this was around the 2008 global financial crisis. “The labour market is demanding an increasingly skilled and productive workforce and the weakness of South African human capital policies is limiting opportunities for those who were particularly disadvantaged by apartheid and it is leaving them poorly equipped to face the future.” (Leibbrandt, Woolard, Finn & Argen, 2010). With the investment in stock, capital formation took a dip in 2010. The country had invested immensely in infrastructure the previous years in preparation for the FIFA world cup.

4.3 Stationarity test results

Before estimating the linear regression equation, it is important to perform a stationarity test in order to ascertain the effect of the time trend in the series. Augmented Dickey-Fuller (ADF) unit root test is one of the methods used to test if the time series is stationary or contains unit roots. A non-stationary time series has a unit root which must be removed to make the time series stationary, hence alleviating the effect of time in the time series data generating process. In time series analysis, a

stationary test is important, as a series that is non-stationary will give invalid results on the regression model (Brook, 2014).

The hypotheses for the test:

H_0: The null hypothesis for this test is that there is a unit root.

H_1: The alternate hypothesis, the time series is stationary.

The absolute value of the t-Statistic should be bigger than the critical values. The coefficient of the variable should be negative for the model to be viable. If the data is non-stationary it can cause odd behaviour. T-ratios will not follow a t-distribution or high r-squared values assigned to variables that are not correlated.

Table 1: ADF tests output- at level

Variable	ADF				
	t-stats	1%	5%	10%	P-value
GDP					
Intercept	-0.738923	-3.592462	-2.931404	-2.603944	0.8258
UEMP					
Intercept	-1.856710	-3.605593	-2.936942	-2.606857	0.3487
BUCLE					
Intercept	-1.701959	-3.592462	-2.931404	-2.603944	0.4231
PATENTS					
Intercept	-3.603230	-3.600987	-2.935001	-2.605836	0.0099
INTL_PTY					
Intercept	-1.231754	-3.596616	-2.933158	-2.604867	0.6518
WAGES					
Intercept	-0.186740	-3.610453	-2.938987	-2.607932	0.9318
CAPFM					
Intercept	-1.396468	-3.592462	-2.931404	-2.603944	0.5752
HCAP					
Intercept	-1.631886	-3.615588	-2.941145	-2.609066	0.4569

Table 2: ADF test output -1st difference

Variable	ADF				
	t-stats	1%	5%	10%	P-value
GDP					
Intercept	-5.217830	-3.596616	-2.933158	-2.604867	0.0001
UEMP					
Intercept	-7.679011	-3.605593	-2.936942	-2.606857	0.0000
BUCLE					
Intercept	-3.523784	-3.596616	-2.933158	-2.604867	0.0121
PATENTS					
Intercept	-3.032340	-3.596616	-2.933158	-2.604867	0.0400
INTL_PTY					
Intercept	-9.572491	-3.596616	-2.933158	-2.604867	0.0000
WAGES					
Intercept	-2.417787	-3.610453	-2.938987	-2.607932	0.1436
CAPFM					
Intercept	-4.464748	-3.596616	-2.933158	-2.604867	0.0009
HCAP					
Intercept	-1.835758	-3.615588	-2.941145	-2.609066	0.3581

Based on Table 1 and 2, ADF tests for GDP series point out that the series has the unit root at level. At first difference, the series has the probability value which is less than 5% and the t-stat value is more than the critical values, so the series is stationary at first difference. UEMP- unemployment series is also stationary at first difference. At level the series has a unit root and we cannot reject the null hypothesis. BUCLE-business cycle series is non-stationary at level as the p-value is more than 5%. Also, the t-statistic value is less than the critical values at 1%, 5%, and 10%. To make the series stationary we have to use it at first difference using the 5% level as at 1% the t-statistic value is smaller.

PATENTS series has the probability value less than 0.05, however the t-statistic value is less than the critical values at level. If integrated at first difference the series null hypothesis is rejected so the series is stationary. INTL_PTY-intellectual property series in non-stationary at level. However, the series is stationary at first difference. WAGES series has a unit root at level and first difference. The series have to be integrated at second difference to make it stationary.

CAPFM-capital formation series has a unit root at level. It is stationary at first difference with t-stat value more than critical values, probability value less than 0.05, the null

hypothesis is rejected. HCAP-human capital series is non-stationary at level as well as at first difference as the t-stat values are less than critical values. The probability value is more than 5% so we accept the null hypothesis. The series have to be integrated at second difference for it to be stationary. Unit root tests are done with an intercept. It is not advisable to do second difference on the series as it could reduce the power of the ADF model. The series will be logged to make it stationary.

4.4 Descriptive statistics for the sample

Table 3: Descriptive statistics

	GDP	UEMP	PATENT	INTL_PTY	WAGES	CAPFM	HCAP	BUCLE
Mean	2935943.	25.20455	6491.409	286.6429	4.37E+08	592360.6	2.631368	102.4545
Median	2979856.	25.10000	6532.945	272.0000	4.30E+08	606681.0	2.635098	104.1000
Maximum	3161082.	27.70000	7697.719	491.0000	6.79E+08	652624.2	2.850542	108.2000
Minimum	2657131.	21.50000	5476.688	148.0000	2.35E+08	526021.4	2.397945	87.60000
Std. Dev.	169426.6	1.493545	439.1893	92.60354	1.40E+08	35299.95	0.134438	4.794835
Skewness	-0.310156	-0.156656	-0.519043	0.202129	0.229925	-0.466194	-0.090565	-1.586837
Kurtosis	1.615115	2.604706	4.196675	1.950751	1.676483	2.005685	1.839007	4.991931
Jarque-Bera	4.221606	0.466440	4.601034	2.317969	3.599122	3.406354	2.531306	25.73999
Probability	0.121141	0.791979	0.100207	0.313805	0.165371	0.182104	0.282055	0.000003
Sum	1.29E+08	1109.000	285622.0	12612.29	1.92E+10	26063867	115.7802	4508.000
Sum Sq. Dev.	1.23E+12	95.91909	8294151.	368742.9	8.40E+17	5.36E+10	0.777159	988.5891
Observations	44	44	44	44	44	44	44	44

Descriptive statistics analysis is critical for time series analysis as it provides basic information of the data series in a single unit or number. It is also used to gauge the distributional behaviour of the data series used in the study. Analysis of time series data requires that data used is normally distributed and the distribution characteristics must be understood. Descriptive statistics have two main measures, that is, measures of central tendency, including mean and median, and measures of dispersion including standard deviation, skewness and kurtosis. Measures of central tendency- mean and median are as indicated in Table 3 for all the variables. The mean for GDP is 2935943. The standard deviation which measures how much variation exists from the mean or average is 169426.6 for GDP. The mean is sensitive to extreme score if there are outliers in the sample. If that is the case, the median is a better statistic to use. The table above provides all the values for the rest of the variables.

4.4.1 Interpretation of the measures of normality:

Normal skewness has a 0 skew, and when the series has normal distribution (Mesokurtic) the kurtosis is 3. Based on the results of the sample, GDP mirrors a negative skewness which is a long left tail. The kurtosis is platykurtic because 1.615115 is less than 3. UEMP mirrors negative skewness long left tail and kurtosis is platykurtic as 2.604706 is lower than 3 (2.604706<3). PATENTseries has negative skewness long left tail and leptokurtic, that is positive kurtosis (peaked-curve), higher values (4.196675 >3). INTL_PTY has positive skewness long right tail, higher values and platykurtic because 1.950751 is less than 3. WAGES has normal skewness, symmetric distribution around its mean and platykurtic 1.676483 is less than 3 (1.676483 <3). CAPFM has negative skewness long left tail and platykurtic (2.005685<3). BUCLE has negative skewness long left tail and leptokurtic (4.991931>3). Values are more than 1 so data is extremely skewed. HCAP mirrors negative skewness and its kurtosis is platykurtic a (1.839007 <3). Data is mostly skewed left, negative skew. The mean is mostly less than the median so the data is negatively skewed.

4.5 Results of the degree of association

Table 4: Correlation Analysis

Correlation t-Statistic	GDP	UEMP	PATENT	INTL_PTY	WAGES	CAPFM	HCAP	BUCLE
GDP	1.000000 -----							
UEMP	0.784569 8.200408	1.000000 -----						
PATENT	0.258403 1.733515	-0.104465 -0.680737	1.000000 -----					
INTL_PTY	0.905784 13.85323	0.770626 7.836691	0.152302 0.998678	1.000000 -----				
WAGES	0.957507 21.51567	0.827645 9.556783	0.098562 0.641882	0.927091 16.02890	1.000000 -----			
CAPFM	0.776927 7.997360	0.327055 2.242910	0.488443 3.627650	0.630217 5.260404	0.690549 6.187422	1.000000 -----		
HCAP	0.977763 30.21568	0.857674 10.80987	0.114892 0.749546	0.920475 15.26438	0.982647 34.33268	0.677140 5.963643	1.000000 -----	
BUCLE	0.310857 2.119599	0.365333 2.543437	0.145999 0.956429	0.242694 1.621306	0.219940 1.461151	-0.080683 -0.524597	0.286240 1.936055	1.000000 -----

From the table above (Table 4), validity of the study was assess by using the statistical correlation analysis. The degree of association was measured, GDP results show that there is a positive correlation with most variables except for patents and business cycle. Most of the variables show a correlation of more than 0.6, which indicate good correlation. This correlation indicates that there is a positive linear association between them. For variables patents and business cycle, the association is small with GDP. The measure showed similar results when measured against the unemployment variable. The capital formation also has a small association with unemployment.

The t-statistic values are also greater than 2 except for patents. The variables are statistically significant. The p-values indicate that the results were unlikely to have

occurred by chance alone. Again, patents have p-values that are greater than 0.05 significance level.

4.6 Results of the Regression Models

4.6.1 Characteristics of the best regression model

High R square value, preferably it should be more than 60%. The model must not have a serial correlation in the residual (or autocorrelation). It must not have heteroskedasticity in the residual, the model should be homoscedastic - desirable. Residuals should be normally distributed. The null hypothesis should be accepted for the model to be the best.

Null hypothesis :	Residuals are not serially correlated
Alternative :	Residuals are serially correlated
Null hypothesis :	Residuals are not heteroscedastic, that is they should be homoscedastic
Alternative :	Residuals are heteroscedastic
Null hypothesis :	Resduals are normally distributed
Alternative :	Residuals are not normally distributed

To achieve a good regression model, the residuals should be elastic. It means that in all cases above if the null hypothesis is not rejected, that is preferred. The model can be used for forecasting.

The regression model was performed to test the relationship amongst the dependent and independent variables. Model 1 tested the unemployment as the dependent variable and model 2 tested GDP as the dependent variable.

4.6.2 OLS Model1 results

Unemployment is the dependent variable for this model with 43 observations.

Table 5: Unemployment OLS results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.007885	0.026918	0.292942	0.7712
LPATENT	-0.056633	0.169139	-0.334831	0.7397
LINTL_PTY	-0.059081	0.033897	-1.742945	0.0899
LHCAP	2.214422	6.561838	0.337470	0.7377
LWAGES	-0.475648	0.092117	-5.163533	0.0000
LCAPFM	-0.337141	0.196628	-1.714610	0.0950
LBSCLE	0.087415	0.161412	0.541563	0.5915

R-squared	0.549234	Mean dependent var	0.003614
Adjusted R-squared	0.474107	S.D. dependent var	0.036498
S.E. of regression	0.026468	Akaike info criterion	-4.277879
Sum squared resid	0.025220	Schwarz criterion	-3.991172
Log likelihood	98.97439	Hannan-Quinn criter.	-4.172150
F-statistic	7.310686	Durbin-Watson stat	2.787606
Prob(F-statistic)	0.000037		

From Table 5, R-squared is 54.92%, variation in unemployment or fluctuation in unemployment can be explained by patents, ip, wages, capital formation and business cycle jointly and the rest, 45.22% variation in unemployment, can be explained by other independent variables or residuals which are not included in this model. The value of R-squared is not more than 60% so this model is not well fitted. However, 40% is still acceptable. The model also seems stable judging from the p value of F statistics and the coefficient of the Durbin-Watson test which measures autocorrelation. The standard rule of thumb is that the coefficient should be more than 2.0 for the residuals not to affect the innovations of the dependent variable.

Only independent variable wages has the probability value that is less than 0.05. Intellectual property and capital formation are only significant at 10% significancy. These can individually influence unemployment. The rest of the variables are not significant individually. All the independent variables should jointly be significant to influence unemployment. F-statistics is used for joint significance. To measure the significance or the influence of individual variables t-statistic is used. F statistic for the above model is significant. The variables can jointly influence unemployment.

Sign of the coefficient should follow economic theory, or expectation or intuition. In this case, the model is the best regression model. If innovation measured by patents

as well as the intellectual property goes up by 1 unit, unemployment will go down by 0.056 and 0.059 respectively provided other independent variables are constant. Unemployment and business cycle showed a positive relationship. “Fluctuations in business activities caused by significant innovations have a great impact on investment and consumption spending and therefore on output, employment and the price level” (van Rensburg et al., 2015). Wages and capital formation also have a negative relationship with unemployment. Human capital has a positive relationship with unemployment according to this model.

The regression model is good when it has the residual that follows some special feature. Residual- gap between Actual unemployment and estimated (Fitted) unemployment. If you sum up all the residuals all should be zero. The residual plot indicates that the unemployment series has spikes.

4.6.3 OLS Model 2 Results

The dependent variable is the GDP with 43 observations.

Table 6: GDP OLS results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.002489	0.000974	2.555776	0.0151
LUEMP	0.025339	0.030348	0.834940	0.4094
LPATENT	0.031971	0.029760	1.074297	0.2900
LHCAP	-0.002866	0.007126	-0.402148	0.6900
LINTL_PTY	0.006984	0.006400	1.091343	0.2826
LWAGES	0.036726	0.021935	1.674326	0.1030
LCAPFM	0.137457	0.036767	3.738610	0.0007
LBSCLE	0.086555	0.029200	2.964223	0.0054

R-squared	0.489744	Mean dependent var	0.003755
Adjusted R-squared	0.387693	S.D. dependent var	0.006102
S.E. of regression	0.004775	Akaike info criterion	-7.684627
Sum squared resid	0.000798	Schwarz criterion	-7.356962
Log likelihood	173.2195	Hannan-Quinn criter.	-7.563794
F-statistic	4.799001	Durbin-Watson stat	1.825002
Prob(F-statistic)	0.000727		

Results of model 2 as shown in Table 6, R-squared is not more than 60%. It is 48.97% which means the model is not well fitted. All the coefficients are positive except human

capital variable which is strange for unemployment to have a positive relationship with GDP. Innovation has a positive relationship. A unit increase in innovation in terms of patents will result in an increase in GDP by 0.031971. Only three variables including the constant are significant in explaining the dependent variable at a 5% significance level. These are capital formation and the business cycle. These two variables have a strong relationship with GDP. According to the test results above, a unit increase in unemployment will have 0.025339 increase in GDP. However, this variable is not significant in explaining GDP as the p-value is more than 5%.

The constant's coefficient is significant which indicates that the dependent variable is mostly explained by the error term. F-statistic is positive and its corresponding probability value is close to zero. This indicates the statistical significance of the F-statistic as it is less than 0.05. Schwarz criterion has a smaller value (-7.356962) so it is the ideal model to be adopted for the analysis. Durbin-Watson stat is used to find out if there is first-order serial correlation in error terms. Rule of thumb, if DW is less than 2 there is evidence of a positive serial correlation. For the above model, Durbin-Watson stat is 1.825002, which is less than 2 so the model is suffering from serial correlation. The GDP residual plot indicates that the series has spikes.

4.6.4 Test results for serial correlation, heteroskedasticity and normal distribution

Below are tables for both the 2 models with regards to residual. A serial correlation test was done using the Breusch-Godfrey serial correlation LM test. Observation R-squared for unemployment 7.324284 and 3.163153 for GDP. Probability Chi-Square value for unemployment model is 0.0257 and is less than 5% so the null hypothesis is rejected. The model has serially correlated residuals. Model 2, on the other hand, the probability value was more than 5% at 0.2057 so the null hypothesis cannot be rejected. The model does not have serially correlated residuals.

The residuals should not have heteroskedasticity so Breusch-Pagan-Godfrey test was performed to test for heteroskedasticity. Obs*R-squared for model 1 came out as 3.652830 and 6.376700 for model 2. There is no heteroskedasticity, p- value is

72.35% which is more than 5% so there is no heteroskedasticity. Model 1 does not have heteroskedasticity. Model 2 as well does not have heteroskedasticity in the residuals, p-value is 49.65%. Models are homoscedastic, which is desirable.
Normal Distribution Test was conducted using the Jarque-Bera test and the results came out as below.

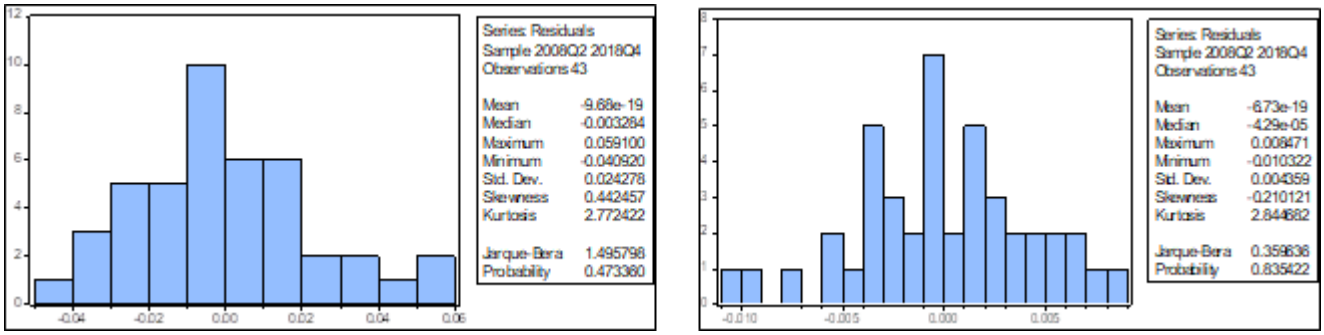

Figure 6: Jarque-Bera test-employment and GDP series residuals

The Jarque-Bera value for unemployment is 1.495798. The corresponding probabilty is 0.473360 which is more than 5% so the residuals are normally distributed for Model 1. Model 2, the Jarque-Bera value 0.359636 with the corresponding probability value for the Jarque-Bera test at 0.835422 is more than 0.05. The series is normally distributed. Figure 8 shows the graphical presentation of the series.

The good signs of the above models, R squared is high, though not more than 60%. The residuals are normally distributed for both models. Serial residuals for both models do not have heteroskedasticity and are not serially correlated. For the models to be good so that they can be used for forecasting most of the independent variables should be significant and in this case, they are not.

What is not good about these models is that more than half the coefficients have p-values that are more than 5%. So individually they are not statistically significant. Nonetheless, the F-statistic values are high, and the corresponding p-values are significant. So jointly the independent variables are significant to explain the dependent variables. Model 1, the residual is serially correlated.

Residuals should not have a serial correlation. They should not have heteroskedasticity and should have a normal distribution. Therefore, the two models above do not seem to indicate the best regression models as they are only meeting a few of the requirements of the best regression model. To deal with the errors in the above two models, the researcher had to perform the seemingly unrelated regression (SUR) modelling. SUR analysis was done to take care of contemporaneous errors in the simultaneous equations.

A SUR is so called because the dependent variables may seem unrelated across the equations at first sight, but a more careful consideration would allow us to conclude that they are in fact related after all. There is not any type of relation between equations in the SUR method and that there is no correlation in the error terms. The errors are assumed to be homoscedastic and linearly independent within each equation. The error of each equation may have its own variance. Each equation is correlated with others in the same time period. The latter assumption is called contemporaneous correlation, and it is this property that sets SUR apart from other models. The OLS models were not adequate to use for this study so had to perform the SUR modelling.

4.7 Research findings of the Seemingly Unrelated Regression Model

Table 7: SUR results

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.016648	0.004185	3.978365	0.0002
C(2)	-0.017056	0.149522	-0.114070	0.9095
C(3)	-0.060874	0.030790	-1.977052	0.0519
C(4)	-0.034409	0.035423	-0.971382	0.3347
C(5)	-0.470670	0.083651	-5.626621	0.0000
C(6)	-0.325420	0.177965	-1.828566	0.0717
C(7)	0.077670	0.146251	0.531076	0.5970
C(11)	0.002489	0.000879	2.832847	0.0060
C(12)	0.025339	0.027380	0.925456	0.3579
C(13)	0.031971	0.026849	1.190761	0.2377
C(14)	-0.002866	0.006429	-0.445745	0.6571
C(15)	0.006984	0.005774	1.209655	0.2304
C(16)	0.036726	0.019790	1.855838	0.0676
C(17)	0.137457	0.033171	4.143911	0.0001
C(18)	0.086555	0.026344	3.285573	0.0016

Equations:

LUEMP = C(1) + C(2)*LPATENT + C(3)*LINTL_PTY + C(4)*LHCAP + C(5)*LWAGES + C(6)*LCAPFM + C(7)*LBSCLE

LGDP = C(11) + C(12)*LUEMP + C(13)*LPATENT + C(14)*LHCAP + C(15)*LINTL_PTY + C(16)*LWAGES + C(17)*LCAPFM + C(18)*LBSCLE

The findings of the SUR model had 86 observations. The t-statistic values that are more than two are constants as well as the variables capital formation and business cycle according to Table 5 above. This means that the dependent variable is mostly explained by undefined variables.

The probability values of the constants are almost zero. Intellectual property (C3), wages (C5), capital formation (C17) and the business cycle (C18) have p-values that are less than 0.05 significance level. (C6) Capital formation and (C16) wages have p-values that are significant at a 10% significance level. Some literature states that there is a long run relationship between capital formation and economic growth. As the country invests in more stock such as machinery or equipment, transportation assets, and electricity, this should lead to an increase in economic growth. The model indicates that this variable is very significant in explaining economic growth as well as

unemployment. Wages are also very significant in explaining unemployment and GDP. For unemployment, variable wages has a p-value of zero. More than 50% of variables are significant so the regression is good.

Table 8: OLS and SUR coefficient results

	OLS EUMP	OLS GDP	SUR EUMP	SUR GDP
Patents	-0.056633	0.031971	-0.017056	0.031971
IP	-0.059081	0.006984	-0.060874	0.006984
HCAP	2.214422	-0.002866	-0.034409	-0.002866
Wages	-0.475648	0.036726	-0.470670	0.036726
Capital Formation	-0.337141	0.137457	-0.332498	0.137457
Business Cycle	0.087415	0.086555	0.077670	0.086555
Unemployment		0.025339		0.025339
Constant	0.007885	0.002489	0.016648	0.002489

Innovation in the form of issued patents and intellectual property, both have a negative relationship with unemployment based on the results of the above model. An increase in innovation will result in a decrease in unemployment. Human capital, wages as well as capital formation, they also have a negative relationship with unemployment. Looking at the minimum wage and unemployment model, theoretically shows that by increasing minimum wage, unemployment increases. Mostly the unskilled labour force suffers. South Africa has the highest levels of the unskilled labour force. When the forces of supply and demand are applied to minimum wages, there will be an increase in unemployment. “In any stationary state, when the investment is equal to zero, high real wage rate leads to high aggregate demand, but it also leads to high equilibrium capital intensity and hence to a low labour requirement per unit of output”(Malinvaud, 1982). The above model, however, indicates that an increase in wages will result in a reduction in unemployment.

The business cycle has a positive relationship with unemployment. In terms of macroeconomics, when the economy expands, unemployment should decline. When the economy is experiencing staggering growth, unemployment should increase and the economy goes through the recession. The model above shows a positive relationship between GDP and business cycle. Unemployment and GDP have a positive relationship. This means an increase in unemployment will result in an

increase in economic growth. Macroeconomics, states that there should be a negative relationship.

Human capital has a negative relationship with GDP. According to literature, economic growth and human capital have a strong relationship. The skills and quality education play a critical role in improving economic growth (Hanushek, 2013).

Patents and intellectual property have positive coefficients, the relationship with GDP according to the model is positive. An increase in innovation results in an increase in economic growth. The coefficients have very small values. One unit increase in patents will cause a 0.031971 increase in GDP.

R-squared is 55.75% for unemployment as a dependent variable and this suggests that the model is well fitted. R-square is arguably high, indicating that more than 50% of independent variables jointly influence innovations in the dependent variable unemployment. 48.97.75% variation in GDP can be explained by the independent variables jointly. The other variation which is 51.03% can be explained by other residuals not included in this model. Adjusted R-squared for unemployment is 48.37% and for GDP is 38.76%. Adjusted R-squares are small as the variables are more and as more independent variables are added, this value will further decrease.

Durbin-Watson stat - the rule of thumb: if DW<2 equals evidence of positive serial correlation. For this model (unemployment), the Durbin-Watson stat is 2.711418, so the model does not have a serial correlation. Then again the GDP model has Durbin Watson stat that is 1.825002. It is almost 2, so there is some evidence of positive serial correlation.

Simultaneous covariance testing was done to investigate whether there are any correlations between SUR errors. The **residual correlation matrix** indicates that the correlation between the residuals is very small (2.49E-16) therefore the model is stable. **Residual covariance** (2.57E-20) also indicates that the error terms are not correlated.

4.7.1 Results of Portmanteau tests for Autocorrelations

Portmanteau autocorrelation test and correlograms were performed to test if the error terms have autocorrelation.

Table 9: Portmanteau test results

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	7.197961	0.1258	7.369341	0.1176	4
2	12.12366	0.1458	12.53531	0.1289	8
3	16.77529	0.1582	17.53582	0.1305	12
4	18.76856	0.2808	19.73352	0.2325	16
5	28.74928	0.0928	31.02750	0.0548	20
6	32.77451	0.1089	35.70547	0.0586	24
7	33.79080	0.2078	36.91938	0.1206	28
8	36.61719	0.2630	40.39179	0.1466	32
9	38.46860	0.3584	42.73328	0.2043	36
10	40.70423	0.4393	45.64638	0.2490	40
11	45.77021	0.3985	52.45378	0.1790	44
12	46.76069	0.5237	53.82768	0.2612	48

The probability values of the Portmanteau test are all more than 5%, therefore there is no autocorrelation relation between error terms. The null hypothesis which state that there are no residual autocorrelations up to lag h can be accepted.

4.7.2 Results of the normality test

The Jarque Bera normality test was done to measure the goodness of fit. This test was implemented to measure the deviation or movement away from normality, based on the sample kurtosis and skewness. Under the null hypothesis of normality, the statistic Jarque Bera has an asymptotic chi-square distribution with two degrees of freedom.

Table 10: Normality test results

	Unemployment			GDP		
		Chi-sq	Prob.		Chi-sq	Prob.
Skewness	0.442457	1.403005	0.2362	-0.210121	0.316414	0.5738
Kurtosis	2.772422	0.092794	0.7607	2.844682	0.043222	0.8353
Jarque-Bera	1.495798		0.4734	0.359636		0.8354

Skewness for unemployment mirrors normal skewness, for GDP the distribution is negatively skewed as per table 10. However values are close to zero, so the series is normally distributed. The kurtosis for both variables is less than three. The series is platykurtic, flatted-curve and has lower values below the sample mean.

The chi-square tests for independence, it tests if there is a significant association between two variables. The Jarque Bera normality test statistic shows that both series have a normal distribution. The p-values are greater than 5%. The null hypothesis is accepted that the residuals are multivariate normal.

4.7.3 Correlograms of Residuals

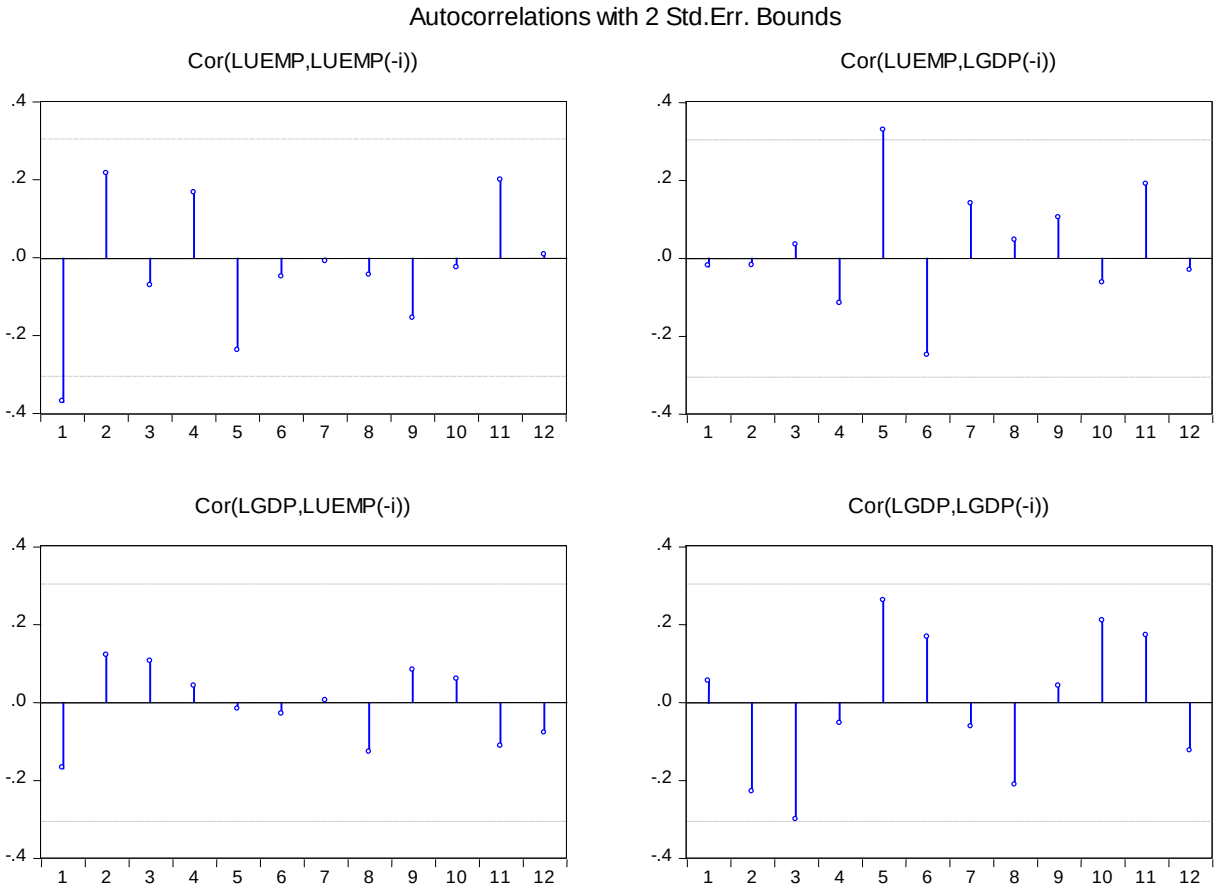

Figure 7: Autocorrelation graphical representation

There is no autocorrelation relation between error terms according to Portmanteau test result and correlograms table 9 and figure 7 above. All the probability values of the Portmanteau test are bigger than 0.05 and correlograms showing the graphical representation of autocorrelation are in the range of no autocorrelation. These tests indicate that the most optimal model was done, and the results of SUR can be relied upon.

4.8 Conclusion

This chapter presents the stationarity test results. The regression model was done and results analyzed. The OLS models proved to be unreliable to present meaningfull data, so the reasearcher had to conduct the seemingly unrelated regression modeling in order to cater for the error terms. The test measured whether the models are correlated or not and that the error terms are related to the models. The SUR model proved to be reliable so the model was used for forecasting.

- Innovation was measured by patents and intellectual property. There is an inverse relationship between unemployment and innovation. Individually, some of the independent variables are not significant, however, combined or jointly they are significant in explaining the dependent variables. More than 50% of the variables are statistically significant in explaining the dependent variables.
- The model indicates that there is a positive relationship between GDP growth and innovation as well as a positive relationship between GDP growth and unemployment.

The challenge with the study was incomplete data. South Africa only started measuring innovation index from 2007. GDP and unemployment are measured quarterly, the other indicators are measured annually. Innovation measured in a number of patents and intellectual property only have data from 2008. So the time span of the data is very short. Though the model was able to provide significant results.

5. Discussion and conclusion

5.1 Introduction

South Africa is a highly unequal society. Many South Africans are still poor with little access to basic services like good quality education, housing and health services, and unequal incomes. The quality of school education for the majority especially black communities is of poor quality and the government does not have the capacity in critical areas (NDP, 2012). South Africa as an emerging economy needs to look at different ways to improve its economic growth.

This chapter covers the discussion of the study results. Lastly, an action plan and further research recommendations are also provided.

5.2 Discussion

The results reported of the models analysed indicate that there is a positive relationship between economic growth and unemployment. Empirical findings from literature also reflect a relationship between economic growth and unemployment which in many cases is inverse. This study also highlighted that the relationship is most significant in conjunction with the other variables. Individually the relationship is insignificant. The ordinary least squares models were not adequate to forecast the test results. A seemingly, unrelated regression model was performed to cater for the error terms that exist in simultaneous equations.

Significant conclusions to be drawn from this study highlights the following;

Primarily, South Africa's economic growth rate and unemployment are responsive to the business cycle changes as when the economy is experiencing recession or boom. This is evident looking at the low GDP rates and high unemployment rates. Figure 4 of chapter 2 shows a decline in unemployment when GDP growth occurs. However this study shows a positive relationship as indicated in table 8 of chapter 4. The study indicates that reduction in unemployment levels will not increase economic growth. It

also highlighted that the unemployment variable is not significant in explaining the dependent variable GDP on its own, table 7 of chapter 4. Similarly, this study highlights that wages have a positive relationship with GDP and negative relationship with unemployment. It was also very significant in explaining both dependent variables. Prior literature states that when minimum wage is increased, unemployment will increase especially in the low skill sectors. When the forces of supply and demand are applied to minimum wages, there will be an increase in unemployment. “In any stationary state, when the investment is equal to zero, high real wage rate leads to high aggregate demand, but it also leads to high equilibrium capital intensity and hence to a low labour requirement per unit of output”(Malinvaud, 1982). Higher wages would mean, more disposable income available. Demand for goods and services will increase and this will boost the economic growth.

This study shows in table 8 of the previous chapter, that an increase in wages will cause unemployment levels to reduce. It is important to take into consideration that different sectors will respond differently when it comes to wages increase. Labour unions in South Africa have a prominent role. SA’s economy has been negatively impacted by the industrial actions especially the past ten years. Collectively, about 2.5 million working days were lost annually due to industrial action. Productivity is affected by strikes. The strikes are mostly about the minimum wages. Increase in wages has unintended consequences. The employers will tend to retrench employees in order to reduce the costs of employment. Increased minimum wages will also cause businesses to set up shop in countries where wages are lower. A number of companies in South Africa are already outsourcing some services to outside countries. A rise in unemployment also depends on the type of sector and the wages paid to the labour force. Unemployment can increase due to either cyclical or structural reasons. Therefore, unemployment and economic growth should not be measured in isolation of other variables such as wages, capital formation and human capital.

Secondarily, the study also demonstrates that patents and intellectual property increase have a corresponding influence on GDP and ultimately unemployment. Based on this study, when innovation measured by patents, as well as the intellectual

property goes up by 1 unit, unemployment will go down by 0.017 and 0.06 respectively provided other independent variables are constant (table 7 of chapter 4).

Innovation has a positive relationship with GDP growth and the relationship is negative with unemployment. The study revealed that if there is an increase in innovation then there will be a reduction in unemployment. The relationship between innovation and economic growth is very strong. Rensburg argues, “fluctuations in business activities caused by significant innovations have a great impact on investment and consumption spending and therefore on output, employment and the price level.”(van Rensburg et al., 2015).

The fourth industrial revolution poses a threat to low skilled based industries. Technology plays a significant role in automating a number of processes. Robots are quickly replacing humans in their jobs. To ensure that these revolutions do not have a negative impact on the society’s well-being a new set of skills needs to be learned such as coding, programming, data mining, leadership, etc. Structural changes in the economy can result in an increase in unemployment.

New products stimulate demand and supply in the economy. Innovation can improve the lives of the poor through the production of better products and services. The country’s banking services are already ranked high in the world. The telecommunication industry has had a great impact on how people communicate and provide services. Doctors are now able to perform remote surgeries. Mobile communication has made communication easy and affordable. Therefore, focusing on all sectors will also help the country to grow even further.

Lastly, capital formation also has an inverse relationship with unemployment. Investment in capital goods will reduce unemployment in that, demand for labour in building the machinery will increase and thus reduce unemployment. Investment in infrastructure will create job opportunities. So, South Africa needs to invest in areas like infrastructure in order to reduce unemployment levels in the country. Human capital has a positive relationship with unemployment according to this study. Figure 5 of chapter 4 demonstrations an increase in human capital for South Africa during the

observed period. This means that the skills, education, capacity and attributes of labour in influencing productivity and earning potential increased. This variable plays a serious part in reducing unemployment in South Africa.

According to literature, process innovation has both positive and negative effects. Employment tends to increase when technology and machinery are used—less workers are required. Innovation has a positive effect when new products are created. If there is no intervention in the economy, in the long run, that is, no investment on capital goods, the results may be a rise in unemployment. Net unemployment will increase if there is continuous technological change (Woirol, 1996). In the long run, the government needs to ensure that there are policies in place that guide against a rise in unemployment when there is continuous technological change.

South Africa is experiencing negative growth. Productivity is low. There is less capital investment and the amount of labour has seen little change much. The country was faced with retrenchments especially in sectors like manufacturing and mining. These sectors have the highest number of employees. During the financial crisis, TFP for SA dropped and resulted in about 0.7% points reduction in GDP (Greve, 2017). A growing economy is necessary for job creation and a sustainable system for social grants. Due to the limited national budget, it is critical that SA innovate more to improve the living standards of the poor.

The other challenge that the country faces is a shortage of skills. This issue starts with the standard of education in the country. The majority of South Africans are uneducated and those who have some form of education are trained in skills that are not critical for the advancement of the economy. A number of young graduates are unable to find unemployment. So the country needs to ensure that there is a big focus on crucial skills development.

The policy is already focused in the right direction, what is required is the implementation of the plans and strategies to improve economic growth. South Africa's academic excellence and strong urban networks of entrepreneurs, opportunities, and

innovation are being stifled by an unconducive business environment, expensive trading costs, and low skills base. All of these elements are impeding the growth of start-ups whereas elsewhere, young, high-growth firms known as “gazelles” are playing a leading role in innovation. Countries like China support entrepreneurship. The state provides financial support, and this is one of the reasons China’s economy has grown so rapidly. As an emerging market, South Africa needs to focus on innovating affordable products and services that will not only benefit the country but the world at large.

5.3 Further Research, Action Plans, and Recommendations

This study has highlighted that key variable such capital formation, business cycle, wages, patent and intellectual property directly determine the size of innovation to an extent that the level of employment to be generated by the growth in GDP is determined by these variables. Crucially the study reveals that direct correlation exists between innovation and unemployment, particularly in a developing country like South Africa with unique historical challenges such as inequality and unequal incomes. Examples of how innovation has transformed, transitioned and strengthened the economies of countries like China, the US, and some in Europe revealed the extent to which innovation cannot be taken lightly.

South Africa needs to consider the types of innovations that will promote economic growth. Radical and disruptive innovations yield great returns as in the cases of Facebook and Uber. Frugal innovation is also better suited for a country like South Africa, with limited resources and targeted at low income markets. Reverse innovation will help the country capture international markets and this will improve the economy of the country.

The country needs to consider the impact of minimum wage. Wages must also be compared to other emerging markets. If the cost of labour is too high, investors and businesses might take their businesses somewhere else. The number of strikes impact productivity of businesses and this has a potential of chasing businesses away from the country and as a result unemployment would rise.

The culture dimension was also argued, that it pervades education, social skills, organizational norms, public policy formulation and generally the interest in young people to cultivate the habit of generating new ideas. This study recommends that the continuous study of the state of the South African innovation landscape is compared to other economies in other developed countries in order to measure the country's innovation maturity.

In a future study, the researcher recommends that a larger sample should be taken for observation. Another recommendation is a study on how South African education influences the unemployment rate. To gain more insight into the behaviours of these variables and their causal effects, it should also be considered to conduct a causality study using the same data series. Results here can also be extended to other countries with the same characteristics as South Africa in order to ascertain if the behaviours of economic variables are the same across the board.

The culture of innovation should be encouraged in schools, at workplace, etc. to inculcate the culture of innovation in the South African society.

5.4 Conclusion

Innovation has been identified by this study as one critical and fundamental approach in overcoming the wicked problem of unemployment.

For sound economic management that is intended to create a stable economy evidenced by low prices, low unemployment and GDP growth, it is important to take care of these critical contributions of; Capital formation; Fair wages; Human capital; Good business cycles management; Patents and intellectual property so that there is effective integration of these variables to create the desired macroeconomic benefit of low unemployment.

Innovation must cut across all groups of South African society so that it creates the equilibrium and equality to achieve the macroeconomic benefits mentioned above.

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