SOUTH AFRICA'S HEADWINDS GOING INTO THE FOURTH INDUSTRIAL REVOLUTION

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ABSTRACT

Little is known about the growth prospects and headwinds South Africa may experience during the Fourth Industrial Revolution. This dissertation follows an inductive research approach and a sequential qualitative mixed method design. It employs an *inductive thematic analysis* to identify and explore the main headwinds South Africa's economic growth may face during the Fourth Industrial Revolution. A *comparative analysis* is conducted to compare the severity of these headwinds relative to Mauritius, Nigeria, Brazil, the United States, Switzerland, and Greece. The research aims to determine whether South Africa will be able to grow within the view of the Fourth Industrial Revolution. South Africa's main headwinds are identified as inequality, demographics, unemployment, education, and the COVID-19 economic shock. Inequality and education were found to be, relatively, most severe. The study concludes that, without addressing the existing headwinds, South Africa would not be able to exploit the economic growth opportunities presented by the Fourth Industrial Revolution.

Key terms:

Fourth Industrial Revolution; 4IR; Secular stagnation; Headwinds; Technological change; Economic Growth; South Africa; Demographic dividend; Productivity paradox; Technological unemployment

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ABBREVIATIONS

1IR	First Industrial Revolution
2IR	Second Industrial Revolution
3D	Three-dimensional
3IR	Third industrial revolution
4IR	Fourth Industrial revolution
AAL	Ambient assisted living
AARP	American Association of Retired Persons
AHA	Active and healthy ageing
AI	Artificial Intelligence
AIDS	Acquired Immunodeficiency Syndrome
AR	Augmented Reality
ARDL	Autoregressive Distributed Lag
ASCI	Accelerated Strategic Computing Initiative
BRICS	Brazil, Russia, India, China, and South Africa
CA	Comparative analysis
CAGR	Real Compounded Average Growth Rate
CCMA	Commission for Reconciliation, Mediation and Arbitration
CMIA	Credit Market Imperfection Approach Channel
CTT	Critical thinking in teaching
CWI	Current Workforce Index
DBE	Department of Basic Education
DLT	Distributed Ledger Technology
DoE	Department of Education
ECD	Early Childhood Education
EESI	Enabling Environment sub-Index
FRED	Federal Bank of St. Louis
FRED	Federal Reserve Bank of St. Louis
GCR	Global Competitiveness Report
GDP	Gross Domestic Product
GMM	System Generalised Method of Moment
GNI	Gross National Income
GPT	General purpose technology
GPT	General Purpose Technology
HEI	Higher Education Institute
HIV	Human Immunodeficiency Virus
ICT	Information and Communication Technology
ILO	International Labour Organisation
ISSI	Income Security Sub-Index
IMF	International Monetary Fund
IoT	Internet of Things
IT	Information Technology

ITA	Inductive thematic analysis
LCH	Life-cycle hypothesis
LFPR	Labour force participation rate
LLL	Lifelong Learning
LMDSA	Labour Market Dynamics in South Africa
LTC	Long-term care
MIT	Massachusetts Institute of Technology
ML	Machine learning
MR	Mixed reality
MTAR	Momentum Threshold Autoregressive
N-ARDL	Nonlinear autoregressive distributive lag
NASA	National Aeronautics and Space Administration
NCD	Non-communicable disease
NEDLAC	National Economic Development and Labour Council
NEET	Not in employment, education, or training
NGO	Non-governmental organisation
NHI	National Health Insurance
NICD	National Institute for Communicable Diseases
NIDS	National Income Dynamics Study
NTA	National Transfer Accounts
OAG	Old-age Grant
OECD	Organisation for Economic Cooperation and Development
OLS	Ordinary least squares
P2P	People-to-teacher ratio in primary education
PALMS	Post-Apartheid Labour Market Series
PGDA	Program on the Global Demography of Aging
PRB	Population Reference Bureau
PSLSD	Project for Statistics on Living Standards and Development
SA	South Africa
SACE	South African Council for Educators
SAIRR	South African Institute of Race Relations
SALDRU	Southern Africa Labour and Development Research Unit
SARB	South African Reserve Bank
SARB	South African Reserve Bank
SARS	South African Revenue Service
SASI	South African Savings Institute
SASSA	South African Social Security Agency
SBTC	Skill-biased Technological Change
SCW	Skills of the Current Workforce Index
SDG	Sustainable Development Goals
SFW	Skills of the Future Workforce Index
SI	Skills Index
SIFAR	Samson Institute for Ageing Research

SOLI	Standard of Living Identity
SSA	Sub-Saharan Africa
STATS SA	Statistics South Africa
STEAM	Science, Technology, Engineering, Art, and Mathematics
STEM	Science, Technology, Engineering and Mathematics
TFP	Total Factor Productivity
TVET	Technical and Vocational Education and Training
US	United States
UABA	United Africa Blockchain Association
UMIC	Upper-Middle Income Country
UN	United Nations
UNDESA	United Nations Department of Economic and Social Affairs
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations International Children's Emergency Fund
UNU-WIDER	United Nations University World Institute for Development Economics Research
UoT	Universities of Technology
VAT	Value Added Tax
VECM	Vector Error Correction Model
VR	Virtual reality
WEF	World Economic Forum
WIL	Work-integrated Learning

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CHAPTER 1 : INTRODUCTION

1.1. INTRODUCTION

In every economic discussion, there is always division. The question of whether the Fourth Industrial Revolution (4IR) will drive economic growth is no exception. Schwab (2017) described the 4IR as an amalgamation of technologies and the synergies they form across physical, digital, and biological spheres. This era, although in its early stages, is characterised by the emergence of technologies and innovations that are much faster than any of the previous revolutions.

Schwab identified the two opposing sides of the argument as 'techno-pessimists' and 'techno-optimists'. On the one hand, techno-pessimists argue that the largest impact of technology on growth has almost been fully realised. On the other hand, techno-optimists advocate the view that the best is yet to come (2017: 29).

According to Schwab, global growth was around five percent annually before the 2008 financial crisis. After the crisis, despite expectations of a growth recovery, global real gross domestic product (GDP) growth stagnated at around three percent. Some economists fear the possibility of a "centennial slump" or "secular stagnation", which can be defined as a "situation of persistent shortfalls of demand, which cannot be overcome even with near-zero interest rates". (2017:30).

FIGURE 1-1: SA'S REAL GDP PER CAPITA GROWTH RATE, 2002-2019
Compiled by researcher (2021)
Data from SARB (2019b)

As can be seen from **Figure 1-1**, South Africa's per capita economic growth was around four percent during the period 2005-2007. After 2007, economic growth declined significantly following the global financial crisis, and the subsequent Great Recession, which caused per capita economic growth to fall to -2,73 percent in 2009. South Africa's per capita economic growth behaved contrary to business cycle predictions, i.e., that a recession is followed by a boom. The South African economy showed an even weaker recovery than the global economy with an average growth rate of 0,39 percent over the period 2010-2019. South Africa's lagging growth could be symptomatic of a secular stagnation.

The remainder of this chapter will discuss the aim and objectives of the study; followed by the concluding remarks and outline.

1.2. AIM AND OBJECTIVES

In recent years, South Africa has experienced many disruptions while entering the 4IR. Average real GDP per capita has declined to near zero average growth rates over the past decade, and unemployment has soared to new heights. In the fourth quarter of 2019, unemployment, according to the strict definition, reached a decade-high of 29,1 percent (South African Reserve Bank [SARB 2020a]). Despite the 4IR's promise of growth miracles in some developing countries, South Africa has not recovered to pre-global financial crisis levels.

There is increasing interest in developing countries' growth potential during the 4IR. Although research has been conducted on the headwinds[1] to economic growth faced by the United States (US) (Hansen, 1939; Cowen, 2010; Gordon, 2014a), little is known about the growth prospects and headwinds South Africa may experience during the 4IR.

Gordon (2014a) argued that the recent slowdown in economic growth in the US was due to six well-known headwinds: inequality, demographics, education, repaying debt, globalisation, and energy/environment. However, the author recognised that developing nations still had room for catch-up growth - a situation

[1] Headwinds, within this context, refer to an economic variable which moves in the opposite direction of economic growth. It is therefore a force that slows down economic growth.

where developing countries grow faster than developed countries until per capita income converges - and would therefore need to be examined within their own contexts. The purpose of this dissertation is to determine whether South Africa will be able to grow within the view of the 4IR. The study intends to identify and explore the main headwinds South Africa's economic growth may face during the 4IR and compare the severity of these headwinds relative to other select developing and developed countries.

The following questions are set as guidelines to fill this aim:

1. What are the major headwinds to South Africa's economic growth during the 4IR?
2. How severe are South Africa's headwinds relative to other select developed and developing countries?
3. Will South Africa be able to exploit economic growth opportunities presented by the 4IR based on its current trajectory?

Research objectives:

Objective 1: Determine which major headwinds to economic growth South Africa will face during the 4IR.

A. Identify and analyse South Africa's major headwinds to economic growth during the 4IR.
B. Identify the channels through which the major headwinds could impact South Africa's economic growth during the 4IR.

Objective 2: Compare South Africa's major headwinds to economic growth during the 4IR with other select countries.

A. Collect and analyse data for selected developed and developing countries.
B. Evaluate the severity of South Africa's major headwinds relative to other developing and developed countries.

Objective 3: Conclude whether South Africa will be able to exploit economic growth opportunities presented by the 4IR based on its current trajectory.

A. Investigate the role of technological advancements in South Africa's economic growth.
B. Determine, given the outcomes of objectives one and two, whether South Africa will be able to realise its economic potential during the 4IR.
C. Identify and advise stakeholders on strategies to maximise economic growth in South Africa during the 4IR.

The findings of this study will redound to the benefit of South Africa considering that the 4IR will play an important role in country development during the coming decade. Increasing concerns about the ability of Africa to leapfrog into the 4IR justifies the need for research into the headwinds faced by developing countries. Thus, if South Africa applies the recommended strategies derived from the results of this study, it will be able to better prepare for the 4IR. The study will make recommendations to the South African government to maximise economic growth during this era.

1.3. OUTLINE OF THE STUDY

South Africa's stagnating economic growth figures prompt an investigation into whether it will grow during the 4IR. The purpose of this dissertation is to: first, determine which main headwinds to economic growth South Africa will face during the 4IR; second, to compare these headwinds relative to other select developed and developing countries; and finally, conclude whether South Africa will be able to exploit economic growth opportunities presented by the 4IR based on its current trajectory.

The study will be presented as follows:

Chapter 2 describes the design and methodology.
Chapter 3 provides a background to the 4IR.
Chapter 4 discusses the productivity paradox.
Chapter 5 explains the significance of the headwinds to productivity.
Chapter 6 analyses the first headwind: inequality.
Chapter 7 analyses the second headwind: demographics.
Chapter 8 analyses the third headwind: unemployment.

Chapter 9 analyses the fourth headwind: education.

Chapter 10 discusses the fifth, and final, headwind: the COVID-19 economic shock.

Chapter 11 conducts a comparison study of the headwinds.

Chapter 12 discusses the results.

Chapter 13 concludes the study.

CHAPTER 2 : DESIGN AND METHODOLOGY

2.1. INTRODUCTION

The previous chapter introduced the aims and objectives of the study. It is therefore necessary to address the manner in which these objectives will be addressed.

Chapter 2 will explain the particular design of the study, followed by the methodology that will be employed in order to answer the research questions. The remainder of the chapter will discuss the assumptions and delimitations of the study; followed by the conclusion of the chapter.

2.2. RESEARCH DESIGN

The current dissertation takes on a positive economics paradigm. In order to develop a fitting theoretical argument for South Africa's unique economic circumstances, an inductive approach is needed. The research type is exploratory and descriptive.

This dissertation combines qualitative methods to make inferences. More specifically, it follows a sequential qualitative mixed method (QUAL → qual) design. Morse defined qualitative mixed methods as a situation where "one of the components is complete and forms the theoretical base and the other component supplements the core component" (2010: 491). This form of design is used because the researcher must follow up on the initial exploratory findings made when addressing research question two, i.e., the identification of the major headwinds in South Africa are followed up by investigating its comparative performance with other countries.

Creswell (2011) argued that mixed methods refer to the use of both qualitative and quantitative methods. However, Morse (2010) argued that mixing a comprehensive qualitative method with a supplementary qualitative element qualifies as a valid mixed method design.

Holmes (2006) argued that paradigms cannot be mixed because of their rigid boundaries and, because of the strong link between paradigms and research designs, a mixed method design is impractical. However, Johnson & Onwuegbuzie (2004) maintained that various research method could be associated with a specific paradigm and that a delinking of paradigms had taken place.

The current dissertation uses two qualitative methods, the inductive thematic analysis (ITA) and comparative analysis (CA). Morse (2010) noted that the sequential supplemental qualitative component (→*qual*) is employed to respond to minor questions that have emerged from the fundamental research. The CA is added to the current dissertation because research question two emerged from the core project, the ITA, when answering research questions one and three. Furthermore, in a *QUAL→qual* study, the supplementary element cannot be performed independently. Similarly, the *→qual* component, or CA, cannot be performed independently because the headwinds must first be identified before they can be compared.

2.3. METHODOLOGY

The current dissertation uses two methodologies:

2.3.1. INDUCTIVE THEMATIC ANALYSIS

In order to address the first research question, i.e., determining and analysing the major headwinds to South Africa's economic growth during the 4IR, a qualitative ITA is implemented. This type of approach permits the data to determine the themes (Denzin and Lincoln, 2005).

Guest, MacQueen & Namey (2012) described ITA as a process which starts with reading through the written data in order to identify themes. Once these themes are identified, they are coded. Thereafter, the structure and contents of the theme is interpreted.

Figure 2-1 summarises the methodology the current dissertation follows to answer research question one. The first step entails reviewing the literature and identifying and coding the headwinds. Once this is done, a framework can be created for the headwinds to be identified. In step three, qualitative data is collected for each headwind. Once the data is analysed, the researcher can identify and analyse which headwinds are deemed major. The researcher can then proceed to report and analyse the results based on the literature reviewed and data analysed within the identified headwinds.

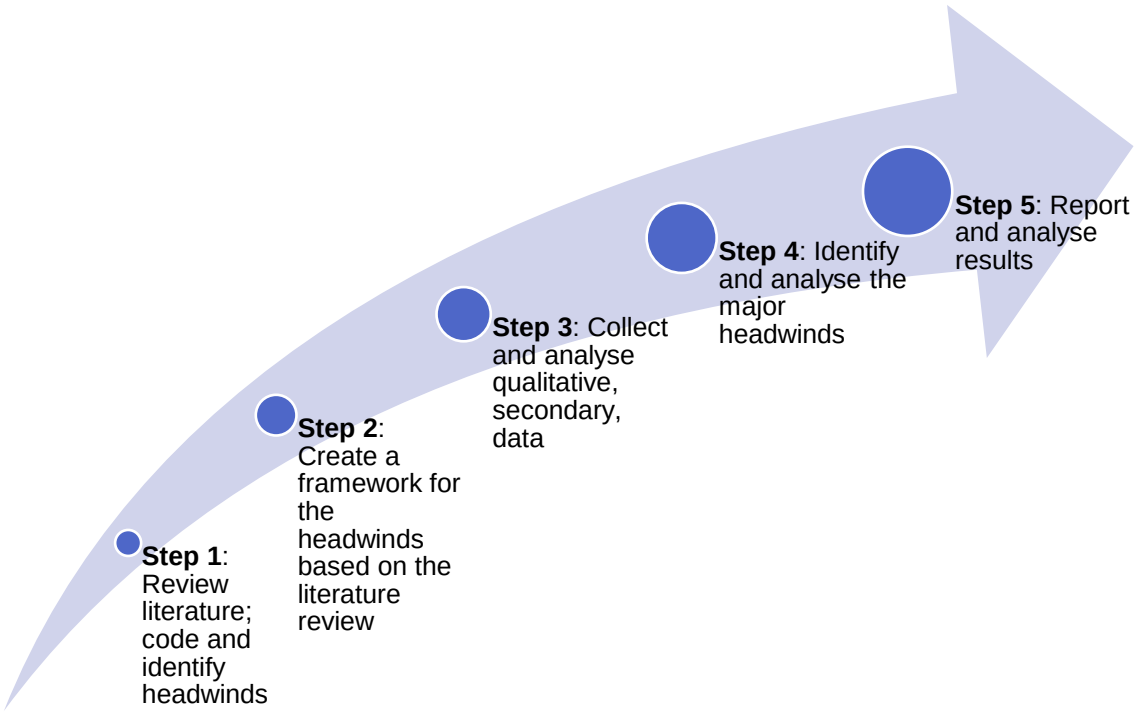


FIGURE 2-1: QUALITATIVE METHODOLOGY
Compiled by researcher (2021)

2.3.2. COMPARATIVE ANALYSIS

This section deals with the methodology used to answer research question two, i.e., comparing South Africa's major headwinds to economic growth with select developing and developed countries. In order to pursue the second objective, a qualitative CA will be conducted.

Esser and Vliegenthart (2017) described comparative research as the process of contrasting various units at macro-level. It attempts to make inferences that go

beyond single cases and highlights similarities and differences between the objects being analysed. It additionally attempts to find relations between these objects within their respective contextual circumstances.

Comparing countries can be tricky since nations and cultures are dissimilar (De Vaus, 2012). Conversely, Esser and Vliegenthart (2017) argued that CAs enhance understanding by placing familiar structures and practices against other structures; enables the researcher to contrast; and gives access to more options and solutions.

Once research questions one and two have been answered, the primary research question can be answered based on the outcomes, i.e., whether South Africa will be able to exploit its economic growth opportunities during the 4IR.

2.3.3. Sample and Data

To conduct the CA, South Africa – an upper-middle income country (UMIC) - will be compared with other developing and developed countries within the parameters identified as the major headwinds in research question one.

In order to compare South Africa within the parameters identified as major headwinds, three developing and three developed countries are chosen.

Brazil, also a UMIC, is chosen as the second developing country due to its economy's similarities to South Africa's. Nigeria is chosen due to its large economy – which competes head-to-head with South Africa in Africa – and to add a lower-middle income economy to the comparison.

The final developing country in the sample is Mauritius. It should be noted that Mauritius was classified as a UMIC during the initial phases of conducting the current study. Until recently, Mauritius and South Africa competed in becoming the next developed country in Africa after Seychelles. In July 2020, Mauritius was declared a high-income country by the World Bank (Serajuddin and Hamadeh, 2020). However, for the purpose of this study, Mauritius will be viewed as a UMIC since the data collected pertains to periods prior to July 2020.

South Africa will also be compared to select developed countries. Switzerland is chosen due to its advanced, aged, population and competitive leadership; the US is chosen as a developed country outside Europe with fewer similarities to Switzerland. However, Switzerland and the US are global top performers. Therefore, Greece is added to the comparison because of its decade-long struggle to recover from the Great Recession following the global financial crisis and the European Sovereign debt crisis.

Once the headwinds have been established, secondary data from publicly available sources will be obtained to compare the selected countries within the parameters of the headwinds. Because countries differ in releasing data, the most recently available data will be sourced.

2.4. ASSUMPTIONS

The study identifies various channels through which each headwind could impact economic growth. It assumes that these channels are present and thoroughly explains the impact of each headwind on economic growth in South Africa. Most of the literature on the 4IR concerns the US and other developed countries. For the purpose of this dissertation, it is assumed that the impact of the 4IR will be similar, unless stated otherwise.

2.5. DELIMITATIONS

The current study is limited by the sample of countries compared. The qualitative nature of the study limits the sample size and can be time-consuming. Additionally, the study's focus is primarily on South Africa. This means that the recommendations cannot be applied to other developing countries.

2.6. CONCLUSION

The current dissertation takes on a positive economic paradigm by means of an inductive approach. The research type is exploratory and descriptive and follows a sequential qualitative mixed method (QUAL → qual) design. Research question one will be addressed using an ITA; and research question two will be addressed

using a CA. Research question three will be answered given the outcomes of research questions one and two.

Chapter 3 provides the necessary background to the 4IR.

CHAPTER 3 : THE FOURTH INDUSTRIAL REVOLUTION

3.1. INTRODUCTION

In Chapter 2, the methodology behind the study was described. Chapter 3 dives deeper into the background of the 4IR. While there has been significant interest in the academic literature on the 4IR in the past decade, intensive research efforts only gained momentum after Klaus Schwab, founder, and chairman of the World Economic Forum (WEF), coined the term in his book, *The Fourth Industrial Revolution,* in 2016. However, there have been noteworthy breakthroughs since in the theoretical comprehension of the 4IR.

Chapter 3 reviews the background of the 4IR. Important concepts that make up the 4IR are defined and discussed. The chapter starts by providing a history of the industrial revolutions up to the 4IR. The three main characteristics are then explained and analysed. Thereafter, the expected impact and complementary fear of technology are explained.

3.2. THE INDUSTRIAL REVOLUTIONS

Humanity, and economies, have been revolving throughout its existence. The first noteworthy revolution of modern times was the First Industrial Revolution (1IR). According to Schwab (2017), this revolution extended from 1760 to 1840. It was activated by the creation of hydropower, and ultimately the steam engine. For the first time in history, mass production was possible. Around 1870, electricity allowed the possibility of assembly lines; and the Second Industrial Revolution (2IR) was born. In the 1960s, semiconductors and mainframe computing initiated the Third Industrial Revolution (3IR) or Digital Revolution. These technologies laid the groundwork for personal computers and the internet, which in turn laid the foundation for the next chapter of human development: the 4IR.

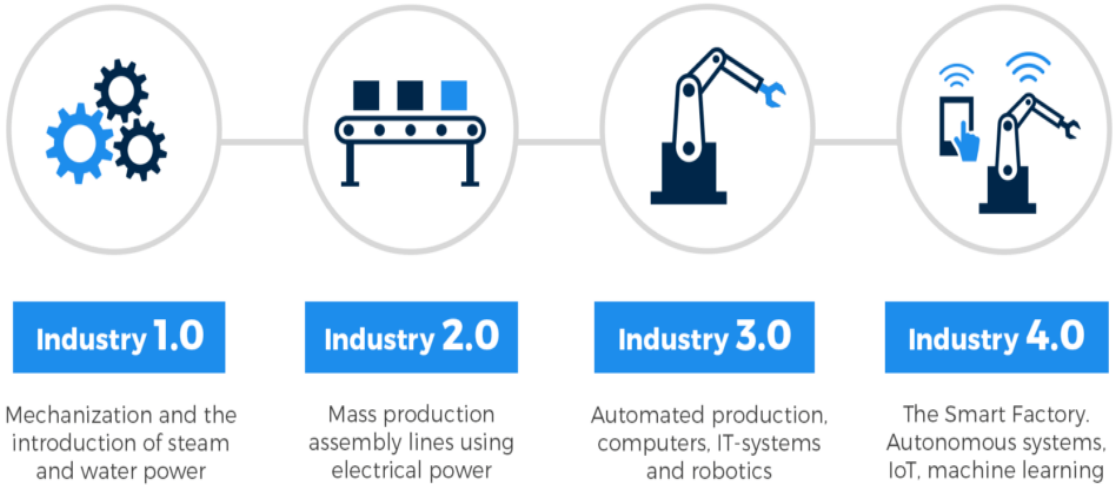


FIGURE 3-1: THE INDUSTRIAL REVOLUTIONS
Sourced from Pluto-men (2020)

Figure 3-1 illustrates the production methods and technologies characteristic of each revolution. Production in the 4IR is characterised by - amongst others - smart factories, autonomous systems, the internet of things (IoT) and machine learning (ML). A more comprehensive definition and analysis of the key characteristics of the 4IR follows.

3.3. THE 4IR

According to Lasi, Fettke, Kemper, Feld & Hoffmann "Industry 4.0[2]" describes different – primarily IT driven – changes in manufacturing systems" (2014: 241). As can be recalled from Chapter 1, Schwab (2017) described the 4IR as an amalgamation of technologies and the synergies they form across physical, digital, and biological spheres. This era, although in its early stages, is characterised by the emergence of technologies and innovations that are much faster than any of the previous revolutions.

Schwab characterised the 4IR by its "much more ubiquitous and mobile internet, by smaller and more powerful sensors that have become cheaper, and by artificial intelligence and machine learning" (2017: 7). McAfee and Brynjolfsson (2018) referred to this era as the 'second machine age' which started its first phase in

[2] Industry 4.0 is a carbon-copy for the 4IR. The coin was termed in Germany at the 2011 Hannover Fair to describe the revolutionary changes planned for global value chains (Schwab, 2017).

the late 1990s – the authors believe that we entered the second phase somewhere in the past decade.

The 4IR is said to create opportunities for economies that have benefited from the previous three Industrial Revolutions to continue to advance human development; and to improve the lives of those that have missed out on the previous revolutions (Schwab and Davis, 2018). Moreover, global improvement in freedom, health and education can be expected if technologies are accompanied by appropriate institutions, standards, and norms.

According to Schwab (2016), the velocity, scope and impact on systems indicate that the 4IR is not simply an extension of the 3IR. While other revolutions moved at a linear pace, this one moves exponentially. It disturbs industries globally and alters systems of production, management, and regimes.

3.3.1. Moore's Law

The first important characteristic of the 4IR is its velocity. In 1965, Gordon Moore wrote that transistors in lower-cost integrated circuits doubled every year. This became known as Moore's law and explains the reasoning behind the 4IR's velocity. Nowadays, an 18-month period is more commonly accepted for doubling to take place. In other words, there is a rapid and consistent doubling of technological advancements (Brynjolfsson and McAfee, 2011).

According to Brynjolfsson and McAfee (2011), Moore's law was best explained by innovator and futurist, Ray Kurzweil, who adapted an ancient story to the present day. In his story, the inventor of chess presents his innovation to the emperor. Impressed by the innovative idea, the emperor offers him a reward of his choice. The inventor asks for an amount of rice cunningly calculated as follows: a single grain of rice is to be positioned on the first square of the chessboard; on the next square the amount is doubled; and each additional square receives double the grains of the preceding square. The emperor agrees to this seemingly small quantity of rice. However, when the quantity of rice is calculated, he realises that the inventor would walk away with a bag of rice bigger than Mount Everest. The inventor was sadly beheaded.

Just like the grains of rice, digital technologies are growing at an exponential rate. It may not have seemed significant when the grains of rice on the first few squares were doubled, but it quickly grew to an enormous amount on the second half of the chessboard. Exponential growth is therefore misleading because of its insignificant preliminary effect. As time passes, incredible exponential growth in digital technologies will be observed.

Perhaps the best real-life example of Moore's law and its impact was given by Brynjolfsson and McAfee:

> *"The ASCI Red, the first product from the US government's Accelerated Strategic Computing initiative, was the world's fastest supercomputer when it was introduced in 1996. It cost $55 million to develop and its one hundred cabinets occupied nearly 1,600 square feet of floor space (80 percent of a tennis court) at Sandia National Laboratories in New Mexico. Designed for calculation-intensive tasks like simulating nuclear tests, ASCI Red was the first computer to score above one teraflop—one trillion floating point operations per second—on the standard benchmark for computer speed. To reach this speed it used eight hundred kilowatts per hour, about as much as eight hundred homes would. By 1997, it had reached 1.8 teraflops.*
>
> *Nine years later another computer hit 1.8 teraflops. But instead of simulating nuclear explosions, it was devoted to drawing them and other complex graphics in all their realistic, real-time, three-dimensional glory. It did this not for physicists, but for video game players. This computer was the Sony PlayStation 3…"*
>
> (2016: 49)

Moore's law is important in explaining the velocity of the 4IR. The exponential growth in technological capabilities, which we are currently experiencing during the "second half of the chessboard", is causing exponential growth in the skills and knowledge we need to acquire in order to keep up.

3.3.2. SCOPE

The scope of the 4IR can best be explained by the disruptive nature of *General Purpose Technologies* (GPTs). Brynjolfsson and McAfee defined GPTs as "a small group of technological innovations so powerful that they interrupt and

accelerate the normal march of economic progress. Steam power, electricity, and the internal combustion engine are examples of previous GPTs." (2011: 14). The authors further noted that, in line with Moore's law, GPTs improve over time and result in complementary innovations. GPTs do not only profit their domestic markets. Computers, for instance, are used in almost every industry.

The breadth and depth of the 4IR can be credited to the combination of "multiple technologies that are leading to unprecedented paradigm shifts in the economy, business, society, and individually" (Schwab, 2017: 3). Schwab and Davis (2018) identified four categories of technologies that are expected to change not only industries, but also the course of history and all aspects of human life.

3.3.2.1. EXTENDING THE DIGITAL REVOLUTION

The 3IR initiated the development of computers, software developments, personal computers, and the internet. These technologies form the foundation of many new technologies, characteristic of the 4IR.

An example of the significant changes that are expected is the advances in quantum networks. A team of Dutch researchers at the Delft University of Technology are currently connecting four Netherland cities with quantum internet. It will be the first network to send information between cities using quantum methods, and the messages will be entirely unhackable. A global quantum network is expected in the next decade (Juskalian *et al.*, 2020).

3.3.2.1.1. NEW COMPUTING TECHNOLOGIES

> *"At the heart of advances in computing lie innovations in materials, assemblies and architectures that we use to process, store, manipulate and interact with information. These cluster into fields, such as centralised cloud computing, quantum computing, neural network processing, biological data storage, optical and mesh computing."*
>
> (Schwab and Davis, 2018: 77)

Computing technologies are threatened by the physical limitations of constant reductions in transistor size and costs (Moore's law); in addition, Dennard's law -

i.e., increasing speed and decreasing the use of power in transistors - has already come to an end. There are also several other limitations - such as speed, proximity, and energy requirements – which amplifies the attractiveness of alternatives, including quantum computing, photonics and mesh computing (Schwab and Davis, 2018).

Quantum computing is so powerful that it can solve problems that the most powerful supercomputer will take thousands of years to solve. For instance, Google used a 53 qubits quantum computer to do a calculation in a little over three minutes. Conversely, the biggest supercomputer would have taken 10 000 years to solve the same calculation. However, the next step is for Google to add more qubits – which makes it harder to maintain the delicate quantum state of these computers – before more useful calculations can be solved (Juskalian *et al.*, 2020).

3.3.2.1.2. BLOCKCHAIN AND DISTRIBUTED LEDGER TECHNOLOGIES

In 2008, Satoshi Nakamoto[3] published a paper that significantly transformed payment technology using blockchain or distributed ledger technology (DLT). It used mathematics, cryptography, computer science and game theory; and led to the first digital currency (Schwab and Davis, 2018). Nakamoto posted an online paper named “Bitcoin: A Peer-to-Peer Electronic Cash System”. It this paper Nakamoto questioned why online payment systems were so different from cash payment systems. i.e., why do online payments involve intermediaries, transaction fees and disclosure of identity? On the other hand, cash payments are direct (no third party involved), free and anonymous (you do not need to present your identity document) (McAfee and Brynjolfsson, 2018). Nakamoto’s paper led to the eventual birth of Bitcoin and blockchain technology.

Bitcoin’s volatility contradicted two of the most important functions of money: the means of exchange and the store of value. However, although it became clear that Bitcoin was not destined as a currency, the value of the underlying innovation

[3] Between 2008 and 2010 Nakamoto posted pseudonymous ideas via e-mails and blog posts. Nakamoto remains anonymous with a net worth in 2016 of around $600 million or almost a million BTC (Bitcoin trading acronym) (McAfee and Brynjolfsson, 2018).

became apparent. It was blockchain technology that would change the world as we know it, not Bitcoins (McAfee and Brynjolfsson, 2018).

According to Schwab and Davis (2018), blockchain technology is a type of a distributed digital ledger that enables the safe sharing of digital information and records. McAfee and Brynjolfsson (2018) added that blockchain could in future be used for all kinds of things, such as the transfer of ownership and issuing of company shares.

Blockchain is “open, transparent, global, flexible, and immutable ledger is clearly valuable, especially if it is combined with smart contracts and other digital innovations” (McAfee and Brynjolfsson, 2018: 299). Furthermore, the authors noted that blockchain technologies have sparked innovation and entrepreneurship; and offers the opportunity to decentralise transactions for those who believe that large firms and banks have become too powerful.

In 2019, Facebook announced its plans for a global digital currency, the Libra. However, the Libra was severely criticised because of its potential to increase the disproportionate power the US has over the international financial system. It is said that, if Facebook continues with its plan, China will react to the Libra by globalising its own digital currency, the Renminbi (Juskalian *et al.*, 2020).

In South Africa, the South African Financial Blockchain Consortium was established to educate and bring forth the benefits of blockchain technology to the financial industry. BlockNews Africa (2019) estimates South Africa as not only one of the largest cryptocurrency markets in Africa, but also in the world. The blockchain and cryptocurrency ecosystem in South Africa consists of education and consulting start-ups, such as Bitcoin Events, CoinEd, and the United Africa Blockchain Association (UABA); and cryptocurrency exchanges, such as Luno, Zar X, Xago, VALR, ChainEx and Chankura. These start-ups are seeing significant growth despite the lack of regulation. For instance, South African founded, Luno registered one million new users in 2019 and already has offices in South Africa, Nigeria, Indonesia, Malaysia, and Singapore. It employs more than 300 employees. Paxful, a peer-to-peer Bitcoin marketplace, saw a 2000 percent growth in South African trading volumes in October 2019 compared to

October 2018. South Africa also founded the first ripple exchange in Africa - the Xago.

3.3.2.1.3. THE INTERNET OF THINGS

> *"Imagine this scenario — you are on your way to hold a presentation in front of your whole department when you are suddenly stuck in a traffic jam that seems to go for miles.*
>
> *Nothing to worry about.*
>
> *New technologies will help your phone detect the delay and send information to your work computer. It will find the best time to reschedule the meeting and send notifications to your colleagues, so they don't just sit and wait to no avail. In the meantime, your car will adapt to the current traffic situation and optimise your fuel consumption."*
>
> (Nick G., 2020: para. 26)

The IoT refers to the relationship between things and people made possible by connected technologies and platforms. It consists of various smart and connected sensors that accumulate and transfer data (Schwab, 2017).

James (2019) reported that the IoT is expected to see major developments as cloud computing is being overtaken by edge computing. In the past, raw data from various devices were transferred to a cloud. Edge computing places storage devices within a close area that gathers, sorts, and filters the data before transferring it to the cloud – speeding up the process significantly. The Google Waymo – better known as the self-driving car - is the epitome of the IoT. It involves ML, artificial intelligence (AI) and edge computing - combined to operate the car and analyse its surroundings. These are just some of the developments in the IoT that will change the world as we know it.

South Africa has seen its own IoT inventions that offer a glimmer of hope to the tech industry. To motivate secondary students in South Africa to pursue science, technology, engineering, and mathematics (STEM) careers, Judi Sandrock and Bjarke Gotfredsen experimented with modularising computer chips in 2008 that needed no soldering to connect – improving the safety of learners. Little did they know that these xChips would trade globally a few years later under their start-up

Xinabox[4]. These affordable and reusable xChips are not only used in schools in the US and South Africa, but in 2020 it was sent on board the unmanned Northrop Grumman NG-13 Launch Vehicle from the National Aeronautics and Space Administration (NASA) to collect data. In addition, an XinaBox kit was placed in the Antarctic to monitor and report data to an IoT podium (TalkIoT, 2020).

3.3.2.2. THE PHYSICAL WORLD

Schwab and Davis (2018) explained that digital infrastructure forms the foundation for technologies that produce materials. The major technologies of the physical world are discussed below:

3.3.2.2.1. ARTIFICIAL INTELLIGENCE & ROBOTICS

Schwab and Davis (2018) noted that AI has seen significant improvements in recent years due to advances in ML. AI technologies include computer vision, audio processing and natural-language processing (Schoeman, Moore, Seedat & Chen, 2017). Furthermore, robotics has advanced to near-human level due to the advances in AI - it is not surprising that ethical concerns are increasingly raised.

There are various significant advances in AI. One such advance is the development of tiny AI. The problem with AI is that the constant development of new algorithms requires increasing data, computing power, and cloud services. It not only limits the speed and privacy of AI applications, but it generates significant amounts of carbon emissions. The solution to this is to develop algorithms that can shrink deep learning models and simultaneously maintain its abilities, otherwise known as tiny AI. In 2019, Google announced that its Google Assistant can run on a smartphone without making requests to a remote server; Siri's speech recognition capabilities are already running locally on the iPhone; and IBM and Amazon offer developer platforms for developing and deploying tiny AI (Juskalian *et al.*, 2020).

[4] Pronounced "X-in-a-box".

3.3.2.2.2. ADVANCED MATERIALS

New materials are being designed that have been unimaginable not so long ago. According to Schwab (2017), these materials are mostly lighter, tougher, biodegradable and adaptive. For instance, graphene is about 200 times stronger than steel, but a millionth the thickness of a human hair.

3.3.2.2.3. ADDITIVE MANUFACTURING & MULTIDIMENSIONAL PRINTING

Although three-dimensional (3D) printing is still a niche invention, it is slowly becoming mainstream and could possibly change supply chains forever. In future, products will still be sourced digitally from abroad, but the 3D printer will make it possible to print the digital design locally. One concern of additive manufacturing techniques is the ownership of designs and inventions (Schwab and Davis, 2018).

In South Africa, 3D-printing has already opened doors for breakthrough innovations. In 2019, Professor Mashudu Tshifularo and his team at the University of Pretoria pioneered the first transplant of 3D-printed middle ear bones. This ground-breaking procedure may be the solution to conductive hearing loss (South African Government, 2019).

3.3.2.3. ALTERING HUMAN BEINGS

Technologies are becoming part of human beings. Digital technologies may soon be integrated into the human body (Schwab and Davis, 2018).

3.3.2.3.1. BIOTECHNOLOGIES

Biotechnologies – the use of biology to improve lives – are increasingly changing human beings. These technologies are set to significantly impact precision medicine, agriculture, and biomaterial production. For instance, scientists are planning gene-drives that could possibly eliminate or reduce Malaria in Africa (Schwab and Davis, 2018). A new drug that slows down the ageing process is currently being trialled on humans. Although it will not promote longevity yet, it

will be able to treat illnesses by slowing down an important part of the ageing process (Juskalian et al., 2020).

In recent years, nine-year old Mila Makovec was diagnosed with an illness due to an inimitable genetic mutation. Mila received a drug tailor made for her within a year. The drug, Milasen, was named after her. Although not a cure, it seems to have stabilised her condition. These types of new medicines – gene replacement, gene editing, or antisense - offer treatments that were not possible in the past (Juskalian *et al.*, 2020). However, there are also various ethical concerns raised, such as the safety of a trial on only one child; and the question of who decides which children are helped (those with money or those without?).

3.3.2.3.2. NEUROTECHNOLOGIES

According to Schwab and Davis, Neurotechnologies can be defined as "a wide set of approaches that provide powerful insights into the workings of the human brain, allowing us to extract information, expand our senses, alter behaviors and interact with the world" (2018: 167).

3.3.2.3.3. VIRTUAL & AUGMENTED TECHNOLOGIES

> *"…virtual reality (VR) is already here and soon may be a suitable alternative. It can create immersive experiences, such as visiting the battlefields of the Napoleonic Wars, following in the footsteps of Columbus or walking through the Jurassic among brachiosaurus and tyrannosaurus rex. Less immersive than VR, augmented reality (AR) and mixed reality (MR) brings layers of data, information and virtual objects into real environments."*
>
> (Schwab and Davis, 2018: 177)

VR, AR, and MR is expected to foster empathy and assist people with sensory needs. It may also expand educational tools. However, privacy and accessibility issues are some of the concerns that have been raised.

3.3.2.4. INTEGRATING THE ENVIRONMENT

Schwab and Davis explained that the 4IR will be characteristic of technologies that "enable infrastructure development, perform global systems maintenance and open up new pathways for the future." (2018: 72).

3.3.2.4.1. ENERGY CAPTURE, STORAGE & TRANSMISSION

> *"The first and second Industrial Revolutions were built on energy sector transitions, first to steam and then to electricity. Now, at the beginning of the Fourth Industrial Revolution, the energy sector is on the brink of another historic transition as fossil fuels give way to renewable energy sources. Clean energy technologies and improved storage capabilities are moving from laboratories to factories and markets, and with a broad coalition of countries investing in potential history-changing breakthroughs, such as nuclear fusion, a new energy future could be on the horizon."*
>
> (Schwab and Davis, 2018: 195)

The increased accessibility of clean and inexpensive energy could benefit both the environment and developing countries – where electricity is often either unstable or non-existent (Schwab and Davis, 2018).

3.3.2.4.2. GEOENGINEERING

Schwab and Davis defined geoengineering as "the idea that humans can deliberately and successfully control the behavior of Earth's highly complex biosphere." (2018: 203). Geoengineering proposals include the fitting of colossal mirrors in the stratosphere that will rebound the sun's rays; increasing rainfall by chemically seeding the atmosphere; and removing carbon dioxide from the air with enormous machines.

It should be noted that human interventions with nature could have disastrous effects for humanity. It is, therefore, a controversial issue that must not be taken lightly. However, any attempt to fight global warming is likely to make use of some type of technology. For instance, it took the World Weather Attribution ten days after tropical storm Imelda to announce with near certainty that climate change played a role in the natural disaster. This was done by using high-resolution

computer simulations to compare scenarios where climate change occurred with scenarios where it was absent (Juskalian *et al.*, 2020).

3.3.2.4.3. SPACE TECHNOLOGIES

According to Schwab and Davis (2018), space technologies have reached a crossroad. Most significantly, private companies, such as SpaceX and Blue Origin, have entered the industry and promise large investments in space explorations and commercialisation. Noteworthy advances in aerospace technologies, astronomical observation capabilities, microsatellite development, nanomaterials, 3D printing, robotics and machine vision makes the possibility of historical advances in space technologies much more realistic.

Sending a four ton communication satellite into space cost $200 million during the space shuttle era. Nowadays, SpaceX manufactures a 227kg satellite (SpaceX Starlink), and a SpaceX Falcon 9 can be launched for $1240 per pound. SpaceX started sending 60 Starlink satellites to space every second week in 2020, and OneWeb planned to send up 30 satellites in 2020. These satellites could blanket the earth with fast internet access to even the poor. However, concerns have been raised about its ability to disrupt astronomy research and the possibility of space debris if they collide (Juskalian *et al.*, 2020).

3.4. SYSTEMS IMPACT

The third distinguishing factor of the 4IR is that it transforms entire systems between and across nations, firms, industries and societies (Schwab, 2017). Schwab and Davis (2018) added that the technologies of the 4IR are greatly altering and extending systems. These technologies entail and are based on the digital abilities and networks invented during the 3IR. However, it should not be misunderstood that the 4IR's technologies are merely extensions of the 3IR.

> *"The critical difference is that the Fourth Industrial Revolution technologies promise to disrupt even today's digital systems and create entirely new sources of value, turning the breakthroughs in digital technologies that organizations are struggling to make sense of today into the core infrastructure that business models will take for granted tomorrow."*
>
> (Schwab and Davis, 2018: 20)

3.5. IMPACT

In order to prepare for the 4IR, it is crucial to understand the impact it will have on economies, firms, governments, society and individuals. Schwab (2017) predicted that "empowerment" is likely to cause the largest impacts on them. Therefore, the 4IR will change how economies, firms, governments, society, and individuals relate to their stakeholders. Empowered parties must understand that collaboration will be the most effective interaction tool.

According to Schwab (2017), although all the major macroeconomic indicators will be impacted, growth and employment are expected to be impacted most severely.

The 4IR poses many opportunities for developed and developing countries, such as:

- reducing barriers between innovators and markets;
- economic expansion;
- new job titles;
- integrated disciplines;
- improved quality of life;
- advanced connectivity;
- increased global income;
- efficiency and productivity;
- safer and fruitful employment opportunities; and
- cross-cultural unity through social media.

(Schwab, 2017; Xu, David & Kim, 2018)

However, it also poses several challenges, such as:

- rising inequalities;
- talent-demand that causes social tension;
- unrealistic expectations of the individual created by social media;

- extreme ideologies carried by social media;
- labour market disruptions;
- cyber-attack vulnerabilities, hacking and security threats;
- evolving security threats;
- disruptions in key industries, such as health, education, and business;
- ethical concerns raised by emerging technologies;
- controlling the externalities of the 4IR in terms of the hazards and destruction that it may cause; and
- warranting that the 4IR is human-led and human-centred.

(Schwab, 2017; Schwab and Davis, 2018; Xu, David & Kim, 2018)

3.6. TECHNO-PHOBIA

It is not surprising that the 4IR would be accompanied by technological anxiety. Mokyr, Vickers & Ziebarth (2015) explained that technological anxiety, or techno-phobia, can be divided into three main categories. The first two relate to the techno-optimists' (Brynjolfsson and McAfee, 2016; Schwab, 2017) viewpoint that technology will continue to expand and accelerate: first, technology will substitute labour for machines – causing technological unemployment and increased inequality; second, anxiety stemming from the moral implications of technological advancements.

The third concern relates to the techno-pessimistic viewpoint that the era of technological progress has come to an end. Techno-pessimists (Cowen, 2010; Vijg, 2011; Gordon, 2014a) argue that the greatest concern related to technology should be economic and productivity growth. They reason that the greatest inventions, such as the toilet, have already been invented and that there is little left to be invented that would boost economic and productivity growth. Techno-pessimists maintain that western economies will experience slower technological advancements because they are facing headwinds, such as declining productivity and population growth. Moreover, they argue that western economies have already picked the low-hanging fruit of technological advancements. However, Mokyr, Vickers & Ziebarth (2015) pointed to several historical moments where the same arguments of techno-pessimists were made and proved wrong. For instance, Nobel prize-winner, Albert Michelson wrote in 1903:

> *"The more important fundamental laws and facts of physical science have all been discovered, and these are so firmly established that the possibility of their ever being supplanted in consequence of new discoveries is exceedingly remote."*
>
> (In Mokyr, Vickers & Ziebarth, 2015: 41)

Although the arguments of techno-pessimists may not be valid for the US and other developed countries, their arguments seem to be a perfect fit for South Africa. There are, however, some asymmetries in the current study's argument compared to that of techno pessimists – mostly because South Africa is a developing country with unique challenges. The current study will not argue that South Africa has already picked the low-hanging fruit, but rather that it is failing to pick them due to the significant headwinds it faces.

3.7. CONCLUSION

The 4IR refers to the merging of technologies across physical, digital, and biological spheres. The distinguishing characteristics of the 4IR are its velocity, scope, and impact on systems. South African innovators offer a glimmer of hope for the country's potential to grow during this period. On the other hand, techno-pessimists predict that global technological progress may have come to an end. There is, however, still an opportunity for developing countries to pick the low-hanging fruits of productivity growth.

Chapter 4 investigates the productivity paradox and discusses the possibility of secular stagnation.

CHAPTER 4 : SECULAR STAGNATION

4.1. INTRODUCTION

Chapter 3 provided a background to the 4IR. Chapter 4 narrows down to the relationship between technology and productivity by investigating the well-debated productivity paradox. In order to determine whether South Africa will grow significantly during the 4IR, it is essential to first investigate its productivity growth performance. It stands to reason that highly productive economies would therefore yield greater economic growth per input. It is also reasonable to expect productivity to grow globally following the great advances in technology that the 4IR brings.

Furthermore, according to Brynjolfsson and McAfee (2011), productivity growth in the long-term is a major contributor to living standards. A one percent productivity growth means that it would take 70 years for living standards to double. At four percent, it will multiply 16 times in 70 years. It follows that if South Africa would like to increase its standards of living, it would benefit from high productivity growth rates. Despite the tremendous growth in technology in 'the second half of the chessboard', productivity growth globally has stagnated over the past decade.

The purpose of this chapter is to investigate the possibility of secular stagnation of the South African economy. The chapter starts by discussing the productivity paradox, followed by its reincarnation. This is followed by an introduction to the framework of the study: Robert Gordon's highly criticised headwinds.

4.2. THE PRODUCTIVITY PARADOX

Many developing countries hope that investments in information and communication technologies (ICT) are the key to productivity and growth success during the 4IR. Early economic studies were sceptical, and Robert Solow even noted: "you can see computers everywhere, except in productivity figures" (Edwards, 2002: 22). This became known as the highly debated 'productivity paradox'.

The productivity paradox became a popular topic in the late 20th century. At first, it seemed impossible to solve, and many tried to no avail. Oliner and Sichel (1994) used a Denison-style growth accounting method to determine whether computer hardware made a positive contribution to economic growth in the US, using a neoclassical framework. Their findings suggested that computers did not make a large contribution to growth primarily because of its rapid rate of depreciation. The study resolved that the reason why Solow could not see computers in productivity figures was because they were not everywhere. Even in 1993, computers accounted for only two percent of capital stock. Brynjolfsson (1993) reviewed the existing literature and found a lack of Information Technology (IT) productivity in the US. However, he mentioned that this might have been a result of poor IT management, measurements, and methodologies.

As time passed, the arguments in favour of the productivity paradox weakened. Oliner and Sichel (2000) extended their earlier neoclassical model by adding computer software and communication equipment. This time, they found that output per labour hour during the period 1995-1999 grew to an annual rate nearly double of that observed in the preceding 25 years. Using a production possibility frontier framework, Jorgenson (2001) found computer technology in the US to have a significant effect on economic growth due to price reductions in the ICT sector. Nordhaus (2002) found that the new economy grew an astonishing eight percentage points from 1977 to 2000 in the US. The computer and semiconductor sectors proved to be the major growth sectors. However, they noted that non-new economy sectors also showed significant growth.

The evidence against the productivity paradox piled up and eventually led Robert Solow to declare his statement obsolete (Gordon, 2000).

4.3. The Reincarnation of the Productivity Paradox

Slow productivity growth over the past decade prompted a revival of the productivity paradox. This section will analyse labour productivity, total factor productivity (TFP), global studies and South African studies.

4.3.1. LABOUR PRODUCTIVITY

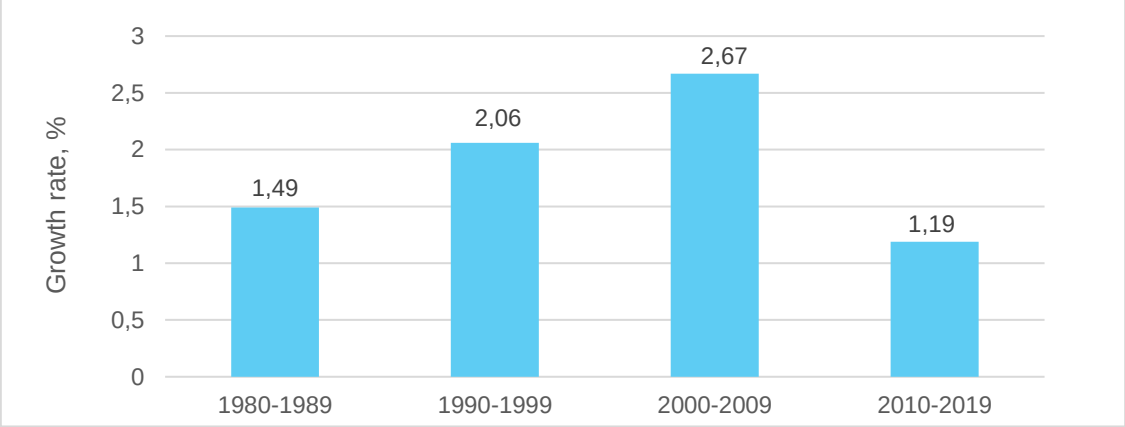


FIGURE 4-1: LABOUR PRODUCTIVITY GROWTH, NON-AGRICULTURE SECTOR, US
Compiled by researcher (2021)
Data sourced from the US Bureau of Labor Statistics (2020c)

The agricultural sector is omitted from labour productivity figures because of the complicated nature of employment (e.g. self-employment and unpaid family employment) and seasonality within this sector (Federal Reserve Bank of St. Louis [FRED], 2019). Labour productivity growth in the US non-agricultural sector has seen significant progress since the 1980s. However, **Figure 4-1** illustrates the declining productivity figures in the US over the past decade. Despite initial increasing productivity rates - peaking in the first decade of the new millennium – labour productivity growth declined in the last decade when it fell by more than half from 2,67 percent in the previous decade to 1,19 between 2010 and 2019.

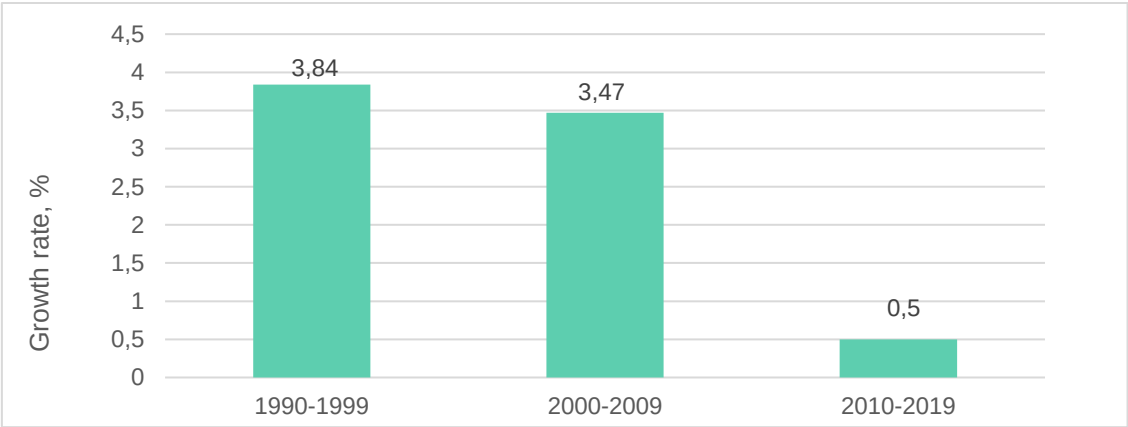


FIGURE 4-2: LABOUR PRODUCTIVITY GROWTH BY DECADE, MANUFACTURING SECTOR, US [5]
Compiled by researcher (2021)
Data sourced from the US Bureau of Labor Statistics (2020b)

[5] Data available only from 1987

Labour productivity growth in the manufacturing sector, illustrated in **Figure 4-2**, has been on a declining path since its highest decade performance in the 1990s. In 2002, it reached its peak performance of 8,6 percent. However, it has been declining since. The latest results showed a 0,5 percent average decade growth rate – a sharp contrast to the previous decade's average of 3,47 percent.

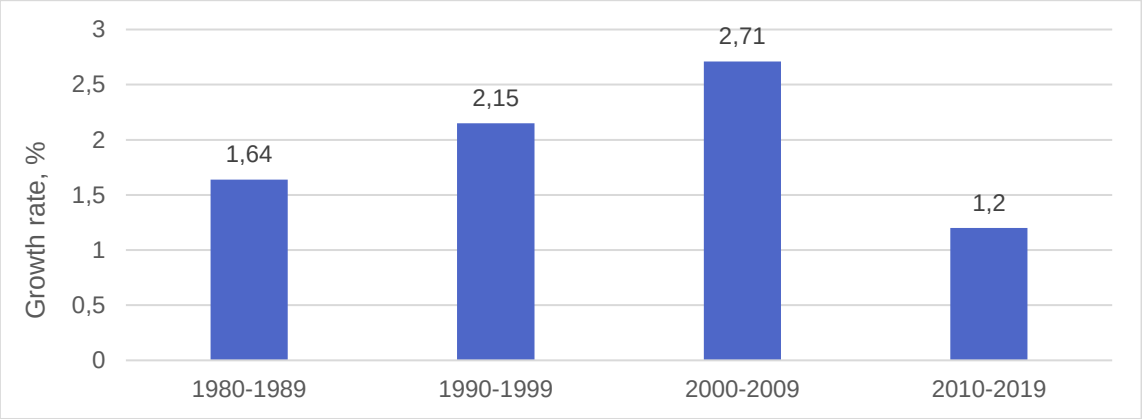


FIGURE 4-3: LABOUR PRODUCTIVITY GROWTH BY DECADE, BUSINESS SECTOR, US
Compiled by researcher (2021)
Data sourced from the US Bureau of Labor Statistics (2020a)

The trend of a decade-long poor labour productivity growth performance continues in the US business sector. Between 2010-2019, labour productivity averaged merely 1,2 percent compared to the 2,71 percent growth rate in the previous decade.

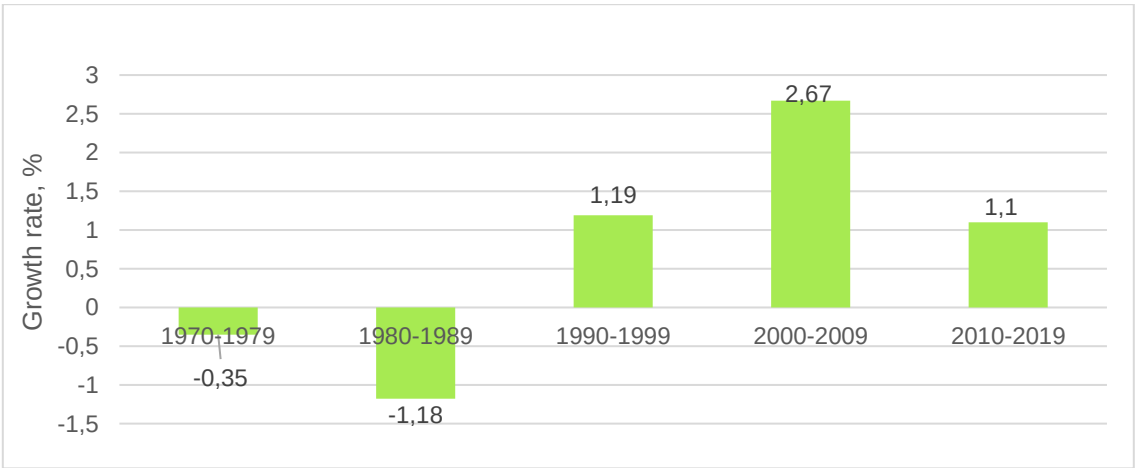


FIGURE 4-4: LABOUR PRODUCTIVITY GROWTH BY DECADE, NON-AGRICULTURE SECTOR, SA
Compiled by researcher (2021)
Data from SARB (2020b)

South Africa's labour productivity growth in the non-agricultural sector, followed a similar declining pattern as the US in the last decade. This is illustrated in **Figure 4-4**. Although it rebounded from negative growth rates in the 1970s to 1980s, the most recent decade's average labour productivity growth rate supports arguments in favour of a centennial slump. The 1990s saw the first positive growth of 1,19 percent, followed by an increased growth rate of more than double that in the first decade in the new millennium of 2,67 percent. The period 2010-2019 is characterised by a decline in labour productivity growth to just over one percent.

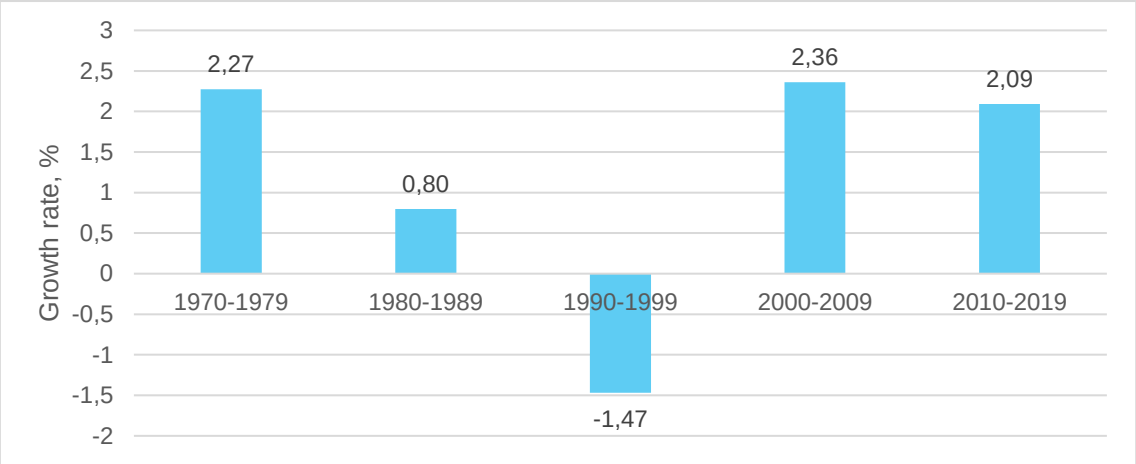


FIGURE 4-5: LABOUR PRODUCTIVITY GROWTH BY DECADE, MANUFACTURING SECTOR, SA
Compiled by researcher (2021)
Data from SARB (2020a)

Not surprisingly, labour productivity in the manufacturing sector of South Africa followed the same disappointing trend – although to a lesser extent. **Figure 4-5** illustrates that productivity growth figures trended downwards in the 1970s and 1980s, eventually reaching a negative decade-average in the 1990s. After the turn of the century, labour productivity growth in the manufacturing sector jumped to an average of 2,36 percent between 2000 and 2009. Nevertheless, it declined slightly in the most recent decade to 2,09 percent.

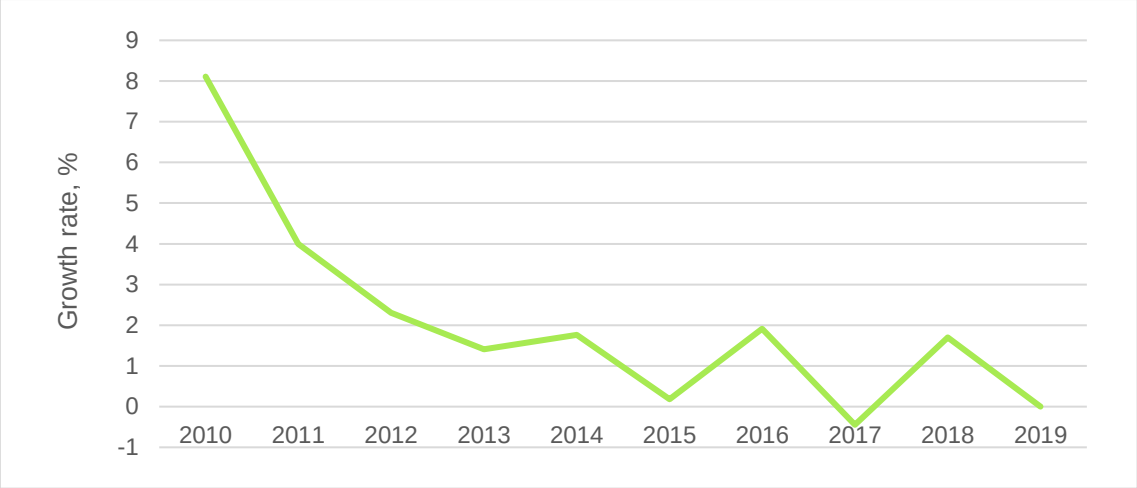


FIGURE 4-6: ANNUAL LABOUR PRODUCTIVITY GROWTH, MANUFACTURING, SA
Compiled by researcher (2021)
Data from SARB (2020a)

On closer inspection, **Figure 4-6** shows the drastic fall in the labour productivity growth rate since 2010. The 8,1 percent growth rate in 2010 was short-lived and fell significantly to below zero percent in 2017. In 2019 there was exactly zero percent growth.

4.3.2. Total Factor Productivity

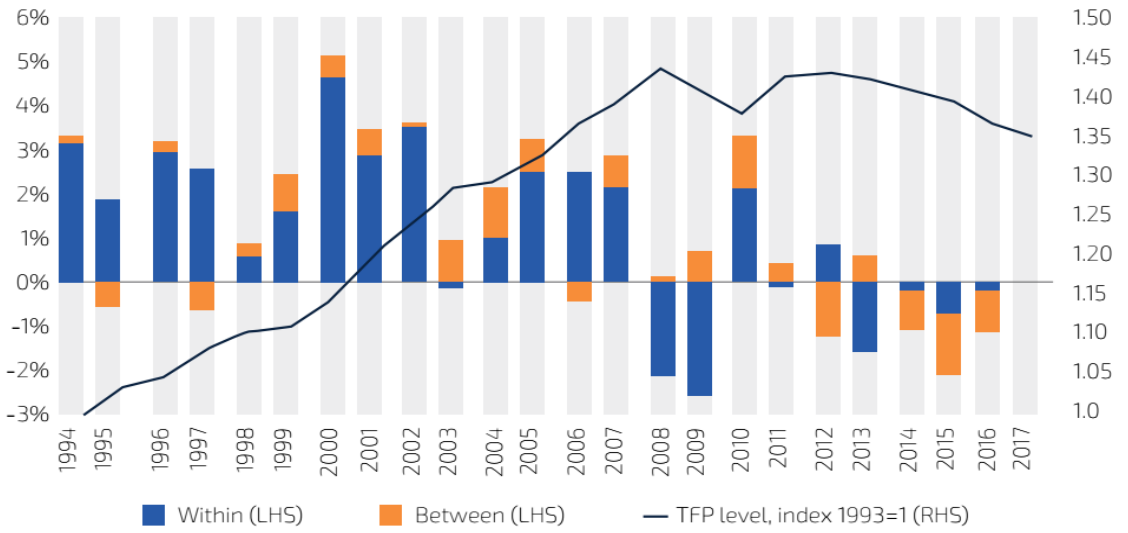


FIGURE 4-7: SA'S TFP CAPTURES AND DISSIPATIONS
Sourced from the World Bank (2017: 9)

TFP levels paint a similar picture of decreasing growth. **Figure 4-7** demonstrates the gains and losses of GDP due to falling TFP. According to the World Bank (2017), the country lost an average of 0,7 percentage points of GDP during the period 2008-2016. These losses were mainly due to TFP losses within sectors.

Between sector losses were due to the reallocation of capital or labour to lower productivity sectors. South Africa suffers from poor allocative efficiency of mostly capital, but also labour.

Figure 4-8 illustrates the disappointing growth rates for TFP for various sectors in the last decade. The primary-, tertiary- and secondary-sectors' TFP growth deteriorated significantly in the last decade. The manufacturing sector outperformed these sectors, but the results are nevertheless disappointing. Low-tech manufacturing doubled in growth, but med-low-tech and high-tech manufacturing industries' growth rates declined. The significant fall in the high-tech growth rate is particularly worrying considering its importance in the 4IR.

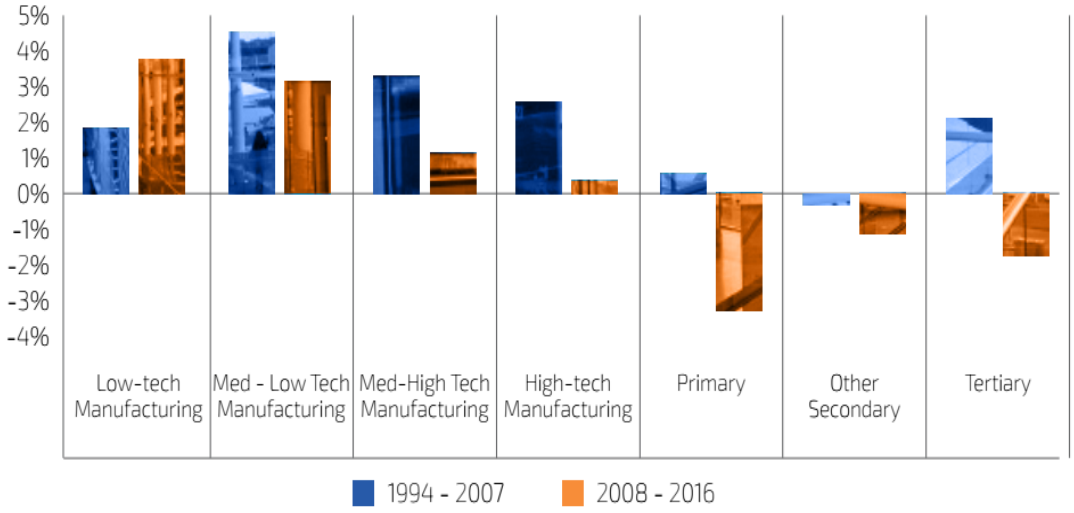


FIGURE 4-8: SOUTH AFRICA'S TFP-GROWTH BY SECTOR
Sourced from World Bank (2017: 9)

The World Bank (2017) attributed the poor within-sector growth in manufacturing industries to a fall in capital-embodied innovation - backed by a significant reduction in machinery and equipment in the high-tech sector after the Great Recession. Additionally, the decline in TFP growth could be attributed to a slump in spill-over effects from technological leaders. However, South Africa's capacity to absorb foreign technology has historically been weak and contrasts this theory. Other possible causes include the loss of skills due to migration; lower production as a result of lower demand; and lags associated with large investments.

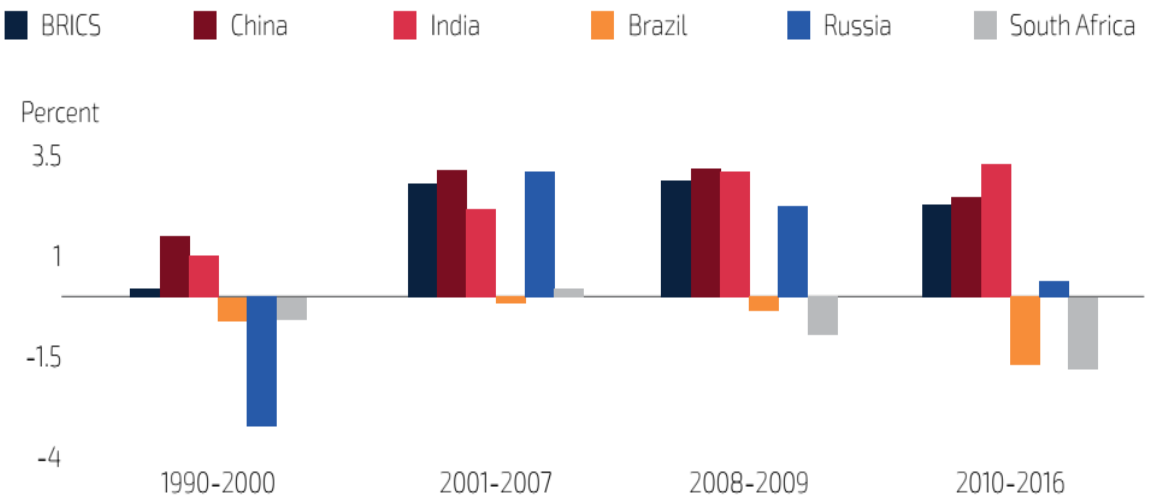


FIGURE 4-9: BRICS TFP GROWTH PERCENTAGE
Sourced from World Bank (2017: 11)

It cannot be argued that South Africa's poor productivity performance in the last decade is inherent in emerging economies. South Africa's TFP growth compared to BRICS[6] countries have been disappointing since the 1990s. **Figure 4-9** illustrates that South Africa's TFP growth rates were far below the BRICS average and significantly contrasted the exceptional growth in China and India.

4.3.3. Global Studies

The reincarnation of the productivity paradox prompted Acemoglu, Autor, Dorn, Hanson & Price (2014) to empirically investigate the effect of information technology (IT) induced technology movements on productivity growth in US manufacturing sectors. In their regression, IT-intensity was measured by expressing IT-expenditures as a proportion of total capital expenditures. The study found that celebrations on the death of the productivity paradox may have been premature. Although some evidence was visible of productivity growth in IT-intensive industries, it was dependent on the measure of IT intensity and was, regardless of measurement, absent during the 1990s. In cases where productivity growth was present, it was induced by a simultaneous decline in relative output and an even larger decline in employment. However, the authors noted that the

[6] BRICS is an acronym for Brazil, Russia, India, China, and South Africa.

effects of IT-induced technologies might have had an impact on the non-manufacturing or non-IT-intensive sectors.

Brynjolfsson, Rock & Syverson (2017) reviewed the literature and theories related to the resurgence of the productivity paradox. They proposed several explanations: first, economists may be over-optimistic about the impact of predicted technologies on productivity. Historically, it would not be the first time economists make this mistake. Many predicted technologies, such as fusion energy and flying cars, have still not realised decades after they were expected.

Second, output and productivity may be measured incorrectly. The "mismeasurement hypothesis" attributes the economic stagnation of recent decades to the illusion created by mismeasurement. These technologies, such as Facebook and smartphones, are often very affordable but offers significant utility. Another possible explanation to mismeasurement is the shifting of offshore profits.

Third, only a small proportion of the economy may have access to the latest technologies. Their restricted range and competitive characteristics often cause wasteful indulgence. The argument for concentrated distribution and rent dissipation remains disputable.

Fourth, the greater and more extensive the technology, the longer the lag between invention and impact. These lags may be attributed to the time it takes to build enough inventory to have a mass effect. In addition, it takes time to invent and build complementaries to allow technologies to grow to its full potential.

Lastly, and most importantly, past poor growth does not prophesise slow future growth. Abramowitz called TFP a "measure of ignorance" (In Brynjolfsson et al., 2017:11) because it cannot be explained by movements in capital and labour inputs. Because TFP is a residual, it is not efficient in predicting from the past. As a result, the productivity growth of the preceding decade cannot predict the subsequent decade's productivity growth. The same applies to labour productivity. The authors suggested abandoning past statistics in the prediction

of productivity growth and instead assess the technological and innovation environment.

Brynjolfsson and McAfee (2011) added that productivity measures are weakened by the fact that complementary services, such as Facebook, are concealed in productivity figures. Furthermore, many government services are offered at cost and results in zero productivity growth. Productivity in the healthcare sector is poorly measured, and its usually stagnant rate does not correspond with rising longevity figures - productivity figures ignore this valuable contribution. Moreover, productivity measures exclude significant upgrades in long-term living standards.

Schwab (2017) explained that 4IR goods and services are of superior quality and functionality and are presented to different markets than the previous revolutions. These goods and services often have no rivalry, zero marginal cost, or function in extremely competitive digital platforms. These factors result in significantly lower prices. Traditional statistics do not capture real value increases. For instance, services such as Uber increase efficiency and therefore, productivity. Economic indicators fail to capture this increased efficiency.

4.3.4. South African Studies

Although research on the South African economy is scanty, a few studies have made significant contributions to the literature. Kpodar and Andrianaivo (2011) investigated the effect of ICT on economic expansion in African countries, including South Africa, from 1988 to 2007, using the System Generalized Method of Moment (GMM) estimator. The results confirmed that ICTs, such as mobile phone development, had a significant impact on economic growth in African countries. The authors found that this positive effect stemmed from greater financial inclusion due to greater access to mobile phones.

Nordås (2001) surveyed the impact of ICT on the growth of manufacturing services in South Africa. The author found that manufacturing services and infrastructure in South Africa were well advanced and ready for the ICT revolution.

Pouris (2013) noted that the South African high-tech industries were lagging, and its research system was not tailored to back this industry. Although the country ranked highly in some positions, such as the *Fisher-Tropsch Process*[7] in which it ranked the highest in the world, it had very little innovation programmes compared to the rest of the world.

Farid (2015) investigated the role of technology in sustainable development in South Africa by critically analysing the literature. The author found that access to telecommunication services resulted in significant growth in the country. Furthermore, South Africa needed a regulatory environment to access the growth benefits of telecommunications brought on by increasing income.

These empirical studies confirm the potential contribution technological change can bring to economic growth in South Africa. However, technology is not the sole driver of economic growth.

4.4. THE SECULAR STAGNATION HYPOTHESIS AND THE HEADWINDS

Alvin Hansen (1939) first introduced headwinds into his secular stagnation hypothesis in response to the Great Depression. Hansen argued that economic maturity leads to secular stagnation because of the saturation of new inventions, discoveries and developments of new territories and resources, and a slowdown in population growth. Therefore, as a country matures, economic growth would be too slow because technological development will be insufficient to counter these headwinds. Hansen's theory was soon discredited when the US military boosted economic growth during World War II, followed by the Baby Boom and technological advancements in the 1950s and 1960s. However, in 2013, Larry Summers, former US treasury secretary, rejuvenated the theory of secular stagnation in his address to the International Monetary Fund (IMF) (Summers, 2013). Summers argued that the US economy stagnated after the Great Recession because savings surpassed investments at positive interest rates.

[7] According to the National Energy Technology Laboratory: "The Fischer-Tropsch process is a catalytic chemical reaction in which carbon monoxide (CO) and hydrogen (H_2) in the syngas are converted into hydrocarbons of various molecular weights…" (2021, para. 3).

Gordon (2014b) pointed out that Summers addressed the demand-side of the secular stagnation dilemma, while his own research addressed the supply-side. He argued that economic growth did not stagnate after the Great Recession because of technology, but because of headwinds. These headwinds to economic growth in the US were identified as demography, inequality, education, globalisation and energy/environment (Gordon, 2013, 2014a). The author further argued that these headwinds could have a possible negative impact on economic growth that exceeds the benefits of technology-induced productivity.

Gordon (2013, 2014a) identified the first headwind to US growth as demography. The US population is ageing rapidly, causing its productivity to decline as the proportion of working-age population decreases. The second headwind is education. Educational attainment in the US stagnated and education deteriorated. The third headwind is inequality. Inequality is on the rise in the US and globally. The fourth headwind relates to the rising debt levels of the US government. Additionally, Gordon (2014a) identified globalisation and energy/environment as secondary or minor headwinds. Globalisation increases the off-shoring activities of firms, the migration of skilled workers, and inequality. Energy/environment refers to the changes in oil and gas fracking in the US as well as the impact global warming may have on economic growth.

Apart from significant criticism on Gordon's pessimistic viewpoint on productivity, the headwinds have received little attention in the literature. Although the literature connects the headwinds to developed economies, the current study will bring to light several headwinds that South Africa is facing; and it will argue that these headwinds are hampering the technological advances brought on by the 4IR, paralysing economic and productivity growth.

4.5. CONCLUSION

The productivity paradox was laid to rest in the late 1990s when research confirmed that computers significantly contributed to economic growth. However, celebrations may have been premature – despite major advances in technology,

productivity growth declined significantly in the last decade. South Africa's TFP growth was particularly disappointing.

The literature indicates that advances in the ICT sector contributed significantly to South Africa's economic growth. However, the current study will argue that growth potential will be retarded by several headwinds for which Robert Gordon laid the groundwork. These headwinds will be identified in Chapter 5.

CHAPTER 5 : THE SIGNIFICANCE OF THE HEADWINDS

5.1. INTRODUCTION

Chapter 4 introduced Robert Gordon's argument of secular stagnation and the headwinds. Chapter 5 identifies the headwinds and addresses their significance to South Africa's economic growth during the 4IR by explaining their impact on real per capita GDP.

The chapter starts by discussing South Africa's current real GDP per capita path, followed by the identification and explanation of each identified headwind's impact on future per capita growth.

5.2. REAL GDP PER CAPITA

The significance of headwinds were brought to light by Gordon (2014a). The current study starts by reconstructing Gordon's analysis of the US economy based on data for the South African economy.

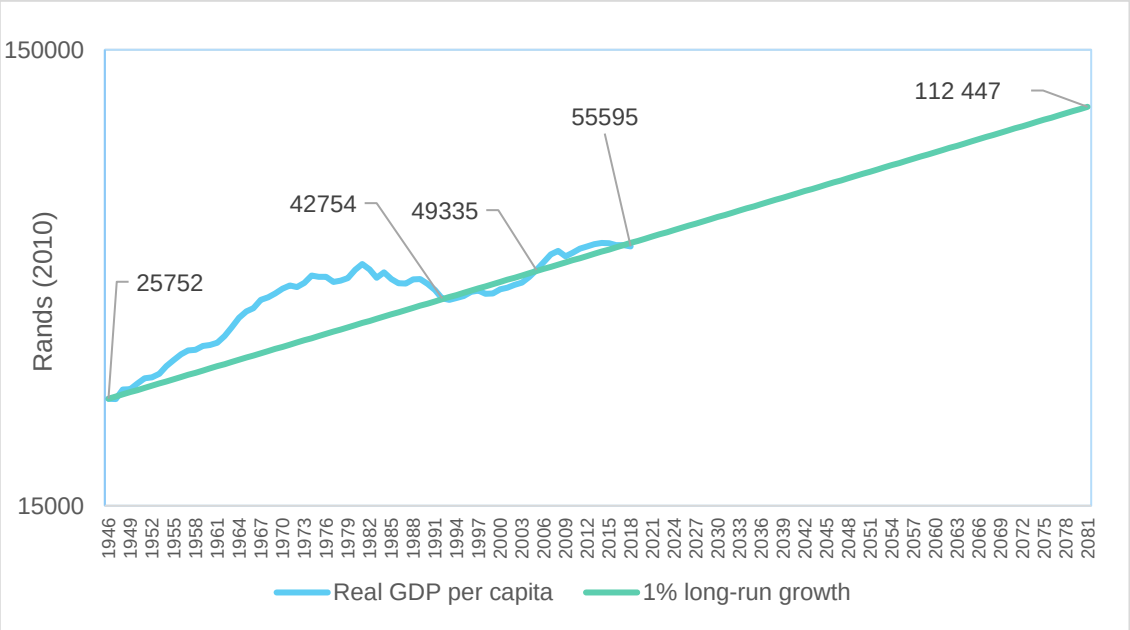


FIGURE 5-1: SOUTH AFRICA'S PROSPECTIVE 2070 REAL GDP PER CAPITA
Compiled by researcher (2021)
Sourced from SARB (2019b)

Following Gordon (2014a), the historical values of South Africa's real GDP per capita for the period 1946 to 2018 is illustrated on a log scale by the green line in **Figure 5-1**. The blue line represents the trend of GDP per capita growth of one percent[8] up to the year 2081. The year 2081 is used because the "rule of 70" determines that at a one percent growth rate, an amount would double in 63 years[9]. The average real GDP per capita growth rate before 1975 was 2,3 percent. Thereafter the average up to 2018 was 0,4 percent. The actual value started following the trend line and has been flirting with a one percent growth rate since 1992. It has therefore been growing very close to a one percent average for nearly three decades. The post-Great Recession period is perhaps most concerning. What the wide-view of the graph does not show is that the average GDP per capita growth from 2010 to 2018 was only 0,72 percent. Real GDP per capita has been on the decline since 2014.

Gordon (2014a) continued to estimate the impact of each headwind on economic growth numerically and created potential growth paths based on these values. However, such an extension is beyond the scope of the current study; and the remainder of the chapter will explain the significance of each headwind on per capita GDP, without making quantitative forecasts.

5.3. THE HEADWINDS

From the analysis conducted in the previous chapters, five major headwinds to South Africa's economic growth during the 4IR are identified by the current study.

[8] The correct growth rate of GDP per capita is 1,0978. For simplicity, I refer to it as 1 percent.
[9] The value 70 is rounded off. As can be seen in the graph, doubling occurs slightly before 2081.

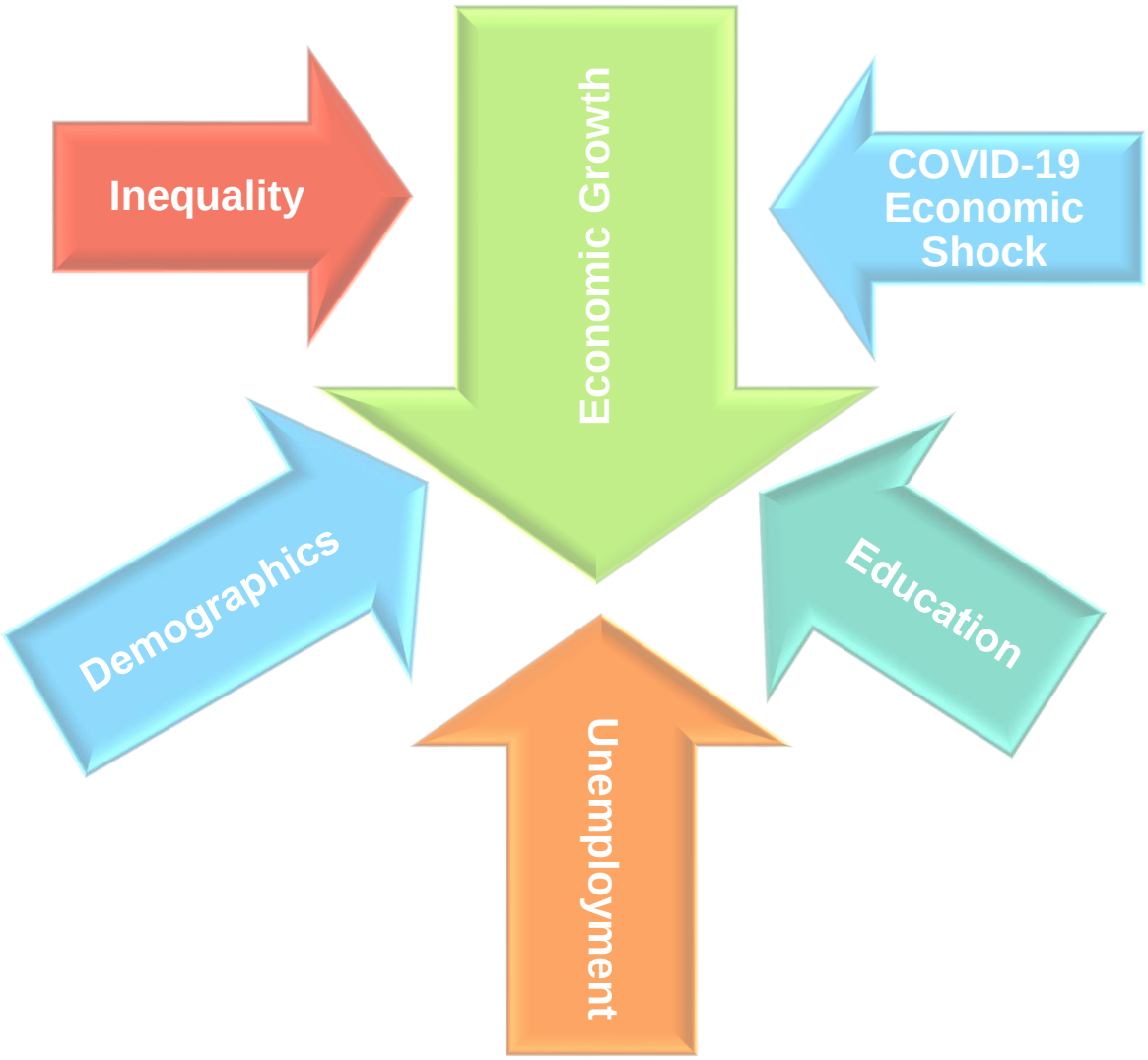


FIGURE 5-2: THE HEADWINDS TO SOUTH AFRICA'S ECONOMIC GROWTH DURING THE 4IR
Compiled by researcher (2021)

Figure 5-2 illustrates South Africa's headwinds to economic growth during the 4IR identified by the current study. South African growth is expected to be hampered by its current trajectories in inequality, demographics, unemployment, education, and economic shocks resulting from the Covid-19 pandemic.

The next section will explain how these headwinds affect output per capita.

5.4. THE STANDARD OF LIVING IDENTITY

Gordon (2014a) used the following identity to explain the significance of the headwinds:

$$\frac{Y}{N} \equiv \frac{Y}{H} . \frac{H}{N}$$

(Equation 1)

Where:

Y: Real GDP

N: Total population

H: Aggregate hours worked in the economy

$\frac{Y}{N}$: Output per capita

$\frac{Y}{H}$: Labour productivity

$\frac{H}{N}$: Hours per capita

The standard of living identity (SOLI) states that the standard of living (output per capita) is theoretically equal to labour productivity times hours per capita. Therefore, anything that reduces labour productivity or hours per capita, must theoretically reduce the standard of living (Gordon, 2014a).

During the 4IR, the SOLI will be negatively impacted by the headwinds as follows:

5.4.1. INEQUALITY

Growing inequality does not have a direct effect on the variables in the standard of living identity defined above, but it "limits the access of the bottom 99 percent of the income distribution to the average growth rate of GDP" (Gordon, 2014a: 5). Moreover, Chapter 6 will discuss six channels through which inequality impacts economic growth. Economic growth is negatively impacted by inequality through the credit market imperfection, fiscal, socio-political unrest, human capital, and fertility channels.

On the other hand, inequality can positively impact GDP through the savings channel; but, as will be noted in Chapter 7, South Africa's savings rate has been on a steady decline for decades.

In conclusion, inequality impacts the SOLI indirectly through the inequality channels by reducing labour productivity via its negative impact on real GDP. Therefore, inequality is a major headwind to economic growth in South Africa that reduces its output per capita through various channels.

5.4.2. DEMOGRAPHICS

The second headwind, demographics, reduces hours per capita (Gordon, 2014a). A declining working-age population will reduce the labour force and therefore, hours per capita. However, as will be discussed in Chapter 7, in the context of South Africa this impact will merely be evident in the white and Indian/Asian population groups who constitute little over ten percent of South Africa's entire population. Based on this argument, South Africa's hours per capita would rather increase due to its young and growing population. However, due to its failure to yield the first demographic dividend so far, hours per capita is reduced due to the increased population size accompanied by stagnating aggregate hours. Similarly, the reduction in hours per capita reduces the SOLI.

South Africa's low and decreasing savings rate not only reduces real GDP as will be explained in Chapter 7 by the life-cycle hypothesis (LCH), but it poses a threat to a second demographic dividend which could be yielded in a few decades. Therefore, South Africa's paradoxical declining savings rate, despite its ageing population, reduces real GDP and therefore, labour productivity. Furthermore, South Africa's labour force participation rate (LFPR) of older persons is significantly lower than the Organization for Economic Cooperation and Development (OECD) average – threatening a direct downwards pressure on labour productivity.

Additionally, Old-age grants (OAGs), the rising need for healthcare, housing and pension savings will be major challenges in future to the South African economy.

These are needs that would otherwise contribute to real GDP by lowering inequalities and improving labour productivity.

5.4.3. UNEMPLOYMENT

As will be discussed in more detail in Chapter 8, unemployment reduces economic growth through the workings of Okun's law. Therefore, unemployment reduces labour productivity because of its negative impact on real GDP. Unemployment is said to be the major cause of South Africa's inability to yield its first demographic dividend. Simply put, without sufficient employment, the working-age population cannot maximise productivity.

Aggregate hours worked in the economy is unlikely to increase relative to population growth when South Africa's workforce is increasingly becoming unemployed. This would reduce hours per capita. Additionally, rising unemployment increases the proportion of low-income individuals and therefore, inequality. Consequently, the SOLI is further impacted via the inequality channel.

5.4.4. EDUCATION

According to Gordon (2014a), the deteriorating education in the US has a direct negative impact on productivity growth while simultaneously slowing down output per capita growth without necessarily impacting hours per capita. However, South Africa's education system can hardly be compared with the US'. Based on the conclusions reached in Chapter 9. The SOLI will be impacted by the education headwind as follows:

Firstly, as will be discussed in more detail in Chapter 9, South Africa's failure to provide quality early childhood development (ECD) programmes, as well as primary and secondary education will continue to impact labour productivity by reducing real GDP through the various channels of inequality. Unless children are given equal opportunities from birth, inequality will continue to rise and reduce the SOLI.

Second, education is negatively related to the fertility rate (DeCicca and Krashinsky, 2016). Therefore, hours per capita could possibly be reduced due to the impact of high fertility on the total population size in the presence of poor education. However, South Africa's fertility rate is declining at a sluggish pace.

Third, the problem of unemployment in South Africa is partly caused by the poor skills of its labour force. This is threatened more by automation, a characteristic of the 4IR. Therefore, poor education will further reduce the SOLI through the unemployment channel discussed in section 5.4.3.

Finally, through the education-growth nexus, discussed in Chapter 9, the rising challenges in providing quality education will have a direct negative impact on real GDP and will therefore reduce labour productivity.

5.4.5. The COVID-19 Economic Shocks

This section is based on the conclusions reached in Chapter 10. Due to the harsh and extended lockdown measures taken and its pre-pandemic economic position, it is unlikely that South Africa will experience a V-shaped recovery from the COVID-19 economic shock similar to China. Therefore, this study predicts a long-term impact on South Africa's economic growth. It should be noted that COVID-19 would likely be eliminated as a major headwind in countries that experience quick recoveries.

COVID-19 shocks will directly impact labour productivity via its direct negative impact on real GDP. Due to the strict and extended closures of industries, such as tourism and tobacco, the shock effects on these industries will not likely jump back to pre-COVID-19 levels soon. Most likely because many businesses have closed their doors permanently.

Aggregate hours worked in the economy were greatly reduced during this period. Although this was temporary, the permanent closure of businesses would likely contribute to soaring unemployment that could remain high for some time. Therefore, downwards pressure will be placed on hours per capita.

Another unintended consequence of the lockdown measures on the SOLI is its impact on education. Due to persistent inequalities in South Africa, the education system has taken severe strain during the pandemic. This impact will negatively affect labour productivity via the education channel.

Despite initial fears, it seems unlikely that the total population will be impacted by COVID-19 due to its low death rate thus far. However, in the event that a more deadly wave hit the country in future, the total population, and hours per capita will be reduced. However, the results may differ according to the demographic impact.

The most concerning economic impact of COVID-19 is the rising debt-to-GDP as a result of the government's attempts to fight the pandemic. Take note that South Africa was recently downgraded to junk status. In order to service its debt, it would need to raise taxes. This will directly impact real GDP and therefore, labour productivity. Higher taxes may also discourage foreign direct investments (FDI), local entrepreneurs and workers from participating in the economy.

The COVID-19 economic shock headwind will be discussed in more detail in Chapter 10.

5.5. OTHER HEADWINDS

The current study investigates the major headwinds South Africa will face during the 4IR. However, it is necessary to point out reasons why other headwinds were either not identified as headwinds or identified only as minor headwinds:

5.5.1. RISING DEBT

Although Gordon (2014a) identified the rising debt-to-GDP of the US as a major headwind, the current study finds South Africa's rising debt to be a minor headwind. Mbeki *et al.* (2018) found that, although still a real and clear threat, the probability of South Africa's fiscal cliff not realising improved. However, the study was conducted prior to the immense debt obligations that were made due to the COVID-19 pandemic and Moody's downgrade of South Africa's credit ratings in

March 2020 to Ba1 with negative outlook. Nevertheless, the increased debt burden was a result of the COVID-19 pandemic and therefore forms part of the COVID-19 economic shock headwind.

5.5.2. GLOBALISATION

Gordon (2014a) argued that globalisation is a minor headwind to US economic growth due to offshoring, the migration of skilled workers, and inequality. However, developing countries mostly benefit from higher standard of living, accelerated growth and economic opportunities (Annan, 2001). Additionally, globalisation is characterised by trade openness which is known to have a positive impact on economic growth in South Africa (Brückner and Lederman, 2012; Mosikari and Sikwila, 2013; Sikwila, Ruvimbo & Mosikari, 2014).

On the other hand, globalisation's impact on inequality (Annan, 2001) and the migration of skilled workers to developed countries retards economic growth. Nevertheless, the current study classifies globalisation as a minor headwind due to the counteracting growth opportunities it provides.

5.5.3. CORRUPTION/POOR GOVERNANCE

The current study initially identified corruption as a possible major headwind to South Africa's economic growth. However, according to Schwab (2017), technologies of the 4IR are breaking down the barriers that used to guard public authority. As the public becomes more informed, their expectations are becoming more demanding, and governments are deemed less effective. Moises Naím noted that "in the 21st century, power is easier to get, harder to use, and easier to lose." (In Schwab, 2017: 68). Consequently, social media has put a spotlight on corruption during the COVID-19 pandemic in South Africa. It is, therefore, more likely that corruption would decline during the 4IR than to act as a headwind.

5.5.4. ENERGY/ENVIRONMENT

It is likely that the disastrous failures of South Africa's power utility, Eskom, are a major current headwind for South Africa. However, the current study did not

identify it as a major headwind during the 4IR because: first, its failures are related to poor governance; second, the 4IR promises innovative energy solutions that could solve the energy crisis. However, this will only happen if the government allows these innovations to take place; and finally, the current study does not deem it a long-term problem due to the exponential growth in innovation and the government's recent commitment to restructuring.

5.6. CONCLUSION

South Africa's real GDP per capita has been growing at around one percent for the last seven decades. It has not seen a growth spurt in more than four decades. In fact, its growth rate since 1975 is less than a fifth of prior growth. Although the 4IR promises economic growth for developing countries, South Africa faces five headwinds that will continue to slow down its economic growth in the coming decades: inequality, demographics, unemployment, education, and the COVID-19 economic shock. Through various channels, these headwinds will ultimately impact per capita GDP negatively. These headwinds will be analysed in the chapters to follow.

CHAPTER 6 : INEQUALITY

6.1. INTRODUCTION

Chapter 5 identified South Africa's headwinds and explained their significance. In Chapter 6, South Africa's first headwind is discussed: inequality. South Africa is known as one of the most unequal societies in the world. Its high Gini coefficient is mostly the result of its historical past of Apartheid. However, 26 years later, the post-Apartheid government has failed to bring social justice to those living in poverty; and its policies have shown little to no evidence of promoting equality. To make matters worse, the 4IR threatens to bring along rising inequalities.

Inequality serves as a tailwind to the other three headwinds. For that reason, the current chapter provides an overview of South Africa's inequality crisis. Inequality cannot be viewed separately from the other headwinds; and the significant effects it has on South Africa's demographics, unemployment, education, and the COVID-19 economic shock will be evident in the chapters that follow.

The current chapter will identify and discuss the various channels through which inequality impacts economic growth. This will be followed by an investigation into the status quo of South Africa's income and wealth inequality; and, subsequently, the chapter conclusion.

6.2. THE INEQUALITY-GROWTH CHANNELS

Classical economists argued that inequality advances economic expansions and the neoclassicals dismissed any involvement of inequality in economic advancements (Galor, 2011). However, according to Galor, the argument was revived in recent decades. Researchers have discovered several channels through which inequality can impact economic growth: the credit market imperfection approach (CMIA), fiscal, socio-political unrest, human capital investments, and fertility channels.

6.2.1. THE CREDIT MARKET IMPERFECTION APPROACH CHANNEL

New interest in the inequality-growth relationship gained momentum when Galor and Zeira (1993) investigated the part wealth distribution played when investing in human capital. They proposed a model, the CMIA, that illustrated how imperfections in credit markets and indivisibilities in human capital investments explained a negative impact of inequalities on economic activity. Moreover, rising inequalities are, according to their model, negatively correlated to per capita GDP in richer countries, but positively in poorer countries. In very poor countries, the argument goes that fixed educational costs are much higher than per capita income and therefore, the top income earners can at least invest in human capital.

Furthermore, Galor (2011) explained that in the early industrialisation stages, when the accumulation of physical capital is the primary driver of economic growth, inequality drives economic growth by channelling resources towards those with higher propensities to save. However, in later stages of economic growth, human capital becomes the foremost driver of economic growth, and lower inequality will stimulate economic growth due to higher investments in human capital.

Several studies have investigated the CMIA. Barro (2000) used a neoclassical model to determine the relationship between inequality and growth. The author found that income inequality negatively impacts poor countries' growth and positively impacts growth in richer countries.

Brückner and Lederman (2015) used the CMIA to estimate the impact of income inequality on real GDP per capita using panel data of 104 countries. They found that, on average, the relationship was significantly negative. However, the study confirmed that this relationship was significantly positive for poor countries. Thus, developed countries can benefit from income inequality while developing countries are unable to.

Odusanya and Akinlo (2020) extended the model used by Barro (2000) to sub-Saharan Africa (SSA) and used the system GMM to overcome the problem of endogeneity. They found that inequality reduced economic growth via the CMIA.

6.2.2. THE FISCAL CHANNEL

The fiscal channel is based on Meltzer and Richard's (1981) rational theory of the size of government. The theory postulates that, in a general labour economy equilibrium model, majority votes determine the size of a government[10]. The percentage of income that is redistributed is dependent on the majority vote and the redistribution of productivity. The main reason why the size of the government changes is the movement of voters in the income distribution and changes in relative productivity.

Barro (2000) explained that in a country experiencing income inequality[11], the majority of voters will support redistributing resources from the rich to the poor, such as transfer payments, community spending programmes and regulatory policies. The higher the inequality in a country, the higher the motivation to redistribute resources via the political channel. More importantly, these transfer payments and tax finance associated with it cause distorted economic decision-making, such as demotivated workers. Therefore, increasing redistributions of resources amplify distortions and reduce investments. Consequently, inequality reduces economic growth through the redistribution channel.

Furthermore, Barro (2000) explained that when political power is more egalitarian[12] than the economic power in a country, the negative inequality-growth nexus occurs. On the other hand, the rich can prevent egalitarian policies and redistribution that accompanies it, through lobbying. However, lobbying consumes resources and advances corruption – negatively impacting economic expansion.

[10] Measured by the percentage of income that is redistributed.
[11] Measured by a mean income that exceeds the median income.
[12] Egalitarian refers to the belief that all humans are equal.

Gouveia and Masia (1998) investigated whether a positive nexus exist between income inequality and government size within the Meltzer-Richard model. They found no evidence that increased income inequality raises the size of the government. However, Odusanya and Akinlo (2020) confirmed that inequality reduces economic growth via the fiscal channel.

6.2.3. The Socio-Political Unrest Channel

According to Barro (2000), inequality promotes crime, riots, and other disruptive activities among the poor. These activities directly divert resources away from productive activities towards unproductive activities. Additionally, those who feel threatened by crime or socio-political unrest divert their efforts into defensive mechanisms in order to protect themselves or their assets. Particularly, investments are discouraged when property rights are threatened. Therefore, socio-political unrest - characteristic of high inequality – reduces economic growth.

Barro (2000) further explained that transfers which promote equality promote political stability only if the poor have a stronger incentive to steal or disrupt rather than work.

6.2.4. The Savings Channel

According to Barro (2000), the savings rate will increase with income. Consequently, when income is redistributed to the poor, the savings rate declines. Given that domestic investment is, to some extent, dependent on domestic savings, inequality would be positively related to investment. Through this channel, inequality would positively impact economic growth. This positive relationship was verified by Odusanya and Akinlo (2020).

6.2.5. The Human Capital Investment Channel

Because interest rates are lower for lenders than borrowers, occupational choices are adversely affected by inequality and may result in long-lasting under-investments in human capital (Galor, 2011). A new strand of research was born

from this observation that investigated the correlation between inequality and talent allocation across occupations by investigating intergenerational mobility (Fershtman and Weiss, 1996; Owen and Weill, 1998; Maoz and Moav, 1999). Odusanya and Akinlo (2020) explained that economic growth could be slowed down because of the inability of those living in poverty to invest in quality education and health. Therefore, inequality indirectly impacts economic growth due to the vital role of human capital investments in the economy.

6.2.6. The Fertility Channel

There exists a negative relationship between the fertility rate and economic expansion (Liu, Yamada and Yamada, 1996; Barro, 2008; Bonner and Sarkar, 2018; Odusanya and Akinlo, 2020). As the fertility rate increases, less human capital investments are made per child. Therefore, via the fertility channel, inequality negatively impacts economic growth (Barro, 2000; Odusanya and Akinlo, 2020).

6.3. Inequality in the 4IR

One of the greatest concerns of the 4IR is rising inequality (Gordon, 2014a; Brynjolfsson and McAfee, 2016; Schwab, 2017). Technology threatens to substitute many existing jobs, leading to unemployment-fears. When labour is replaced by capital, then the worker, now unemployed, falls to the bottom of the income distribution and the owner of capital rises within the top of the income distribution. The poor become poorer, and the rich become richer. This is the main concern highlighted by fears of rising inequality during the 4IR.

In previous industrial revolutions, new technologies were unable to replace the high cognitive abilities of humans. The horse was replaced by the car; the abacus was replaced by the calculator, and the pen was replaced by the typewriter. However, AI and other technologies characteristic of the 4IR threatens to perform cognitive functions which were previously reserved for humans only. Humans are rightly concerned about the effect it could have on inequality. The matter of rising

unemployment and capital vs labour will be discussed in more detail in Chapter 8.

In addition to the threat of unemployment, inequality threatens the standard of living globally. Epidemiologists, Richard Wilkinson and Kate Picket found that inequality gives countries the tendency to violence, increased incarceration, mental illness, and obesity; and lowers life expectancy and trust[13]. On the other hand, more equal countries experience better child well-being; and reduced stress, drug abuse, and infant mortality (Schwab, 2017).

The *Global wealth report 2019* reported that the lower half of the wealth distribution owned less than one percent of global wealth (Credit Suisse, 2019). The top one and ten percentiles owned 46 percent and 82 percent, respectively. The report found that the share of wealth owned by the top one percent increased in recent years. Interestingly, the primary stimulus of global growth in recent years were non-financial assets.

6.4. INEQUALITY IN SOUTH AFRICA

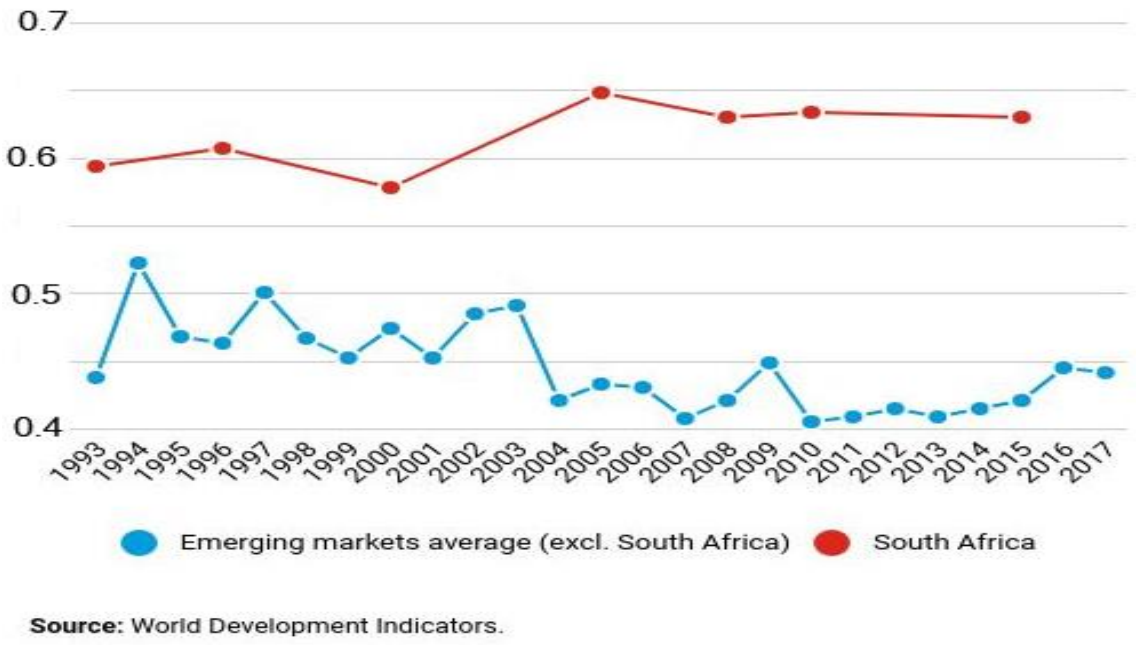
6.4.1. INCOME INEQUALITY

According to Hundenborn, Leibbrandt & Woolard (2018), South Africa's Gini coefficient, based on data from the National Income Dynamics Study (NIDS) and the Project for Statistics on Living Standards and Development (PSLSD), increased from 0,68 in 1993, to 0,69 in 2008. However, the decrease in income inequality from labour market sources caused a decrease in the Gini coefficient to 0,66 by 2014.

Figure 6-1 illustrates South Africa's relatively high and decoupled income inequality compared to the average of emerging markets using data from the World Bank's *World Development Indicators* (International Monetary Fund [IMF], 2020). The data gives a slightly lower value for the Gini coefficient than Hundenborn et al. (2018), but nevertheless demonstrates the country's

[13] Trust refers to the relationship between people in a country. Countries with high trust experience economic prosperity. This is because trust creates favourable business conditions (Harford, 2006).

abnormally high level of income inequality. Based on this data, South Africa had increased its income inequality from below 0,60 in 1993 to 0,63 in 2014. It is clear from this that South Africa's post-Apartheid policies to reduce inequality have sadly not been effective, and many have even been counterproductive. Moreover, its peers have managed to lower their Gini coefficient over the same period.



Source: World Development Indicators.

FIGURE 6-1: SOUTH AFRICA'S GINI COEFFICIENT COMPARED TO EMERGING MARKETS, 1993-2014
Sourced from IMF (2020)

According to the IMF (2020), the top 20 percent of the country's population holds more than 68 percent of income compared to a 47 percent median in emerging counterparts. On the other hand, the bottom 40 percent holds a mere seven percent of income in contrast to a 16 percent median across emerging economies.

Moreover, according to van der Berg and Louw (2003), the inter-racial income gap was narrowed by the rising per capita incomes black Africans. However, the authors also found rising inequalities within the black African population group, or intra-racial inequality. A more recent paper by Hino, Leibbrandt, Machema, Shifa & Soudien (2018), observed that both inter-racial and inter-ethnic income

inequalities dropped during the period 1993 and 2015. However, the authors noted that:

> *…the incomes of the Coloured group were squeezed from below from the Africa/Black group, and, at the same time, pulled apart from above by the Whites group. The disparity ratio analysis is interesting in showing that gains have only been made between the African bottom and the White bottom. So, in general the African group is aggrieved at the pace of transformation, the Coloured group is very threatened, and the bottom end of the White group is threatened too.…Similarly, large inequality emerged between ethnic groups of African origin.*

(Hino *et al.*, 2018: 16-17)

Furthermore, Statistics South Africa (STATS SA) reported a large regional divide between provinces. The income per capita of Gauteng is almost double that of rural provinces, like Limpopo. In addition, the overall income per capita for South Africa has been stagnating for the last decade. The country has failed to create new jobs for the unemployed and new entrants to the labour market (IMF, 2020).

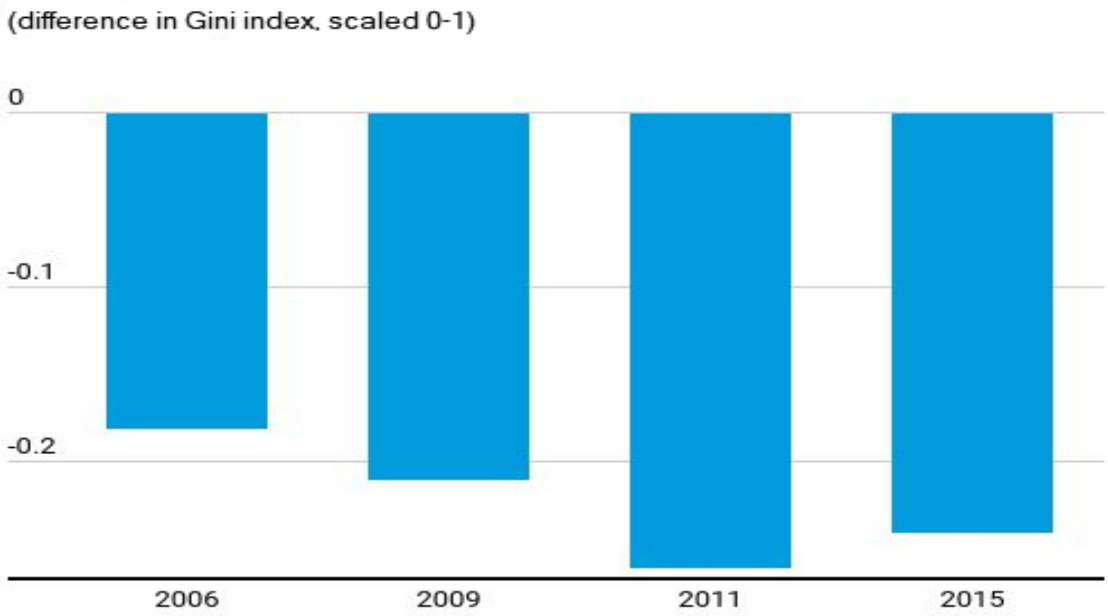


FIGURE 6-2: THE PROGRESSIVE IMPACT OF FISCAL POLICY ON INEQUALITY
Sourced from IMF (2020)

The IMF (2020) stated that South Africa has been effectively utilising its fiscal policy to reduce inequality. When income inequality is measured relative to market income, inequality showed improvement (**Figure 6-2**). This was due to South Africa's mild progressive tax system and social safety nets. However, since

government debt has increased significantly over the years, it has reduced the scope to use fiscal policy as a redistributive instrument going forward.

6.4.2. WEALTH INEQUALITY

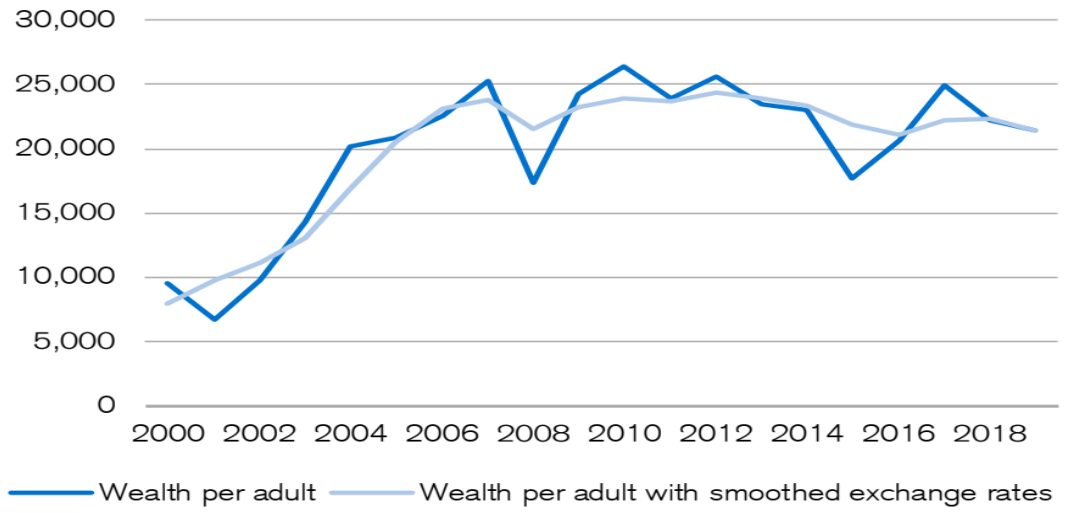


FIGURE 6-3: PER CAPITA ADULT WEALTH, SOUTH AFRICA, 2000-2018
Sorced from Credit Suisse (2019: 55)

In addition to income inequality, wealth inequality poses a threat to South Africa's struggle to amend the injustices of its past. **Figure 6-3** highlights South Africa's stagnating wealth accumulation. Wealth per adult grew sharply at the beginning of the millennium. Similar to per capita income, wealth per adult has stagnated in the last decade. According to Credit Suisse (2019), the main cause of this stagnation is persistent currency devaluations - since 2010, the Rand has lost around half of its value.

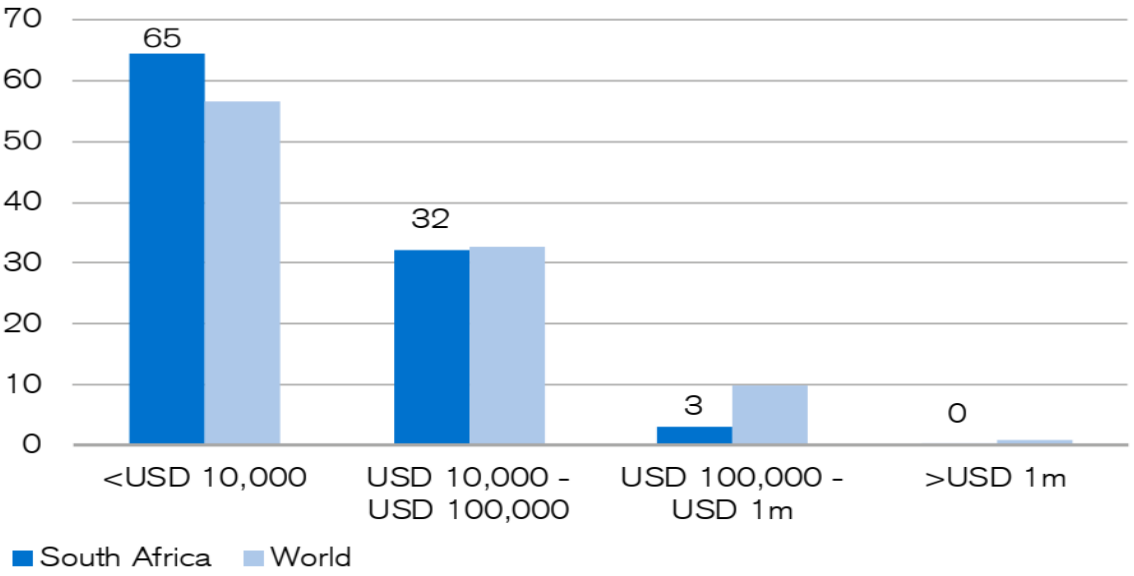


FIGURE 6-4: SA'S WEALTH DISTRIBUTION RELATIVE TO THE WORLD, 2019
Sourced from Credit Suisse (2019: 55)

Figure 6-4 compares South Africa's wealth distribution to the rest of the world. Sixty-five percent of South Africans owned assets worth less than USD 10 000, compared to a 58 percent world average. Similarly, the country did not have many wealthy individuals. While the world had 10,6 percent adults with more than USD 100 000 of wealth, only 3,2 percent of adults owned above this threshold in South Africa. There were only 51 000 South Africans in the top one percent of the wealth distribution, and only 46 000 were USD millionaires. Most significantly, South Africa's wealth Gini coefficient of 0,81 far exceeds its income Gini coefficient.

Chatterjee, Czajka & Gethin (2020) investigated the distribution of household wealth in South Africa. They combined tax microdata, household surveys and macroeconomic balance sheet statistics to obtain a more accurate distribution. The study found that the top ten percent owned 86 percent of aggregate wealth. Nearly a third of aggregate wealth was owned by the richest 0,1 percent. The top 0,01 percent owned around 15 percent of aggregate wealth – more than the entire bottom 90 percent. Moreover, the authors found no evidence of decreasing wealth inequality since the post-Apartheid era started. In fact, they found that wealth income increased slightly.

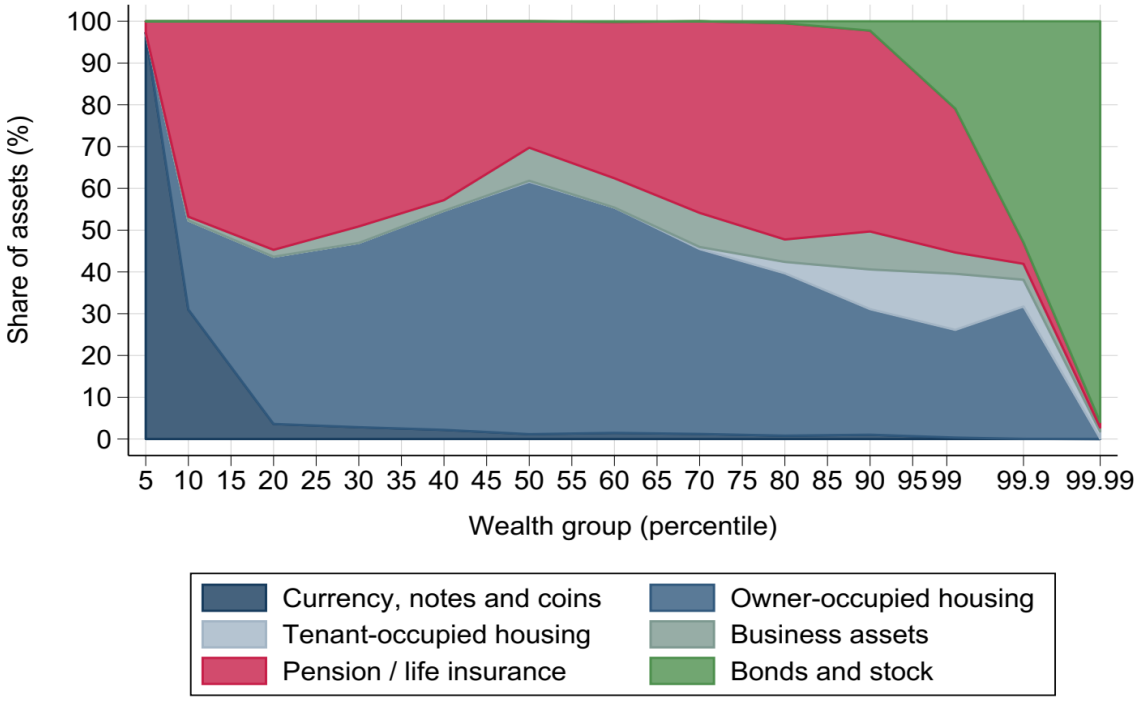


FIGURE 6-5: PORTFOLIO COMPOSITION OF WEALTH PERCENTILES
Sourced from Chatterjee, et al. (2020: 22)

Figure 6-5 sketches a view of how South Africa's wealth inequality is linked to different types of assets. The poorest households mainly held currency, notes and coins as wealth. The remaining 90 percent mostly held owner-occupied housing, pensions, and life insurance. The upper-middle class held a small share of business assets. On the other hand, the top one percent mainly held bonds and stocks, while almost all the wealth of the top 0,01 percent were held in bonds and stocks.

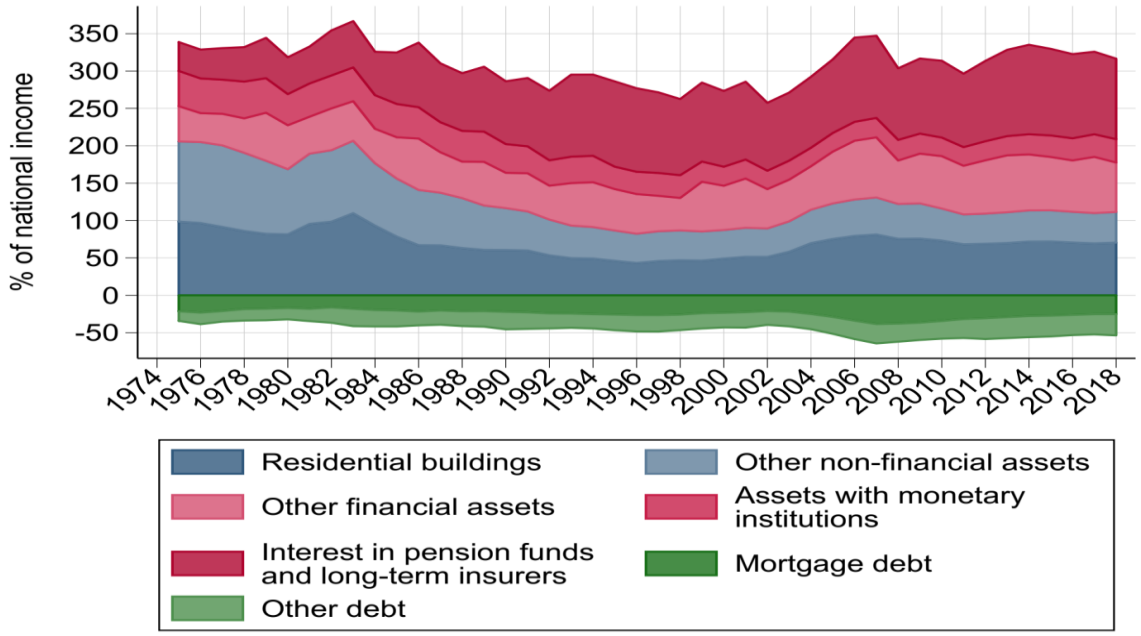


FIGURE 6-6: SOUTH AFRICA'S HOUSEHOLD WEALTH, 1975-2018
Sourced from Chatterjee, et al. (2020:7)

Figure 6-6 plots South Africa's total household wealth as a percentage of national income over the period 1975-2018, composed by Chatterjee, et al. (2020:7). The authors explained that total net wealth over the period followed a U-shaped curve. Aggregate net wealth declined from around 300 percent of national income in 1975 to 220 percent in the late nineties. At the beginning of the 21st century, it had risen to more than 260 percent. Financial assets accounted for double the annual national income in 2018, mainly due to the significant rise in pension assets. However, non-financial assets, such as residential buildings, land, underlying dwellings, and business assets, declined from two years' national income in 1974 to one year's in 2018. There has been a noteworthy increase in household debt until 2008, but this declined to around 55 percent in 2018.

6.5. CONCLUSION

The first headwind to South Africa's economic growth during the 4IR is its high and rising inequality. Inequality can have a negative impact on economic growth via five channels: the CMIA-, fiscal, socio-political unrest-, human capital investments-, and fertility-channels. On the other hand, inequality can make a positive contribution to economic growth through the savings channel.

Rising inequalities are one of the greatest concerns of the 4IR. South Africa's income Gini coefficient of 0,66 is not only significantly higher than the decreasing emerging market average, but it is also increasing. More concerning is its wealth Gini coefficient of 0,81.

The chapter overviewed inequality in South Africa. However, inequality is the strongest headwind that strengthens the other headwinds in addition to its impact on economic growth. Therefore, inequality is addressed in more detail in the coming chapters concerning the remaining headwinds. Chapter 7 will analyse the second headwind: demographics

CHAPTER 7 : DEMOGRAPHICS

7.1. INTRODUCTION

Rising inequalities can have significant impacts on economic growth. However, South Africa's ability to exploit economic growth opportunities during the 4IR is further slowed down by a second headwind: demographics.

Chapter 7 investigates South Africa's ability to yield returns on its young population and analyses the changing environment it can expect due to ageing. In this chapter, ageing is defined; South Africa's demographic transition is analysed; the role of HIV/AIDS on the population structure is discussed; the first and second demographic dividends are investigated; challenges of population ageing are explored, and population ageing in the 4IR is discussed before the chapter concludes.

7.2. AGEING

Not only is the world's population increasing, but it is ageing rapidly. The number of older persons more than doubled globally between 1980 and 2017, and is estimated to further double by 2050 (United Nations [UN], 2017).

In the elementary phase of a demographic transition, starting from high fertility and mortality rates, mortality will start to decline. During this phase, the young population will boom, and only in the next phase will fertility start to decline. As these boom generations age, the median age of the population will rise. At a more mature phase, fertility would have declined significantly to account for an aged population (Oosthuizen, 2015).

7.2.1. THE DEFINITION OF OLDER PERSONS

For the purpose of this study, older persons are defined according to the UN's definition of older persons, i.e., persons aged 60 years or older. However, it should be noted that in some cases the secondary data employed in the current study uses the qualifying age of 65 for older persons. This is because countries differ on the qualifying retirement age. South Africa does not have a compulsory

retirement age, but persons 60 years and older qualify for a state-funded pension grant. The UN's definition is also used by STATS SA. The researcher will inform the reader in cases where secondary data defines older persons as 65 years and older.

7.3. SOUTH AFRICA'S DEMOGRAPHIC TRANSITION

Unlike developed countries, developing countries did not have the time to adjust to the changes in the age structure (Joubert and Bradshaw, 2004). The American Association of Retired Persons (AARP) explained that high-income countries urbanised decades ago before their populations started to age. On the other hand, middle-income countries are facing the challenges of simultaneous urbanisation, family restructuring, and ageing (AARP, 2019).

In South Africa, the percentage of older persons relative to the population is increasing rapidly. Older persons account for 9,1 percent of its population (STATS SA, 2020b). This proportion is expected to rise further to 17,4 percent by 2050 (Samson Institute for Ageing Research [SIFAR], 2016).

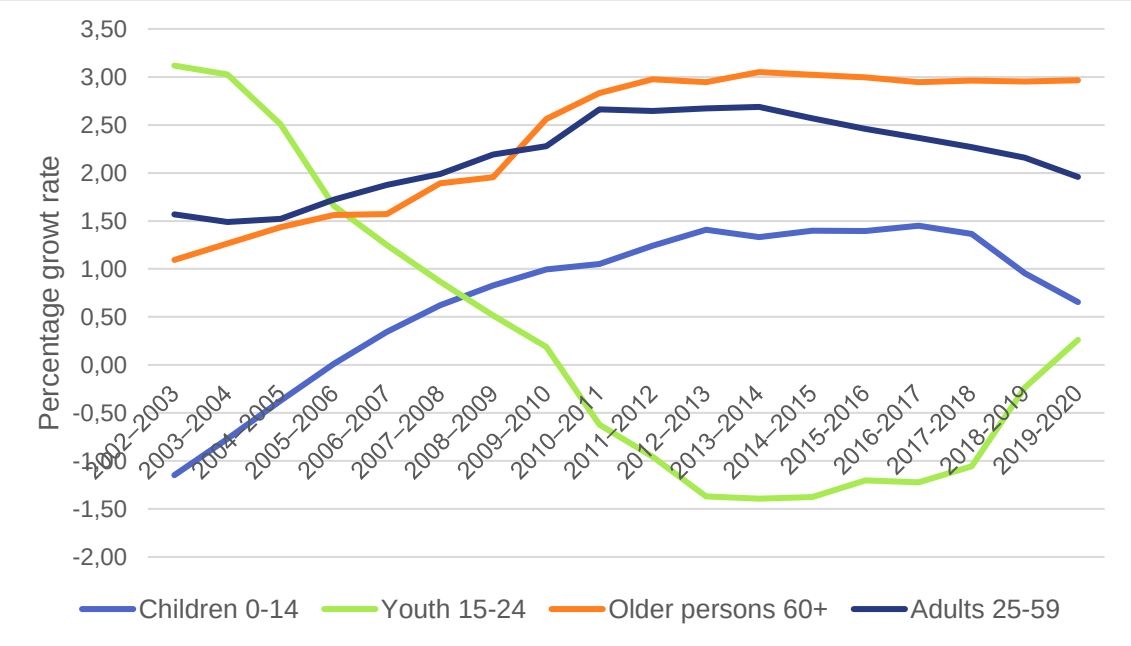


FIGURE 7-1: POPULATION GROWTH RATES OF AGE GROUPS, 2002-2020
Data from STATS SA (2020b)

Figure 7-1 illustrates South Africa's population growth rates for different age groups for the period 2002-2020. The growth rate of older persons as a proportion

of the total population increased from 1,09 percent for the period 2002-2003, to 2,97 percent for the period 2019-2020. Interestingly, a stagnation can be observed in the growth rate of children up to 14 years during the period 2013-2018. At the same time, the growth rate of the youth aged 15-24 declined significantly.

Due to the fluctuating nature of fertility over time, the rise in fertility between 2004 and 2018 is evident in the elevated growth rate of children aged 0-14 between 2002 and 2013 (STATS SA, 2020b). Consequently, the growth rate of the youth aged 15-24 has increased significantly since 2018 due to the ageing of children into the next category. Moreover, a decline in the fertility rate since 2014 has caused a more recent decline in the growth rate of children aged 0-14. The total population growth increased steadily but stalled in recent years.

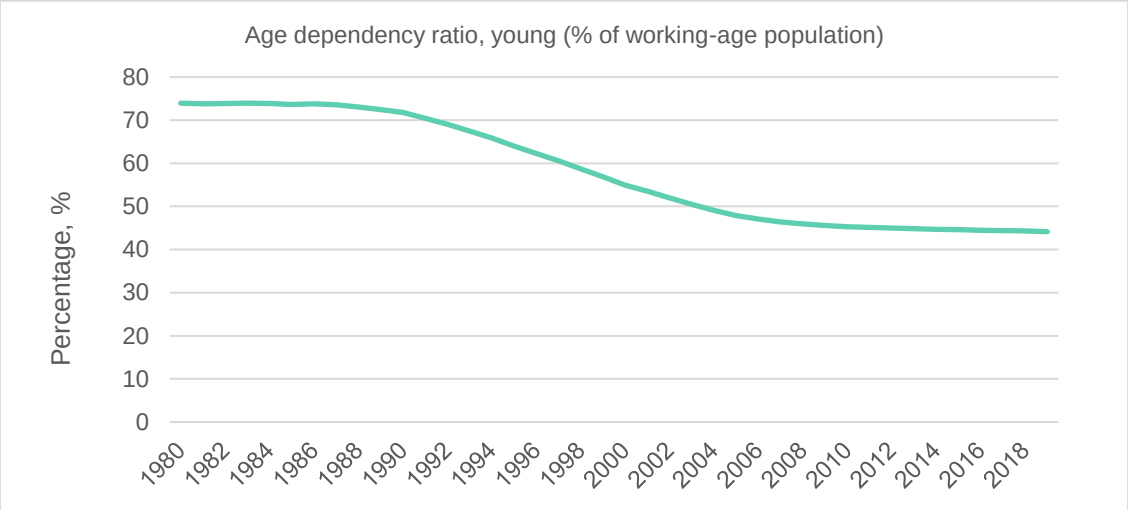


FIGURE 7-2: SOUTH AFRICA'S YOUNG DEPENDENCY RATIO, 1980-2019
Compiled by researcher (2021)
Data from World Bank (2020b)

Figure 7-2 and **Figure 7-3** sketches the relationship between dependent age groups and the working-age population in South Africa. The youth dependency ratio is calculated as the population aged younger than 15 years as a percentage of the working-age population aged 15-64. During the period 1980 to 2019, the youth became less dependent on the working-age population from its peak of 78,49 percent in 1966, to 44,15 percent in 2019. This significant decline was due to declining fertility rates since the 1950s (Joubert and Bradshaw, 2006).

The old dependency ratio, as defined by the OECD, is calculated as the population older than 65 as a percentage of the working-age population (**Figure 7-3**). The old dependency ratio rose from 6,98 percent in 1980, to 8,25 percent in 2019. The net effect being a declining total dependency ratio.

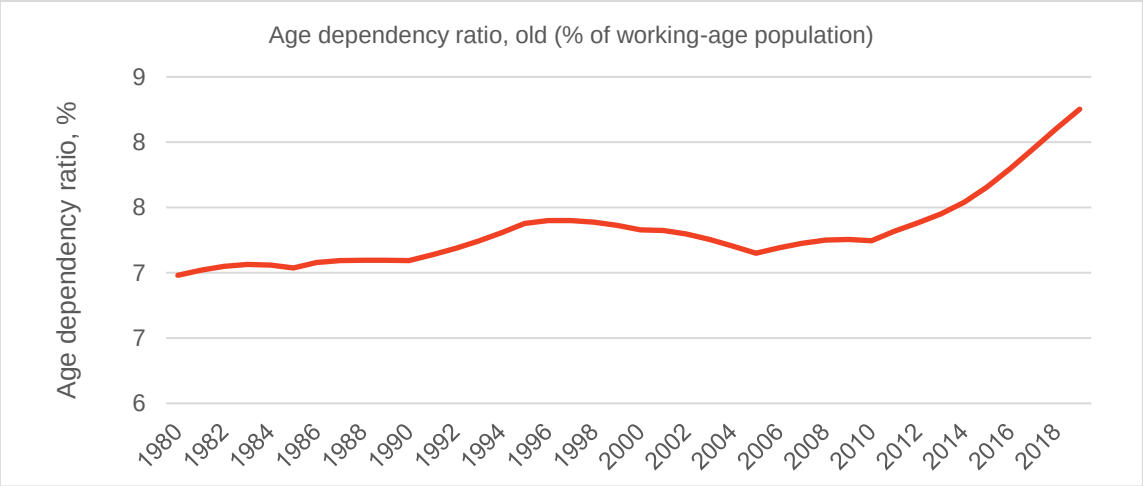


FIGURE 7-3: SOUTH AFRICA'S OLD DEPENDENCY RATIO, 1980-2019
Compiled by researcher (2021)
Data from World Bank (2020a)

Joubert and Bradshaw (2006) reported that the sharp rise in the old dependency ratio was the result of a combination of three factors: fertility, mortality, and migration. Firstly, fertility rates are declining. This lowers the percentage of youth and increases the proportion of older persons. Secondly, although declining mortality rates have not yet advanced to older persons and remain stagnant, increasing mortality in infants, children and young adults resulted in a proportional decrease in the youth and an increase in the population of older persons. Thirdly, migration reduces the working-age population. However, according to the United Nations Department of Economic and Social Affairs (UNDESA), South Africa had a net inflow exceeding 100 000 migrants per year between 2010-2015 (UNDESA, 2017); and STATS SA (2012a) reported an insignificant impact of migration into South Africa on the population structure, except for the Indian/Asian[14] population group. According to STATS SA, "Migration, like death, can occur at any age, thus its effects on the structure depends on a particular age and sex of migrants"

[14] STATS SA classifies the population in four groups consisting of: black African-, coloured-, white-, and Indian/Asian-persons. In order to ensure consistency with national statistics, the current study employs the same population group classification.

(2012a: 3). STATS SA further reported that in-migration from Asia increased the proportion of males aged 20-39 in the Indian/Asian population cohort (STATS SA, 2012a).

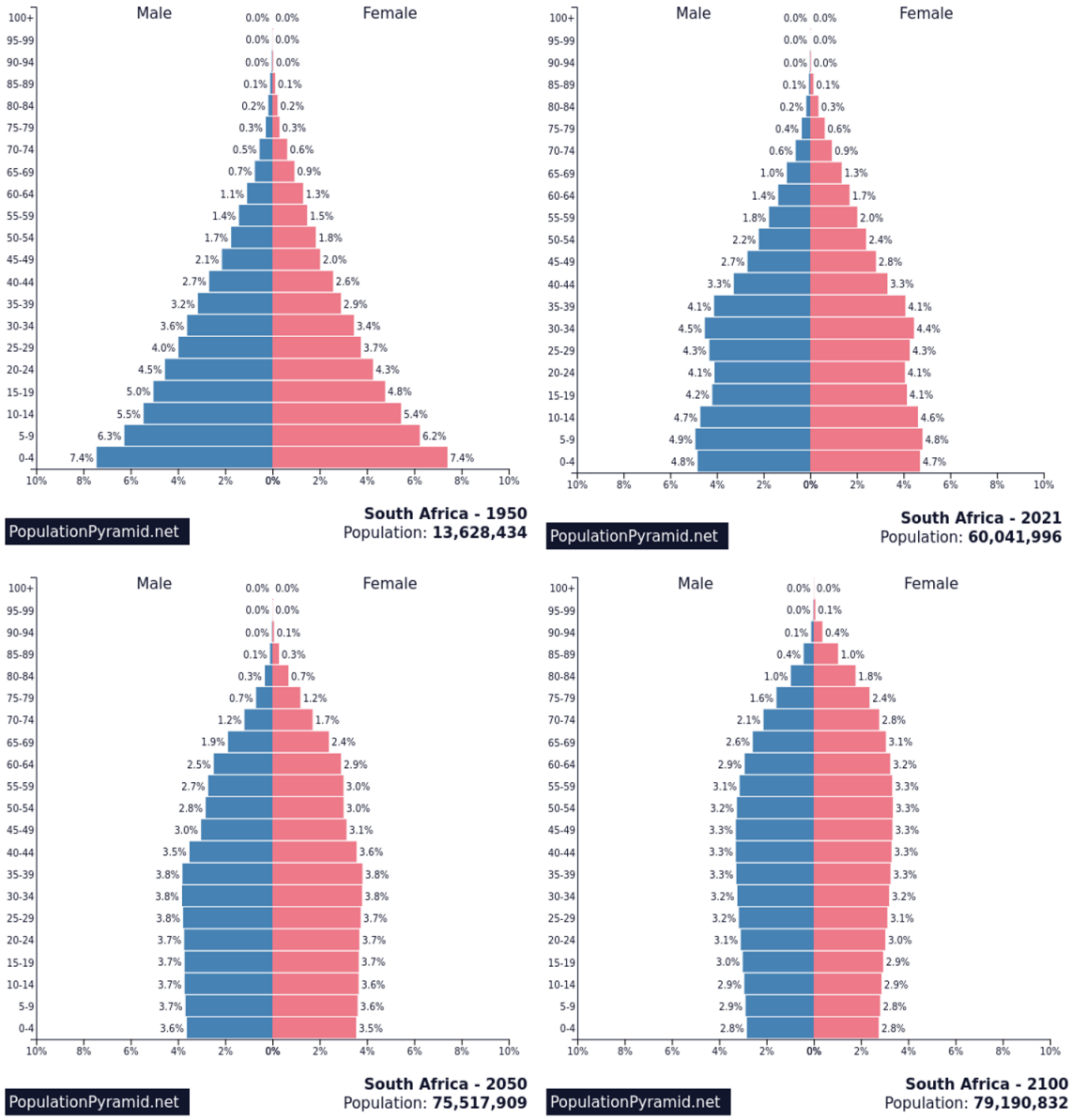


FIGURE 7-4: SOUTH AFRICA'S POPULATION BY AGE GROUPS, 1950–2100
Compiled by researcher (2021)
Data from PopulationPyramid.net (2019)

Figure 7-4 compares the changes in age demographics in South Africa between 1950 and 2021; it forecasts significantly larger proportions of older persons, especially females, by 2050 and 2100. Historically higher mortality rates in males

of all ages, compared to females, can explain the larger relative proportion of females in the category of older persons (Bloom, Canning and Gunther, 2008).

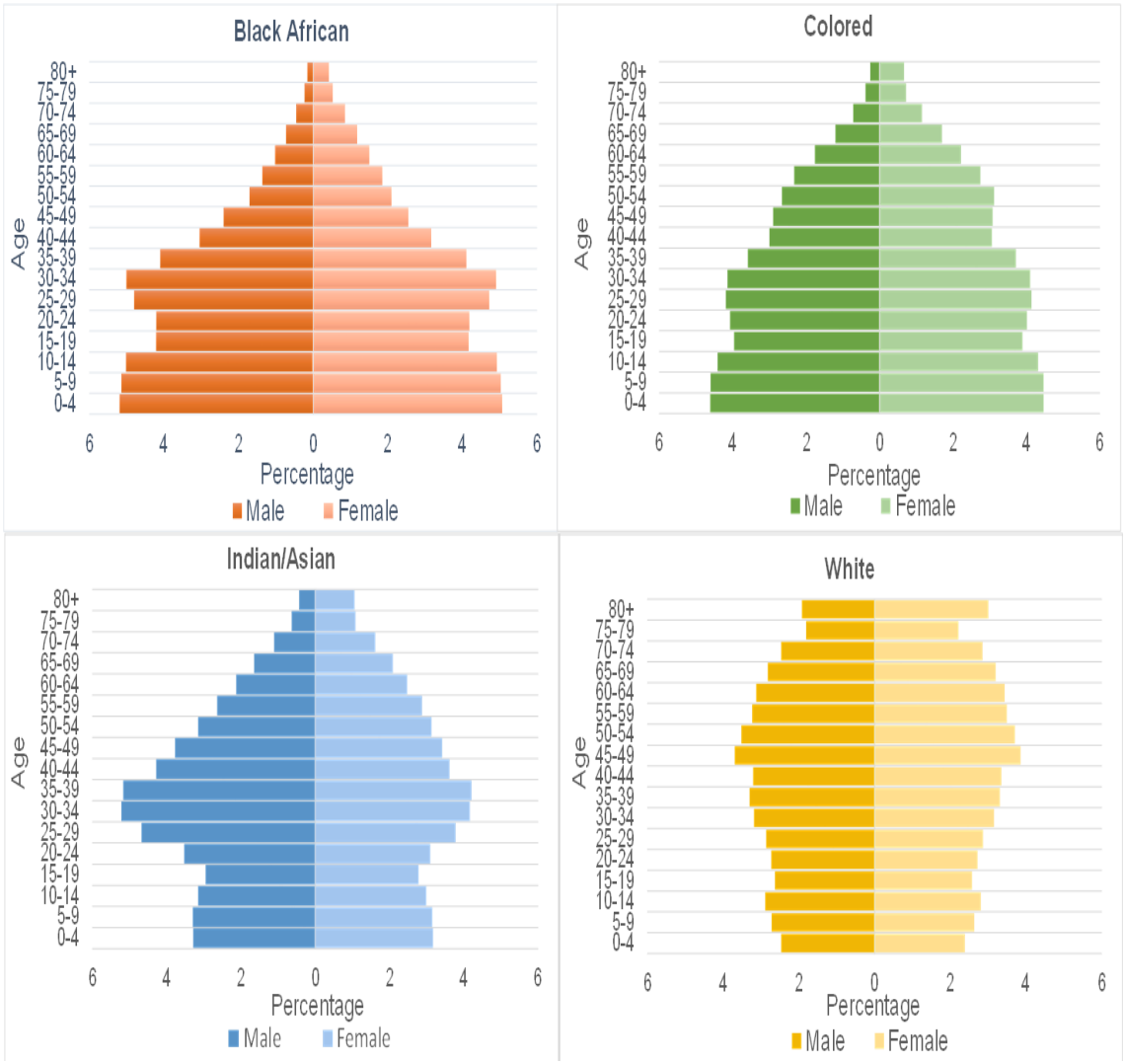


FIGURE 7-5: SOUTH AFRICA'S POPULATION PYRAMID BY POPULATION GROUP, 2016
Compiled by researcher (2021)
Data from STATS SA (2020b)

Figure 7-5 depicts the black African population group in South Africa as a youthful population, followed by the coloured population group. This is evident in its broad base indicating high fertility rates and higher expectancy rates at birth. At the other end of the spectrum is the much older white population group with a narrow base that indicates lower birth rates. It is also characterised by a much broader top – indicative of longer life expectancies at birth – or an ageing population. In addition, while 64 percent of the South African population were older than 18 years in 2016, 62 and 66 percent of black African and coloured

persons were over 18 respectively; and 75 and 79 percent of Indians/Asian persons and white persons were older than 18 (STATS SA, 2016). Additionally, the impact of migration reported earlier in this chapter is visible in the working-age population of the Indian/Asian population group.

7.4. THE IMPACT OF HIV/AIDS ON THE AGE STRUCTURE

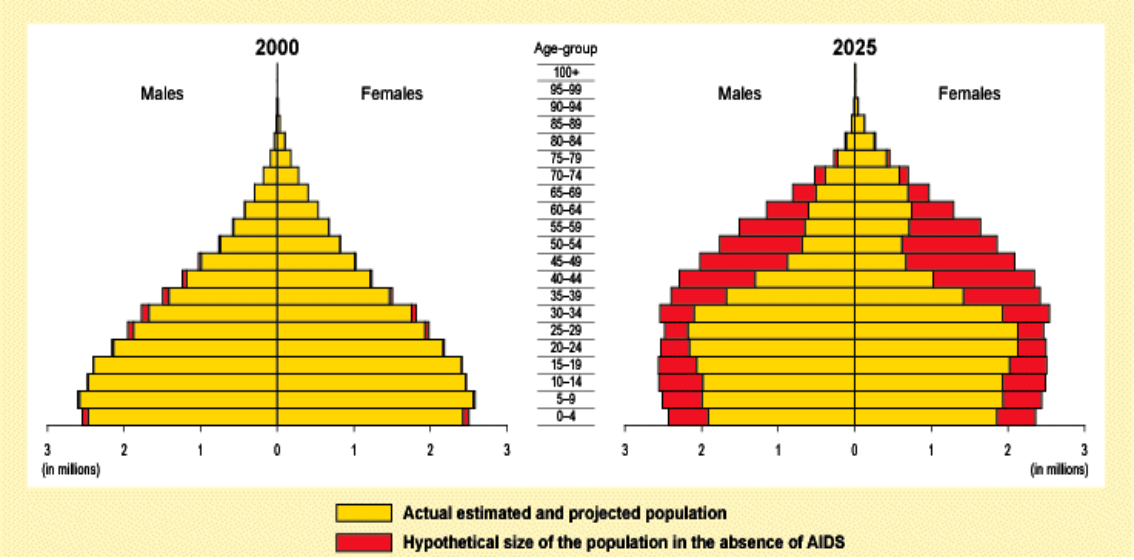


FIGURE 7-6: SOUTH AFRICA'S AGE STRUCTURE WITH & WITHOUT HIV/AIDS, 2000 & 2025
Sourced from (UNAIDS, 2004: 43)

According to Myslik, Freeman & Slawski (1997), the additional burden of HIV/AIDS accelerates the impact of declining mortality and fertility rates in South Africa. **Figure 7-6** forecasts how the additional burden of HIV/AIDS will magnify the ageing population in South Africa by 2025. Lloyd-Sherlock (2019) noted that the major impact HIV/AIDS has on the age structure is the pervasiveness of mortality in younger age groups. It may be argued that the sharp increase in free antiretroviral treatments (ARVs) since 2012 has led to a sharp decline in HIV/AIDS related mortality, but the effects will likely remain for decades.

Myslik et al. (1997) further highlighted the increasing number of orphans left behind by the epidemic. Not only will older persons no longer be supported financially in old-age - due to its fatal destruction of the working-age population - but the burden of raising their orphans often fall on older persons. This rising phenomenon is often referred to as “skip-generation parenting” (Myslik et al.,

1997: 6). Moreover, Joubert and Bradshaw (2006) explained that the HIV/AIDS epidemic puts emotional and physical strain on older persons taking care of the ill. Older persons, often frail, are also at risk of doing more housework, getting infected through physical care-giving, additional healthcare and funeral expenses of infected family members, and the loss of future financial support.

7.5. THE FIRST DEMOGRAPHIC DIVIDEND

According to Lee and Mason (2006) during the early stages when the demographic transition starts with falling fertility rates, the working-age population will grow at a faster pace than their dependents and allow them to invest in economic development and the wellbeing of their families. Consequently, they become more productive and per capita income will grow. This economic growth boost is known as the first demographic dividend.

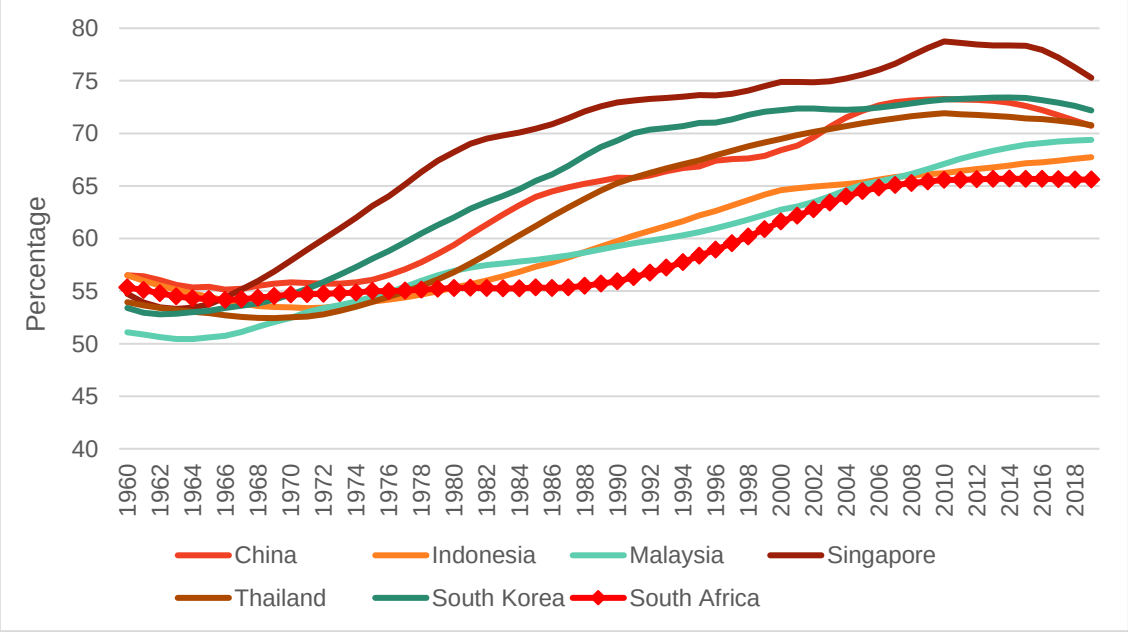


FIGURE 7-7: THE WORKING-AGE RATIOS OF SOUTH AFRICA AND EAST ASIA
Sourced from World Bank (2019c)

The working-age ratio refers to the population from the age of 15 to 64 years as a proportion of the entire population. South Africa's working-age ratio is compared to that of East Asia in **Figure 7-7**. South Africa's demographic transition has so far been much weaker than that of East Asia. Whilst the working-age ratios reached nearly 75 percent in China; South Africa has so far barely managed to get its working-age ratio to reach 65 percent.

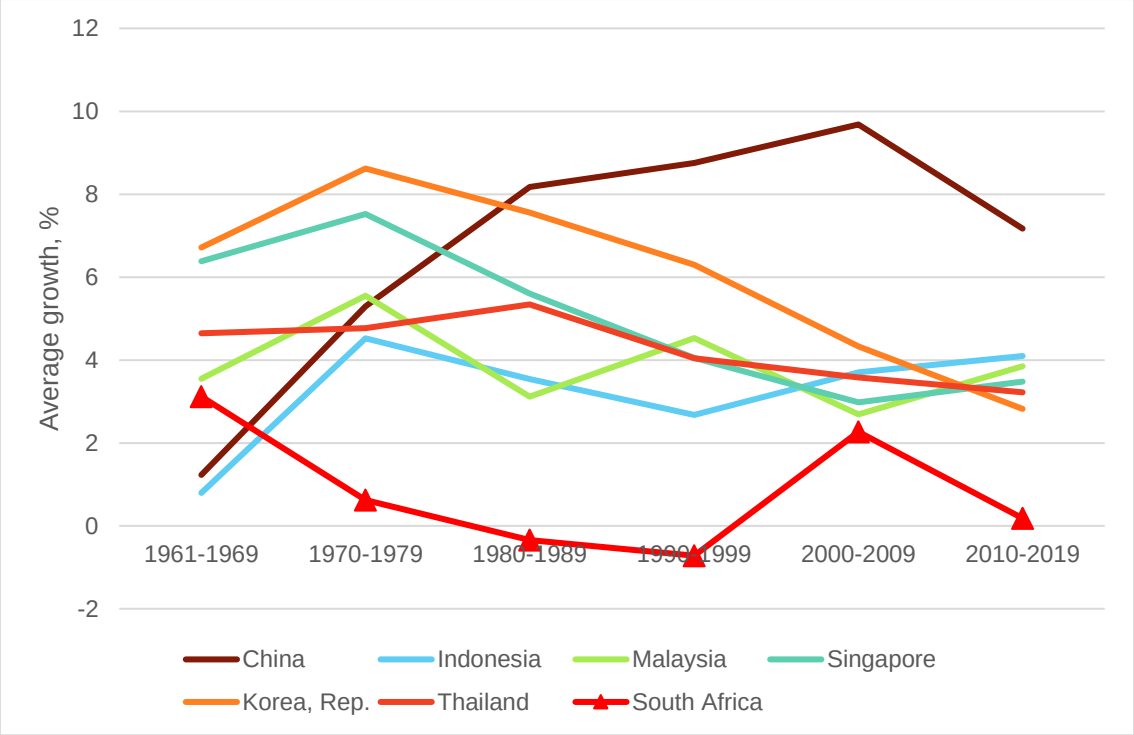


FIGURE 7-8: REAL GDP PER CAPITA GROWTH OF SOUTH AFRICA AND EAST ASIA
Sourced from World Bank (2019b)

Apart from South Africa's weak relative demographic transition, it failed to yield an accompanying real GDP per capita growth rate close to that of East Asia. **Figure 7-8** illustrates South Africa's average growth per capita of around one percent, well below that of East Asia.

> *"South Africa's demographic transition is well underway and estimates suggest that the country has already progressed through at least half of the period during which the first demographic dividend is expected to be positive. Despite the opportunity presented by the changing structure of the population, policy under apartheid has largely weakened the country's ability to capture the dividend, by thwarting human capital investment and preventing the optimal employment of the working-age population."*
>
> (Oosthuizen, 2015: 21)

According to Oosthuizen (2015), South Africa's first demographic dividend started in 1975 when it first indicated positive levels and peaked slightly over one percentage point in the 1990s. Thereafter, it has been declining but is expected to surge after 2020 and turn negative around 2040. Sadly, South Africa has to date been unable to realise a significant demographic dividend during its

demographic transition. Central to this is the weak demographic dividend for the black African and coloured population groups to date, which together accounted for around 90 percent of the total population (Lehohla, 2017).

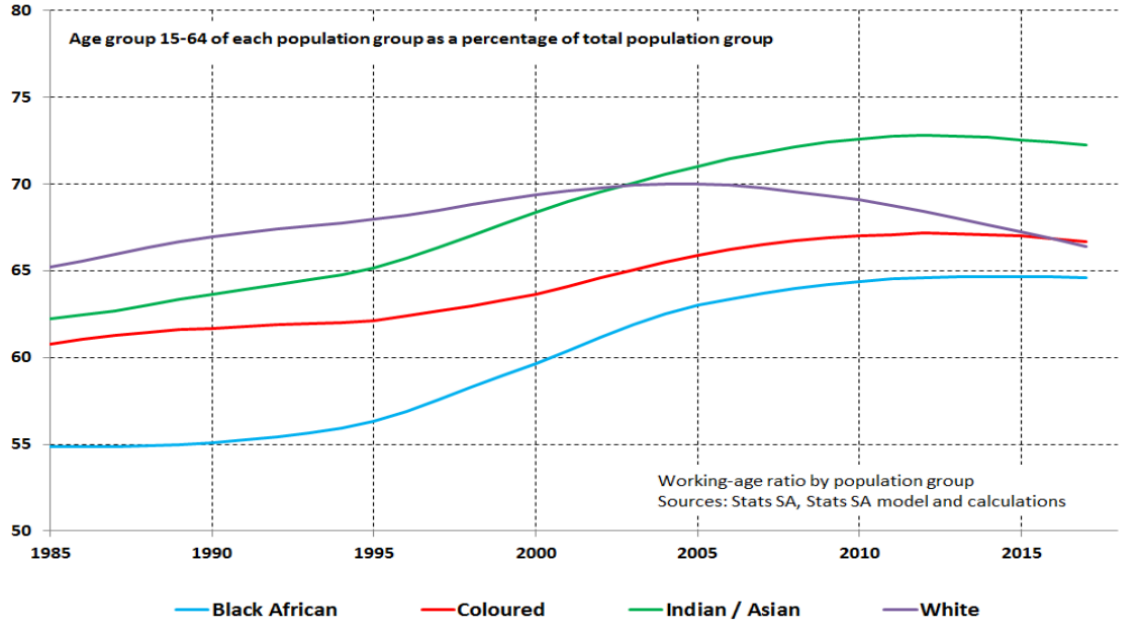


FIGURE 7-9: SOUTH AFRICA'S WORKING-AGE POPULATION AS A PERCENTAGE OF THE TOTAL POPULATION
Sourced from Lehohla (2017: 31)

Figure 7-9 illustrates the ratio of the working-age population of the four major population groups in South Africa. The white population group's demographic dividend reached its highest point of around 70 percent in 2005. The Indian/Asian group reached its peak slightly later, but at around 73 percent – yielding the highest dividend. The coloured group peaked around the same time, but at a lower peak of around 67 percent. The black African population group recently started showing signs of levelling off at just below 65 percent. Consequently, Lehohla observed that South Africa's inability to yield a sufficient demographic dividend for the coloured and black African population groups might be a "demographic disaster in the making" (Lehohla 2017: 4).

Ahmed, Cruz, Quillin, & Schellekens (2016) emphasised that the demographic dividends that usually accompany demographic transitions should not be regarded as automatic. Although changes in the age structure increase

productivity and growth, its magnitude is strongly correlated to the results of effective policies on education, savings-investment, and employment.

Lehohla (2017) identified the following necessary socio-economic conditions for realising the remaining demographic dividend in South Africa: First, employment must be high. If the working-age population is plagued by unemployment, it cannot yield productivity. Second, policies must promote economic growth to accompany a growing workforce. Long-run growth can be promoted by strong institutions, fiscal balance, contained inflation, high savings and investment rates through a stable macroeconomic environment, trade openness, and investments in social and economic infrastructures. Third, good governance in the economic, public, and private domains must be present. Fourth, investments in human capital must be widespread. Education and training are necessary to build a robust and skilled workforce. It facilitates technology adoption and provides the means to educate subsequent generations. Moreover, quality public-education plays a vital role in lowering poverty and inequality. Lastly, healthcare and family planning must be prioritised. A strong healthcare system boosts the dividends received from education. Family planning boosts the working-age ratio and reinforces the demographic dividends. Additionally, Lehohla noted that “there is a two-way relationship between family planning and education: parents with fewer children can invest more in the education of each child, and higher levels of education produce higher earnings and therefore higher opportunity costs of having more children“ (2017:15).

Lehohla (2017) noted that South Africa’s economic growth is hampered by poverty and inequalities, corruption and poor governance, sub-standard education, and inadequate healthcare. The so far poor demographic dividend yielded in the coloured and black African population groups provide evidence of the effects of Apartheid and the inability to address its impact post-1994. These groups showed poor comparative results to the other populations in the areas of income and expenditure, poverty, health, education, skills, and employment.

Furthermore, an urgent call was made to address the failing demographic dividend:

> *"South Africa's demographic opportunity is the transition from a working-age ratio of 57% in 1985 to 65% today. It may not go any higher. The demographic transition has not provided a demographic dividend nationally, and if anything can be done to salvage a portion of the country's potential dividend for the future, it must be implemented now and with the utmost urgency. Since 1994, worthy social and economic plans have come and gone, and to the extent that they have successfully driven socio-economic transformation within a responsible fiscal framework, they deserve credits in spades. But they have not been enough…"*
>
> (Lehohla, 2017: 43)

Lehohla (2017) recommended the following objectives to address South Africa's failing demographic dividend:

- Fully exploit technology and other resources to educate the youth and prepare them for the future economy;
- Clear the path for small businesses prosperity;
- Public and private sector co-operation in broadband availability and quality;
- Stimulate goods and services built on new technologies;
- Level the playing fields, maintain regulatory stability, and promote co-operation between new and old technologies and their markets;
- Address uncertainties and animosity in the mining industry;
- Reduce healthcare inequalities by finding cost-effective solutions;
- Achieve high-quality governance at state-owned enterprises coupled by cost-effective services without drowning taxpayers;
- Superior governance at national, provincial, and municipal levels;
- Termination of corruption; and
- Effective crime investigation and prosecution.

7.6. THE SECOND DEMOGRAPHIC DIVIDEND

A major concern for economic growth during the 4IR is that ageing may put a downwards pressure on investments and savings (Schwab, 2017). According to the World Economic Forum (2018), longevity results in an average shortfall of retirement savings of $250 000 per individual. The effects are worsened by urbanisation, which reduces family support for older persons and increased informal work which lowers pension benefits. Additionally, an ageing population

purchases fewer household assets such as vehicles, homes, and appliances. As people age, assets are preserved for retirement and fewer entrepreneurial ventures are taken. Ultimately, as older persons draw their pension at retirement, both savings and investments fall - hampering economic growth.

There is, however, a small window for opportunity before a country becomes aged. In the later stages of a demographic transition, countries stand to yield a second demographic dividend. According to Ahmed *et al.* (2016), during this stage, the prospect of longevity induces more savings to provide for an extended retirement. The increased savings transforms into human and physical capital investments that may continue to reap permanent benefits after a population has aged. However, this second dividend is strongly dependent on a successful yield of the first demographic dividend. If a population was unable to realise productivity growth and, therefore, per capita income during the first dividend, it will not likely have accumulated the resources to save during the second dividend.

7.6.1. The Life-Cycle of Savings

The LCH theorises that saving patterns differ as the age structure changes. The dependent youth earn zero income and are dissavers. During the early years of employment, income is still low, and assets are accumulated through debt (dissaving). During the prime working-ages, when income is higher, people save towards old age to smooth out future consumption. At old age, dissaving starts (Modigliani and Brumberg, 1954). Therefore, as the population grows, the number of working-age persons will exceed the old and young dependents; and savings will exceed dissaving (Deaton, 2005). Consequently, as a population ages, its youth dependency ratio will fall, which would cause a decline in the total dependency rate and an increase in savings. However, at a later stage, the old dependency ratio will cause another increase in the total dependency ratio, and consequently, dissaving starts again (Thornton, 2001).

7.6.2. SOUTH AFRICA'S SAVINGS-AGE NEXUS

The positive relationship between income growth and savings is well documented in international studies (Thornton, 2001; Modigliani and Cao, 2004; Horioka and Wan, 2007; Rosado, Isabel & Sánchez, 2017). However, results are mixed on whether the LCH holds when the age dependency ratio is added to the equation. While some studies could prove a negative relationship between the age dependency ratio and savings (Horioka, 1997; Thornton, 2001; Ahmad, 2002; Bloom, Canning & Graham, 2003; Rosado et al., 2017), others found the relationship to be insignificant (Ram, 1982; Husain, 1995; Horioka and Wan, 2007).

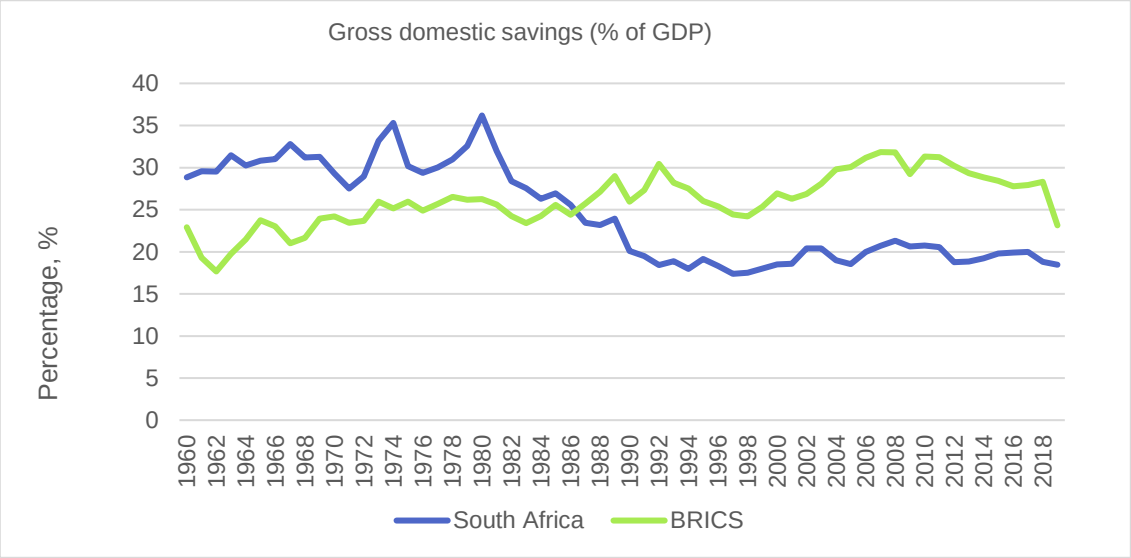


FIGURE 7-10: SOUTH AFRICA'S GROSS DOMESTIC SAVINGS COMPARED TO THE BRICS AVERAGE
Compiled by researcher (2021)
Data from World Bank (2020d)

In South Africa, the savings rate is well below its BRICS counterparts (**Figure 7-10**). In 2019, its gross domestic savings as a percentage of GDP was 18,47 percent. This was slightly higher than Brazil's ratio of 14,78 percent, but significantly lower than China, India, and Russia's savings rates of 47,35[15]; 28,0; and 31,32 percent, respectively. Furthermore, while the BRICS average has been

[15] The most recent data for China is 2018.

increasing over time, South Africa's gross domestic savings is on a declining path.

A clear decline in South Africa's gross domestic savings can be observed in **Figure 7-10.** Aron and Muellbauer (2000) explained that this decline is mostly due to the governments declining saving rate from the early 1980s. The private savings rate exhibited more stability, except in the late 1970s when gold price was exceptionally high. However, household savings declined since the 1980s, but private savings remained stable due to significant growth in corporate savings. Government's dissaving reached its peak in 1993 and improved its savings thereafter.

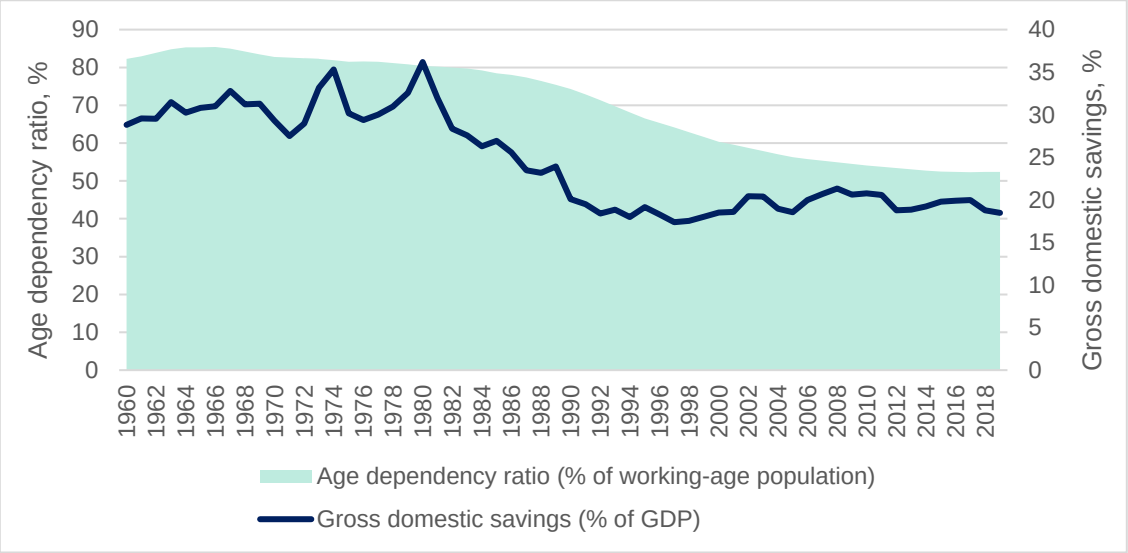


FIGURE 7-11: SOUTH AFRICA'S GROSS DOMESTIC SAVINGS AND TOTAL AGE DEPENDENCY RATIO, 1960-2017
Compiled by researcher (2021)
Data from World Bank (2020d, 2020c)

The LCH predicts that the decline in the age dependency ratio (as a result of a decline in the youth ratio) should increase the savings rate. However, the decline in South Africa's total dependency ratio in recent decades was accompanied by a contradicting fall in gross domestic savings to GDP (**Figure 7-11**).

South Africa has a puzzling savings culture which provides little evidence of the LCH. Zwane, Greyling & Maleka (2016) used panel data from the National Income Dynamics Study (NIDS) to study what determined household savings in South Africa between 2008 and 2012 on the macro-level. The fixed effects,

random effects, and two-stage least squares (2SLS) models were used to estimate. The authors found evidence of a positive relationship between household savings and income in South Africa. They reported a positive relationship between the age of the population and savings; and that the population of older persons' savings diminished with age. In this case, the LCH was proven to hold.

In comparison, Ting and Kollamparambil (2015) used the age cohort analysis and multivariate analysis to study the LCH in South Africa for the periods 2002-2004 and 2008-2010. The study found that household incomes peaked in the early forties – well below the average international age. The authors found evidence of consumption smoothing - indicating support for the LCH; but additional smoothness over the age and cohort variables disproved the LCH. Savings did not decline in old-age, possibly due to the higher propensity of longevity among the rich and the saving of old-age grants by the poor towards funeral costs. Interestingly, the findings showed that while old-age grants improved consumption levels during old age, it also discouraged savings during the working years.

On the other hand, micro-level empirical studies on South Africa found no evidence of the LCH. Spio and Groenewald (1996) used the age cohort technique to test the LCH in South Africa at micro-level and found no evidence of the LCH. Interestingly, they found that the working-age population did not save due to family-dependency. In cases where enough money was available, households were able to save. Similarly, Deaton (2005) noted that low-income households regularly dissaved during their saving years. Esson (2003) used an OLS, logistic approach to test the LCH in Khayelitsha and Mitchell's Plain. The study disproved the LCH and found higher savings in the population of older persons than the working-age population. The author explained that this was because low-income households saved towards funeral costs during old age.

The reason for the inconsistent results of South Africa's age-related savings pattern lies within the way old-age consumption is funded. Consumption during retirement can be funded either through the accumulation of assets in the

working-years, or the transfer of resources from future generations (Oosthuizen, 2015). Lee and Mason referred to the latter as a 'claim' against future generations (2006).

Expansions of non-contributory transfer systems as a mean to counteract ageing will negatively affect asset accumulation, and the second dividend will not be realised. To realise the dividend, the working-age population must be persuaded to save for retirement. This will require sound financial institutions that are within reach for the entire population (Lee and Mason, 2006).

7.6.3. Old-Age Grants

The Samson Institute for Ageing Research (SIFAR) reported that South Africa had a high pension coverage (92,6 percent), and over 77 percent of older persons received non-contributory, means-tested OAGs from the government, while the remaining benefited from strong private pension funds. Challenges, such as high unemployment and poverty, made it difficult for the youth to save for old age. Ultimately, more people would rely on the government to provide assistance in their old age (2016).

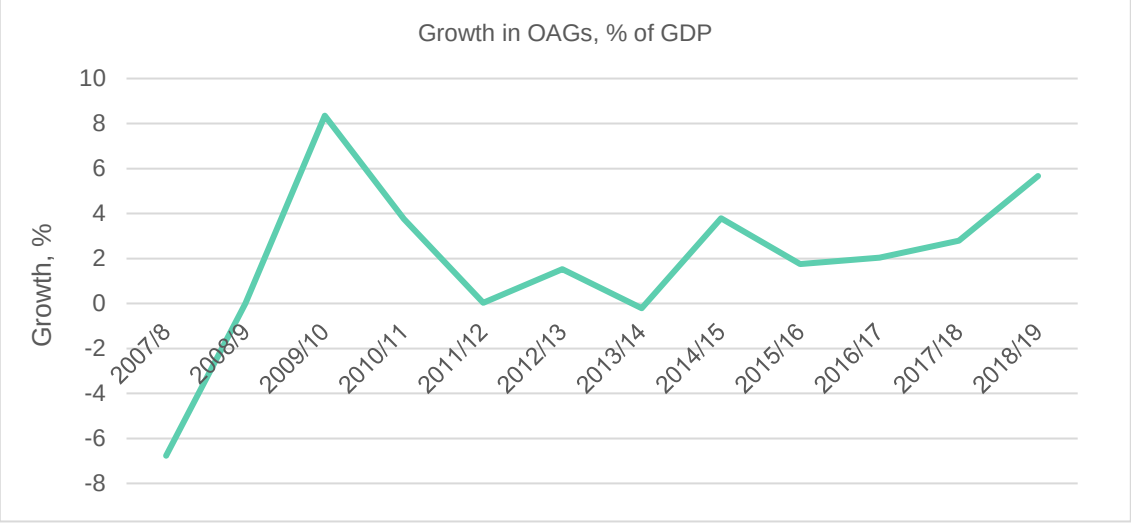


FIGURE 7-12: ANNUAL GROWTH IN OLD-AGE GRANT EXPENDITURE AS A PERCENTAGE OF GDP, 2006/7-2018/19
Compiled by researcher (2021)
Sourced from SARB, (2019a); South African Social Security Agency (SASSA) (2019)

Figure 7-12 illustrates the growth of OAGs expressed as a percentage of GDP at market prices for the period 2006 to 2017. The spike from a negative growth

rate in 2007/2008 to an 8,35 percent growth in 2009/2010 can be explained by a recession characteristic of this period, as well as the change in OAGs qualifying age of men from 65 to 60 (2008-2010). After this shock, the growth rate stabilised but trended upwards. The average growth rate for the period was 1,9 percent, suggesting that OAGs are becoming an increasing burden to the working-age.

Because the taxpayer ultimately funds OAGs, ageing will put more pressure on the working-age population. As the population ages, the need for financial support will elevate together with a declining, tax-paying, working-age population. Furthermore, persistent unemployment will reduce tax contributions from the working-age population even more (Goodrick and Pelser, 2014). The threat of rising grant payment growth threatens the possibility of reaching a fiscal cliff in future decades (Mbeki *et al.*, 2018).

Although the South African Savings Institute (SASI) reported that OAGs have had great success in alleviating poverty and inequality in old age (SASI, 2008); its success may come at the expense of a second demographic dividend. Should South Africa wish to gain this dividend, it will need to increase the current working-age population's private savings.

7.6.4. Pension Funds in South Africa

To prepare for the 4IR, World Economic Forum (2018), stressed the need to: First, increase the amount of workers with pension benefits; and second, increase the amount of savings needed for retirement.

Pension funds can be crucial safeguards for structurally unstable economies (Moleko and Ikhide, 2017). Using the World Bank model, Moleko and Ikhide categorised South Africa's pension system into three pillars. The first pillar is used to alleviate poverty by distributing taxes to the poor. In South Africa, OAGs falls under this pillar. The second pillar is funded by personal savings and is often mandatory. South Africa does not have a mandatory pension system, except in cases where employers offer such a benefit. The third pillar is voluntary and includes lump-sum benefits and annuities. The study found South Africa's pension system to be well-functioning and a worldwide example of success.

However, the second pillar is neglected, and these mandatory pension funds could provide even more success. On the other hand, Pask and Marx (2018) noted that emerging economies do not adapt mandatory savings fruitfully.

In order to expand private pension funds, South Africa may need to look beyond rigid systems. SASI (2008) used secondary research, analysis', interviews and focus groups to investigate the ability of low-income households in South Africa to adapt to different pension systems. Primarily, the study found that: first, the lowest-income households would not be able to contribute to mandatory systems. OAGs will remain their primary source of old-age income but removing the means-test would also remove the disincentive for some to save. Second, those with low and irregular incomes would save involuntary, incentivised vehicles with flexibility of contributions. However, it is unlikely that the private sector would find profit in this market. Third, low-income households with regular incomes would be able to contribute to a saving-vehicle; but, due to financial strains, the flexibility to opt-out would be a prerequisite. Finally, middle-income households would be able to adapt to compulsory and flexible, voluntary savings-vehicles.

7.7. THE CHALLENGES OF AN AGEING SOUTH AFRICA

7.7.1. HOUSING AND LONG-TERM CARE

According to Goodrick and Pelser (2014), suitable housing demand and long-term care (LTC) for older persons will accelerate as South Africa ages. Lloyd-Sherlock (2019) found significant differences in LTC between different population groups. Welfare organisations and churches, usually controlled by the white population, historically developed care facilities designed for western cultures, causing remarkable racial differences in the living arrangements of older persons. Black African persons were more likely to live with their families than white persons. Interestingly, the authors noted that data on the population of older persons living with families did not exclude skip-generation households. Where family support was present, there was a lack of data indicating the quality of support.

Lloyd-Sherlock (2019) observed that in 1982, South Africa's white population group had the highest percentage pensioners in the world living in retirement homes (private or public); while this percentage of other population groups were below average. Furthermore, most retirement homes in South Africa were run by Non-governmental organisations (NGOs) and churches. Many NGOs were partially subsidised by the government, while merely eight homes were fully funded by the government. Over the past decades, these subsidies declined significantly, forcing organisations to focus more on wealthier pensioners.

Lloyd-Sherlock's (2019) study further emphasised the existence of racial structures in retirement homes caused by discrimination and cultural preferences. Many black African older persons resided in informal, unregulated retirement homes, where they were often neglected. The author criticised the Older Person's Act, 2006, for focussing mainly on residential services while neglecting older persons living with family-members; supporting only the frail with no family to care for them; and neglecting the quality of available residences.

The current study could not find any research or data on the demand for housing among the older population of South Africa. In addition, the researcher could find no evidence that - given their financial and social circumstances - older persons in South Africa prefer to live in extended households. South Africa has been struggling since 1994 to meet its housing demands. In the following two decades, the South African Institute of Race Relations (SAIRR) reported that more than three million houses were built by its government, but the backlog grew larger than its 1994 level (SAIRR, 2015). Providing housing suitable for older persons would be a tremendous challenge for the government.

7.7.2. HEALTH

Ageing causes the demand for long-term and chronic healthcare to swell (Goodrick and Pelser, 2014). Over the past few decades, health policies were sensibly geared towards HIV/AIDS and related problems. However, non-communicable diseases (NCD), such as diabetes and cerebrovascular diseases, collectively remained the leading cause of death. Due to the focus on HIV/AIDS,

healthcare related to NCDs - prevalent in older persons - have been neglected (Lloyd-Sherlock, 2019).

Older persons in South Africa face a healthcare system with a lack of specialised treatment. Lloyd-Sherlock (2019) noted that there were only eight registered geriatricians in 2010 to cater for the needs of the entire South African population of older persons, and the South African Nursing Council recently removed gerontology training from its qualification. The Economic Intelligence Unit reported that only four medical schools in the country included geriatric medicine in their tuition (AARP, 2019). Furthermore, the AARP pointed out additional barriers, which prevented older persons from accessing healthcare. These barriers include waiting in long queues and transportation.

According to SIFAR (2016), an ageing population raises concerns in South Africa, already struggling to care for its current population of older persons - especially since the health system is under severe strain from NCDs. A further increase in chronic diseases, linked to ageing, will challenge the health system beyond expectations.

In response to the healthcare problems in South Africa, its government plans to implement the National Health Insurance (NHI). According to AARP (2019), the NHI will unify public and private healthcare and provide an inclusive healthcare system. This system will aim to provide priority for all older South Africans. However, academics are divided on its potential effectiveness. Some are optimistic about the government's commitment so far. On the other hand, sceptics warn that the quality of healthcare should first be revised.

7.7.3. Workforce Productivity

Economic growth may slow down due to an older workforce and fewer economically active workers. According to Goodrick and Pelser (2014), older workers are often less productive, and economic growth may consequently suffer.

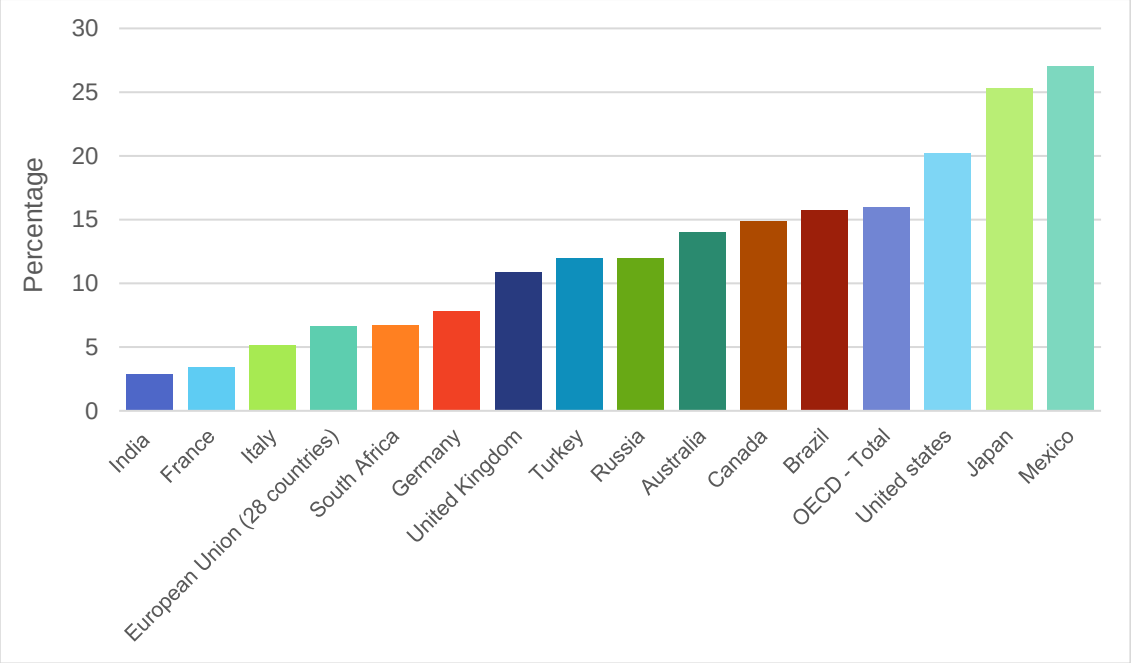


FIGURE 7-13: LABOUR FORCE PARTICIPATION, 65 YEARS AND OLDER
Sourced from OECD (2020a)

Figure 7-13 illustrates that the LFPR of older persons in South Africa was less than half that of the OECD countries' average at 6,7 percent. However, it is slightly higher than the European Union's (EU) average of 6,6 percent; but fourth-lowest of the G20 countries included in the comparison.

According to Bloom *et al.* (2014), the decline in workforce participation, due to ageing, can be offset to a certain extent by investments in education, training, and health. AARP (2019) noted that the accelerated changes in technology pose a challenge to older-workers attempting to obtain updated knowledge and skills. Employers rarely provide education and training to older workers, perceiving this as a poor human capital investment. In South Africa, government and NGOs often focus on adult education, but education for older persons is limited to literacy, caregiving, and basic skills. Additionally, government initiatives often come with an age-ceiling of 55 years.

Bloom *et al.* (2014) reported that lower fertility rates gave rise to diminishing childcare liabilities in females, increasing their participation in the labour force, and spurring growth. The authors further added that productivity figures were significantly affected by diseases and disabilities in older persons. Savings were often redirected to healthcare - exhausting capital. They concluded that the

impacts of ageing on economic performance were exaggerated, and counteracting behaviours and policies could prevent the damage.

According to AARP (2019), an older population poses a productive opportunity. Older persons are healthier than before, live longer, and possess valuable experience. Accessing these opportunities require more than pension reforms. Factors, such as mandatory retirement ages, rigid work arrangements, and discrimination against older workers, prevent older workers from workforce participation.

7.7.4. Extending the Retirement Age

Schwab (2017) suggested that retirement ages be extended to maintain older persons' contribution to the workforce. This would alleviate the decline in the working-age population and rise in older person dependents. However, according to Gruber, Wise & Milligan (2009), many countries discourage early retirement, claiming that increased employment among older persons cause a rise in youth unemployment. Therefore, in South Africa, with an already high youth unemployment rate, it is unlikely that increasing the retirement age will be a popular choice.

Over the past few decades, the retirement age fell gradually. Recently, the South African government announced that, in order to cut its wage bill, early retirement without penalties would be offered to employees. This strategy is commonly used in businesses and governments during recessions to make space for younger, inexpensive, employees. However, Gruber et al. (2009) used various econometric methods to test the validity of boxed economies. They found no evidence that youth unemployment rose when the retirement age in developed countries was extended. In fact, they found that extending the retirement age reduced youth unemployment.

In the absence of literature on the link between the retirement age and youth unemployment in South Africa, researchers have instead addressed the relationship between OAGs and employment of younger household members in South Africa. Bertrand, Mullainathan & Miller (2003) used cross-sectional data to

determine the effect on employment of household members when a member received an OAG. The study found that prime-aged members significantly reduced their labour supply when a member turned the age of retirement. The effects were even stronger when the older member of the family was female. Posel, Fairburn & Lund (2006) extended on the Bertrand et al. (2003) model by including labour migrants in their study. They found that OAGs, especially when received by female pensioners, provided opportunities for other household members to migrate to areas where labour demand was stronger. Abel (2013) criticised Bertrand et al. and Posel et al. on the basis that pension income lured unemployed individuals into homes.

Ardington, Case & Hosegood (2009) used panel data to perform a longitudinal data analysis on households in northern KwaZulu-Natal and found that OAGs increased employment among prime-aged household members. The authors further explained that migration became possible through increased resources and the availability of pensioners to look after children while their parents worked. However, Abel (2013) noted that the data represented only one rural district. In response, Abel performed a national, fixed-effect, cross-sectional regression analysis. The author found that OAGs increased reservation wages and therefore discouraged labour force participation by prime-age members of households. Furthermore, Abel disproved the hypothesis that retired persons provided childcare which enabled parents to work.

OAGs may also serve as a disincentive for labour participation of older persons. According to the AARP (2019), 90 percent of older persons received OAGs in 2015, 80 percent of them received this as their primary income. In 2008, men aged 60 became eligible for OAGs (previously eligible at 65). Between 2008 and 2011, the LFPR for older persons fell by a third. However, the failure of OAGs to adjust to inflation caused a moderate rise in recent years.

Tondini, Ardington & Woolard (2017) examined the effect of the gradual reduction of retirement ages in males from 65 to 60 in 2008 on the employment of older persons. A modified *Regression Discontinuity Design* was applied, and it was found that informal work among older persons fell significantly when they

received OAGs. Formal work was not affected. Interestingly, informal work fell by 40 percent when the transfer was approximately equal to the median wage. The findings stressed the importance OAGs play in the decline of the, already struggling, informal sector; and pointed to the unlikelihood of sustaining the current average retirement age of South Africans in the coming decades of population ageing. As the population ages, many may realise that they need to lengthen their working lives. However, because the OAG is means-tested, it is unlikely that many South Africans will be willing to extend their working lives (Goodrick and Pelser, 2014).

To prepare for a productive ageing population, the AARP (2019) suggested a holistic approach, which includes work flexibility, a focus on the unique requirements of older workers, and acknowledges the productive opportunities of older workers.

7.8. AGEING 4.0

To prepare for an aged population within the next three decades, South Africa can learn a great deal from developed, aged, countries. To deal with the issues of ageing, many countries are encouraging and funding digital innovations. Priego, Switters & Munoz (2017) listed the 25 leading projects for active and healthy ageing (AHA). These projects include integrated care systems; fall prevention devices; pre-frailty detection; monitoring systems for dementia patients; ambient assisted living (AAL) solutions; robotic companions; and home sensors.

According to the AARP (2019), as part of its “smart platinum society” project, Japan plans to support its older persons through robots, big data and IoT. One notable project emerged in Otsuki, a small city with 35 percent of its population consisting of older persons. The project focusses on e-agriculture, e-tourism, and e-health. The e-agriculture component connects urban tenants with rural land-owners. Local farmers are tasked to maintain the farms, and through sensors and digital cameras, urban tenants can communicate with them. E-Tourism attracts tourists through online campaigns, and the e-health component uses digital

devices to track individuals' health and send important data to medical practitioners. The Senior Planet Exploration Centre, in the US, provides technological training for older persons. In Germany, the "train the trainer" initiative trains older persons to serve as trainers of technological skills for the older population. Many similar initiatives are underway in other aged economies.

According to Lee and Lim (2017), an ICT-based medical system that can provide medical and care assistance at home is becoming the future of healthcare. These technologies, called "smart care", will not only provide medical assistance in hospitals, but it will also allow individuals more independence from family-members and care facilities. It is expected that by the mid-2020s, intelligent sensors will be able to realise a "connected home" in which everything will be internet-connected. These systems may have a powerful impact on AHA, especially for dementia sufferers in need of constant monitoring.

The 4IR and the rise of the gig economy could offer creative solutions to expand pension benefits to informal workers. According to Morawczynski and Porteous (2019), digital platforms are rising in Africa; and consequently so are freelance or "gig" workers. A rise in informal work will exclude many from pension and other benefits provided by formal employment. However, digitisation could offer a solution in portable benefits. The concept of portable benefits suggests that employers would pay a percentage of any work performed by gig workers as universal benefits. For instance, if an Uber driver provides his services for a particular trip, then a percentage of the compensation for that trip will be transferred to a universal benefit pocket. Should the worker provide a service to another digital platform, then a percentage of the work done will be transferred into the same pocket. Such a system may provide an opportunity for the rising gig- and informal labour force to save towards retirement.

According to Priego et al. (2017), AHA promises more than just comfortable lives for the old. It also promises the development of the 'silver economy', promising economic growth through highly-skilled tech jobs, re-training of low-skilled workers, and the potential for new start-ups.

7.8.1. THE AGE-RELATED DIGITAL DIVIDE

Technologies that improve the lives of older persons will require digital literacy. According to Mcdonough (2016), older persons are affected more by the digital divide because they are less inclined to use the internet than the youth. The older population has its own challenges with internet penetration; as well as educational-, racial-, income-, and other inequalities. The age-related digital divide is magnified by other factors contributing to digital illiteracy. Although South Africa's mobile connectivity penetration was ranked fourth worldwide at 170 percent in 2018 (DATAREPORTAL, 2019), its internet penetration rate remained low in 2016 with only 5,4 percent of users older than 60 (AARP, 2019). DATAREPORTAL reported that in 2018 only 2,6 percent of females and 2,4 percent of males over the age of 65 in South Africa were accessing social media.

Pew Research Center (2019) reported that 89 percent of South Africans aged 18-29; 77 percent aged 30-39; and 47 percent aged over 50, were internet users in 2018. Moreover, the difference between the youngest and oldest age groups was 42 percentage points. In contrast, Mexico reported a 35 percentage point difference, with 60 percent internet usage among older adults. However, other emerging economies, such as India, fared much worse than South Africa. Although India's age groups had a gap of 35 percentage points, the youngest and oldest age groups reported internet use of only 55 and 20 percent, respectively.

The literature ascribes the digital divide of the older population to low computer literacy, technophobia (fear of technology), physical and cognitive disabilities, age discrimination, lack of interest, income, and the lack of training or opportunities (Antonio and Tuffley, 2016; Mcdonough, 2016). Continuous changes in technology perpetuate these problems. In South Africa, where 95 percent of the adult population used mobile phones in 2018 (DATAREPORTAL, 2019), older persons are limited to use technology with small displays, inadequate input/output facilities, and low audio quality (Van Biljon, Van Dyk & Gelderblom, 2010). However, many large companies, such as Vodacom, have designed devices specifically for older and disabled persons (AARP, 2019). The AARP further noted that, although some municipalities have rolled out free Wi-Fi

spots in recent years, older persons still lack skills and ease in using technology; and, consequently, fail to benefit from these services.

7.9. CONCLUSION

The second headwind to South Africa's ability to exploit economic growth opportunities during the 4IR is its demographics. While most advanced economies will be facing the challenges of population ageing during the 4IR, developing countries' populations are much younger and stand to benefit from this. Paradoxically, even though South Africa should theoretically yield its first demographic dividend, it has so far failed to do so. Plagued by unemployment and poor education, the current boom of working-age adults is not yielding the productivity benefits characteristic of this stage in population growth: the first demographic dividend.

Going into the 4IR, South Africa will, therefore, be poorly equipped to further benefit from a second demographic dividend when its ageing citizens start to save for old age. Furthermore, South Africa's savings rate, far below the BRICS-average, is indicative of poor future savings prospects.

Another interesting trend in South Africa's demographic transition is the large differences between population groups. These categories speak of a majority young, black African population group which contrasts sharply against an ageing white population group. Policymakers should not ignore the diverse ageing processes by applying generalised ageing policies.

Interestingly, the 4IR may bring new technologies for ageing populations that may raise the standard of living of older persons and may open doors for a silver economy – creating jobs and contributing to economic growth. However, these technologies will be fruitless as long as the age-related digital divide is ignored.

Unemployment – together with poor education - is a major obstacle to yielding the first demographic dividend. It is therefore not surprising that the headwinds are interconnected, and poor performance in one can strengthen another.

Chapter 8 will argue that South Africa's high unemployment is the third headwind to economic and productivity growth during the 4IR.

CHAPTER 8 : UNEMPLOYMENT

8.1. INTRODUCTION

The previous chapters introduced the first two headwinds, inequality, and demographics. The first demographic dividend has so far been unable to realise, partly due to South Africa's high unemployment rate. Additionally, inequalities will continue to rise if the country continues to fail in addressing its unemployment crisis.

The purpose of this chapter is to analyse the labour market within the contexts of the 4IR and determine whether a poor performing labour market is a major headwind to South Africa's economic growth. The chapter will provide a background to labour market fears, followed by Okun's law as a framework explaining unemployment's relevance to economic growth. The remainder of the chapter will investigate the challenges workers may face during the 4IR; and analyse South Africa's position given these challenges, before concluding.

8.2. THE LUDDITES

The fear that technology will cause unemployment is not confined to the 4IR. In fact, these fears were alive and well centuries ago when the Luddites became the first known anti-technology movement in history. The Luddites[16] were English textile workers who feared unemployment due to new technologies. Between 1811 and 1817, these workers destroyed machinery and mills in an attempt to prevent technological unemployment (Brynjolfsson and McAfee 2016). However, the momentum of Luddism was soon lost when new employment opportunities were realised through technological advancements (Le Roux, 2018).

According to Brynjolfsson and McAfee (2016), the fears of technological unemployment which transpired, after the Luddites first expressed their fears, evolved into two camps. The first camp acknowledged that technology causes

[16] Named after an unsubstantiated story about Ned Ludd who raged into the house of a stock weaver and burned his machinery in the late 1700s. Although Ned Ludd is likely to be a mythical character, he became a symbol that describes anyone rejecting technology to this day (Brynjolfsson and McAfee 2016).

unemployment, but that this is only temporary. They argued that capital is creative in nature and soon creates better opportunities for those who were temporarily displaced. William Leierson noted that “the army of the unemployed is no more unemployed than are firemen who wait in fire-houses for the alarm to sound, or the reserve police force ready to meet the next call.” (1916: 12).

The second camp argued that technology can cause permanent unemployment. John Maynard Keynes was among the first to voice his concerns:

> *“We are being afflicted with a new disease of which some readers may not yet have heard the name, but of which they will hear a great deal in the years to come – namely, technological unemployment. This means unemployment due to our discovery of means of economizing the use of labour outrunning the pace at which we can find new uses for labour*.”
>
> (Keynes, 1963: 358)

Keynes’ theory was short-lived. Employment recovered after the Great Depression, and technological unemployment was soon forgotten. However, new fears of technological unemployment emerged with the invention of the computer in the 1960s. Leontief (1983) argued that computers would make labour redundant in the following decades – but once again, this theory was short-lived.

Decades later, economists find themselves, once more, expressing the very concerns of Keynes, Leontief, and the Luddites. These concerns are magnified by the ability of recent innovations to replace cognitive behaviour (Brynjolfsson and McAfee, 2016). Rifkin warned that, although there is no timeline, the world is increasingly moving towards the “end of work” (1995: 291).

8.3. OKUN’S LAW

The relationship between unemployment and economic growth is best described by Okun’s Law. According to Okun’s law, a negative relationship exists between unemployment and economic growth. If unemployment rises, then it follows that economic growth would fall and vice versa. Okun’s law is well established in international studies (Pierdzioch, 2009; Ahmed, 2011; Stephen, 2012). According to Geldenhuys and Marinkov (2007), the specification of Okun’s law results in

misspecifications during economic booms or recessions. These so-called asymmetries imply that unemployment would be more responsive to economic growth during economic booms and less responsive during recessions.

Results on Okun's law on the South African economy yielded contradicting results. Kavese and Phiri (2020) conducted a provincial analysis to test Okun's law. They used the nonlinear autoregressive distributive lag (N-ARDL) and the Corbae-Ouliaris filter. Although only a short-run significant negative relationship could be proven at country level, long-run significant relationships between unemployment and economic growth were found in the Western Cape and KwaZulu-Natal. The remaining provinces displayed weakly significant relationships.

Other studies have found clear evidence of Okun's law. Geldenhuys and Marinkov (2007) investigated the validity of Okun's law in the South African economy using various detrending methods in order to decompose the data into its cyclical and trend segments. The authors found that Okun's law holds in South Africa, accompanied by evidence of asymmetries during recessions. Phiri (2014) examined South Africa's asymmetric co-integration adjustment in Okun's law for the period 2000-2013. The author used a momentum threshold autoregressive (MTAR) framework. The study confirmed the negative relationship between unemployment and economic growth. Furthermore, during smooth shocks, economic growth did not granger cause unemployment. However, unemployment granger caused economic growth.

8.4. LABOUR MARKET DISRUPTIONS IN THE 4IR

Schwab (2017) noted that the 4IR would have a more disruptive effect on the labour market than the previous revolutions because of its speed, breadth and depth, and system transformations. He mentioned two effects technology can have on employment:

1) *the destruction effect*: technology will fuel disruption as it replaces labour with capital, creating unemployment; and
2) *the capitalisation effect*: a rise in the demand for new products and services causes the formation of new occupations, firms, and industries.

If history is a trustworthy guideline, we are bound to experience both the destruction and capitalisation effects. Moreover, the 4IR has, so far, created less new occupations than the preceding revolutions.

By 2030, SSA will accommodate more than 25 percent of the world population under the age of 25. Over the next decade, a generation of Africans with the highest education and global connectivity in SSA's history will enter the workforce (WEF, 2017b).

SSA can potentially yield new economic opportunities by leveraging its demographic dividend. Economic potential can be realised by creating new industries, rapid increases in labour productivity and per capita income, economic diversification, stable growth, job creation, and the production of high-skilled labourers. However, SSA has so far performed poorly when optimising its human capital potential; and the region is ill-prepared for the labour market disruptions that the 4IR will bring (WEF, 2017b).

Schwab (2017) raised his concerns with regards to the inclusion of developing countries in the 4IR. Developing countries traditionally offer more affordable labour and therefore become havens for manufacturing. Automation will make these workers redundant and pose a serious risk to labour and growth in the developing world.

8.5. THE END OF WORK

After the Great Recession, unemployment rates surged globally. For years economists have been debating the cause of this unusual phenomenon. At the time, Brynjolfsson and McAfee (2011) gave three possible explanations for this surge:

- *Cyclicality*: The economy is simply not growing fast enough to create employment;
- *Stagnation*: Innovation and productivity declined in the long-run; or
- *The end of work*: A new era in which fewer workers will be needed for production.

Although the authors acknowledged the effects of cyclicality and stagnation on employment, they disagreed with stagnationists that technological innovation has deaccelerated. They argued that it has accelerated so fast that many workers were unable to catch up. While it is the end of work for some workers, other human skills have become more valuable (Brynjolfsson and McAfee, 2011).

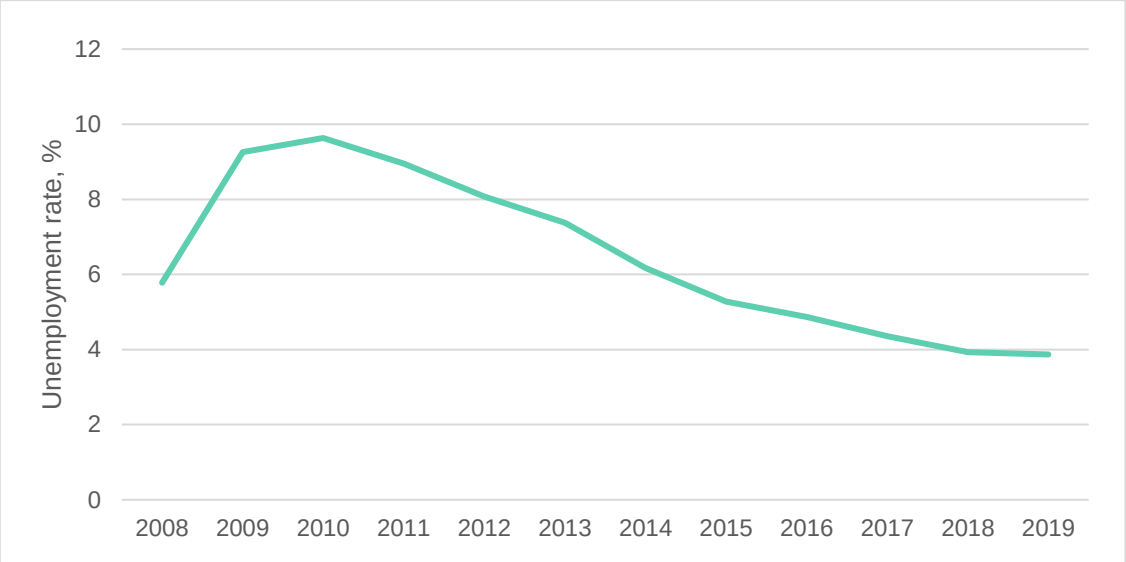


FIGURE 8-1: UNEMPLOYMENT RATE IN THE US, 2008-2019
Compiled by researcher (2021)
Data from World Bank (2020e)

However, **Figure 8-1** shows that unemployment in the US has recovered since Brynjolfsson and McAfee raised their concerns. In fact, in 2019 it reached its lowest point in decades of 3,87 percent. While it was not the end of work for US workers, South Africa's data tells a different story.

8.5.1. UNEMPLOYMENT IN SOUTH AFRICA

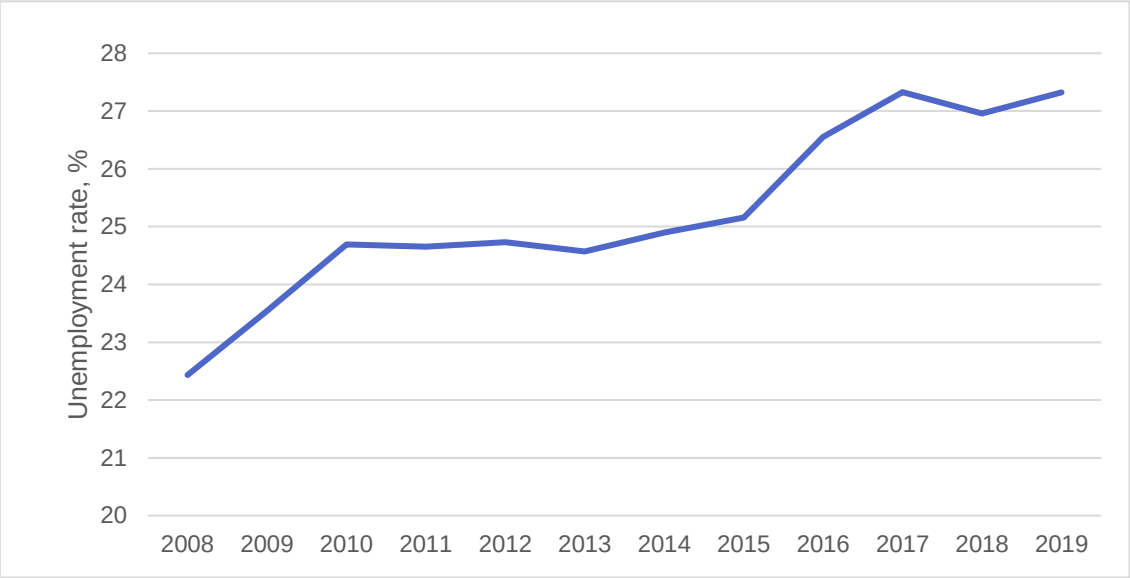


FIGURE 8-2: SOUTH AFRICA'S ANNUAL UNEMPLOYMENT RATE[17], 2008-2019
Compiled by researcher (2021)
Data from SARB (2020c)

South Africa has been struggling to reduce its high unemployment rate for decades. So far, during the first decades of the post-Apartheid era, there has been a long-term increase in unemployment. In 2002 the unemployment rate reached its peak of 33,5 percent, but swiftly recovered and fell to its lowest point of 22,4 percent in 2008. However, after the Great Recession a steady, continuous, increase in the unemployment rate can be observed, gaining even more momentum in the latter part of the decade. This is illustrated in **Figure 8-2**. More significantly, the latest data from SARB (2020c) recorded an unemployment rate of 30,1 percent in the first quarter of 2020. While this is most likely the initial impact of the Covid-19 pandemic, the pre-COVID19 unemployment rate in the last quarter of 2019 was already high at 29,1 percent.

According to Jordaan (2019), the Commission for Reconciliation Mediation and Arbitration (CCMA) reported that the 4IR contributed to most retrenchments in South Africa in the 2018/2019 financial year and were expecting more referrals in the near future. The hardest sector hit by the 4IR was the banking sector, where automation is increasingly replacing branch-based approaches. Moreover,

[17] Unemployment is defined according to the strict definition.

CCMA director, Cameron Marojane, expressed his concerns about the breadth of these dismissals.

NEDLAC (2019) further noted that cyclical and structural unemployment is particularly important in the South African context. During the period 1960-1990, cyclical unemployment was evident in the private, non-agricultural sector. In the 1960s, a one percent increase in value added resulted in a complementary increase in employment of 1,44 percent. This elevated to 1,6 and 2,2 percent in the 1970s and 1980s, respectively. In contrast, employment rose merely 0,2 percent for every one percent value added during the 1990s. This was followed by an average employment increase of 0,25 percent for every one percent increase in value added in the first 17 years of the new millennium. Moreover, during the same period, employment in the manufacturing sector declined by 0,7 percent for every one percent value added.

In South Africa, structural unemployment is an additional concern. According to the National Economic Development and Labour Council (NEDLAC), structural unemployment refers to a mismatch between skills and vacancies (NEDLAC, 2019). NEDLAC remarked that unemployment in South Africa was primarily affected by structural factors. Most workers were employed in the services sector where dissimilar skills were required than the mining and manufacturing sectors where unemployment fell significantly since the 1990s. The structural change in labour demand can also be attributed to factors such as new production methods and techniques, shifts in goods and service types produced, foreign competition, structural deterioration of certain industries, poor labour productivity, soaring minimum wages, and weak skill levels.

Burger and Fourie (2019) emphasised that unemployed persons in South Africa were 2 and 3,3 times as many as the amount of people employed in the informal sector. The authors explained that the high unemployment rate and comparatively small informal sector can be explained by an association between employment, in both the formal and informal sectors, and involuntary unemployment. Finally, the authors concluded that the informal sector was unable to absorb the significant unemployment numbers due to entry barriers.

8.6. THE WINNER TAKES IT ALL

The modern Luddite does not reject technology per se. However, modern Luddites are more concerned about rising inequality (Lehman, 2015). According to Brynjolfsson and McAfee (2011), technological change does not naturally increase all income. It creates winners and losers, and the losers can be a significantly large portion of the population. Through flexible wages, workers can accept lower wages to avoid technological unemployment. However, David Ricardo theorised that this wage reduction has a limit. If wages fall below subsistence, then workers would choose not to work (Brynjolfsson and McAfee, 2016).

The earliest example of technological unemployment is probably Clark's (2007) example of the horse. In 1901, there were 3.25 million working horses in England. When the combustion engine arrived, most of these horses were displaced, and by 1924 there were less than two million working horses in England. By this time, the wage at which horses could continue working fell below the cost of feeding them.

Technological unemployment can also arise when wages far exceed the subsistence level. This can happen when downward rigidities, such as minimum wages, unemployment insurance, medical benefits, and permanent contracts avert wages from falling consistently with the cost reductions of growing automation (Brynjolfsson and McAfee, 2011).

Brynjolfsson and McAfee (2011) described three types of winners and losers, characteristic of the 4IR:

8.6.1. SKILL-BIASED TECHNICAL CHANGE

"…there is a growing mismatch between rapidly advancing digital technologies and slow-changing humans." (Brynjolfsson and McAfee, 2011: 14).

Brynjolfsson and McAfee (2011) noted that skill-biased technical change (SBTC) creates an increased demand for high-skill labour while reducing low-skill labour

demand. In the US, wages for workers with no high school education has fallen dramatically, whilst wages of workers with tertiary education rose sharply since the 1970s. Autor (2014) highlighted this rising trend illustrated in **Figure 8-3**.

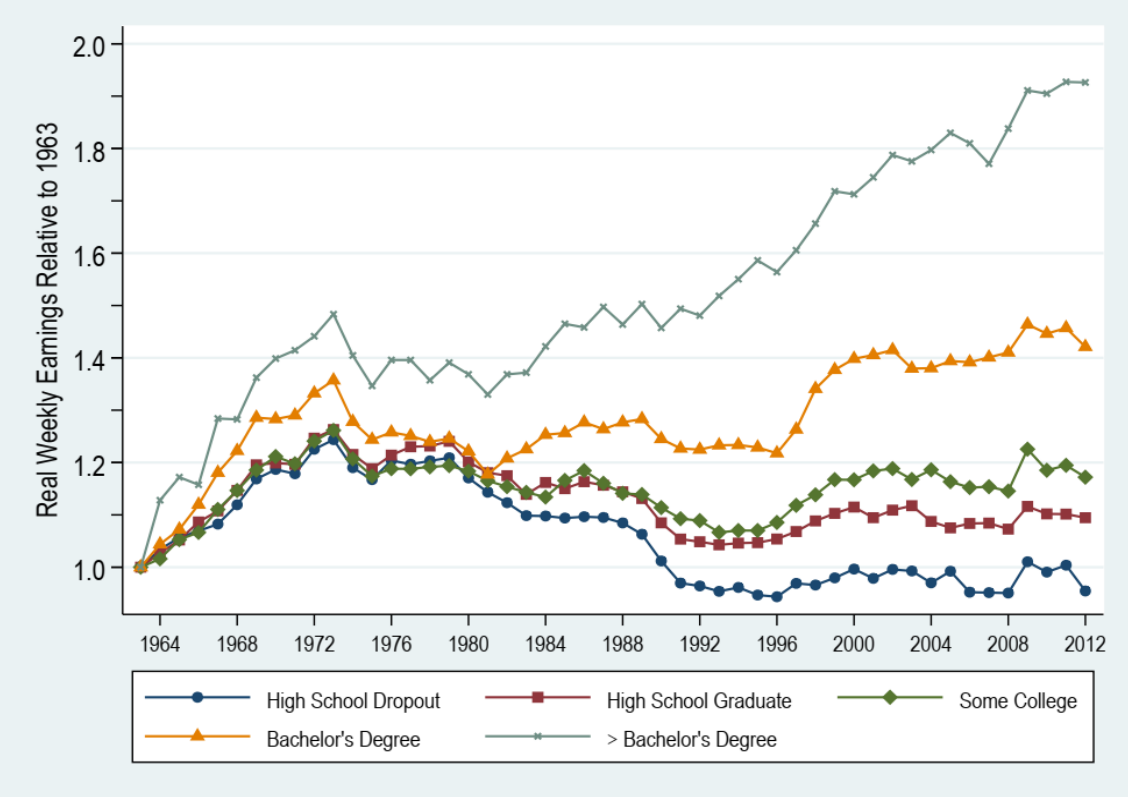


FIGURE 8-3: CHANGE IN REAL WAGE LEVELS OF FULL-TIME MALE[18] WORKERS BY EDUCATION, US, 1963 - 2012
Sourced from Autor (2014: 33)

Moreover, Brynjolfsson and McAfee (2011) explained that the increase in high-skill wages in the US was accompanied by an increase in high-skilled labour supply, pointing to an increase in the relative demand for high-skill workers. Because low-skilled workers started with low wages, SBTC has increased income inequality.

According to Brynjolfsson and McAfee (2011), the increased relative demand for high-skill labour exhibits a positive relationship with digital technologies. SBTC consists of two mechanisms: technologies that replace workers doing routine

[18] A similar trend can be observed among females.

tasks, such as robotics and computerised inventory control; and technologies that increase the value of skills requiring abstract and data-driven logic, such as data visualisation and analytics. In the 20th century, investments in education prevented income inequality from rising due to SBTC.

Brynjolfsson and McAfee (2011) explained that SBTC does not merely impact workers directly related to computers, but also causes changes in the organisation of firms. To exploit information technologies, firms will need to re-engineer their production processes and business models, such as incentives systems, the flow of information, and hiring systems. This may require more highly skilled employees. Moreover, investments in complementary capital of ten times the dollar value is often required for every dollar of computer hardware. A firm's intangible assets are rigid to change but play an important part in prosperous growth.

NEDLAC (2019) noted that economies are reliant on highly-skilled workers to foster innovation, competitiveness, sustainable growth, and development. South Africa's structural imbalances perpetuate structural unemployment and the weakening of economic growth and development.

8.6.1.1. Risk of Automation

Frey and Osborne (2017) investigated the probabilities of automation for 702 occupations in the US. The study revealed that automation was less likely to substitute occupations in which assisting and caring for others, persuasion, negotiation, social perceptiveness, fine arts, and originality were key skills. By comparison, occupations characterised by manual dexterity, finger dexterity, and cramped workspace, exhibited high probabilities of automation. These characteristics served as bottlenecks, and automation of occupations are dependent on how fast engineers can overcome them. Most importantly, the authors found that around 47 percent of employees in the US were at high risk of being replaced by automation.

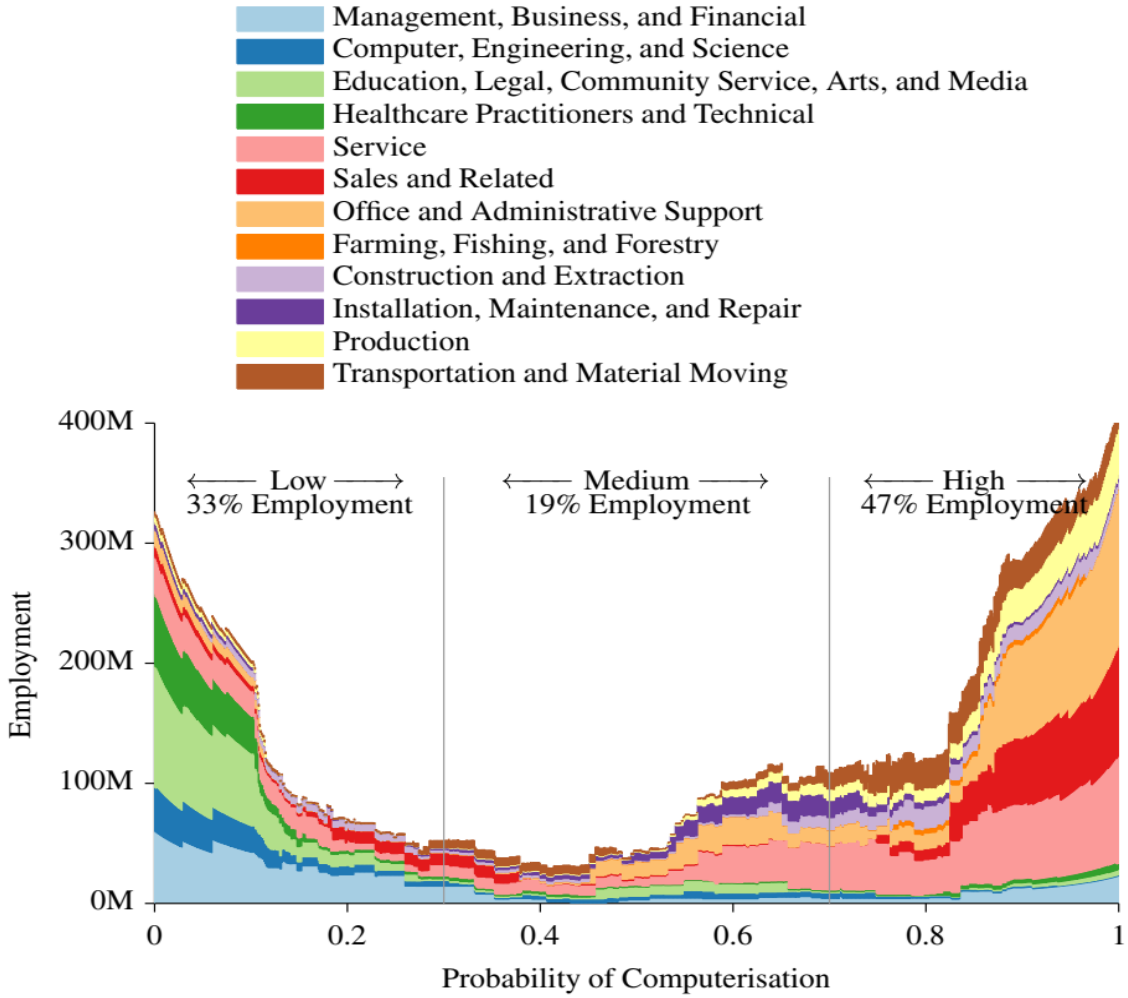


FIGURE 8-4: EMPLOYMENT IN THE US CATEGORISED BY RISK OF AUTOMATION LEVELS
Sourced from Frey & Osborne (2017: 267)

Figure 8-4 illustrates Frey and Osborne's (2017) occupational categories in the US, distinguished by their automation probability risk levels. Occupations in transport and logistics exhibited the highest risk due to the development of computerised vehicles and declining costs of sensors. Algorithms for Big Data are growing rapidly and increases the risk of office and administrative support in these occupations. Production occupations have already shown a trend of computerisation in the past few decades due to the increased developments in industrial robots - it is, therefore, likely to continue this growing trend. Due to the high growth rate of personal and household service robots and the diminishing comparative advantage of human labour concerning mobility and dexterity, sales- and service-related occupations are at high risk of computerisation. Similarly, prefabrication will eliminate task variability in the construction industry.

8.6.1.2. SKILLS IN SOUTH AFRICA

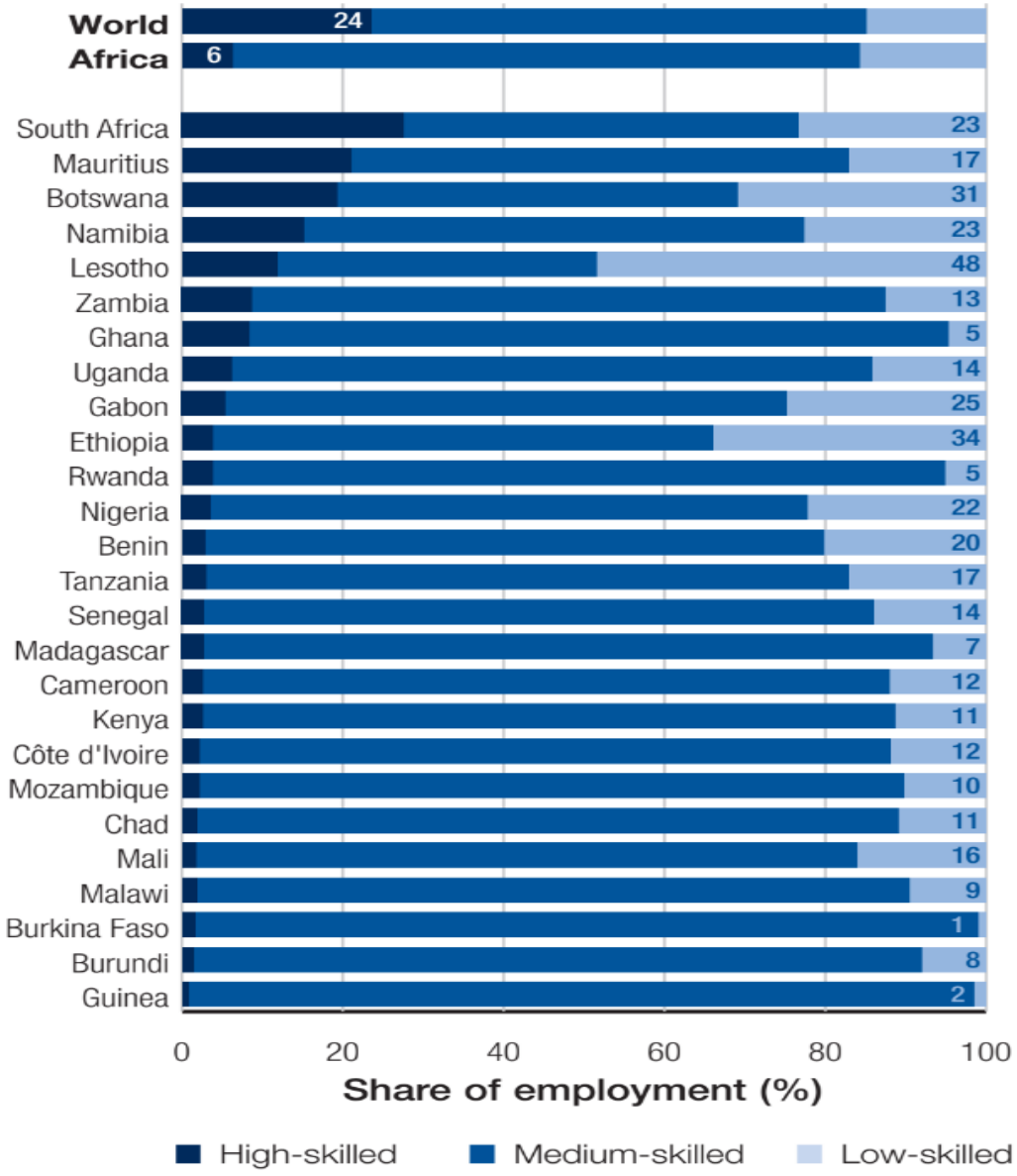


FIGURE 8-5: SSA'S SKILL DISTRIBUTION OF THE EMPLOYED, 2016
Sourced from WEF (2017b)

Although many African countries are less vulnerable to SBTC, the landscape is undergoing rapid change. SSA's skills gap needs urgent attention (WEF, 2017b). In 2016, high-skilled workers in SSA amounted to eight percent of employment compared to the global average of 24 percent. However, South Africa led the region with 23 percent of workers possessing higher skills (**Figure 8-5**).

✓	Analytical thinking and innovation	✓	Leadership and social influence
✓	Creativity, originality, and initiative	✓	Reasoning, problem-solving and ideation
✓	Active learning and learning strategies	✓	Critical thinking and analysis
✓	Technology design and programming	✓	Resilience, stress tolerance and flexibility
✓	Complex problem-solving	✓	Emotional intelligence

TABLE 1: EMERGING SKILLS, SOUTH AFRICA, 2018
Compiled by researcher (2021)
Sourced from WEF (2018: 97)

The WEF (2017b) estimated that 39 percent of core skills required of South African workers would change between 2015 and 2020. Table 1 illustrates the emerging skills identified by the WEF (2018) for the South African labour market.

In addition to SBTC, SSA is expected to yield 15 to 20 million increasingly educated young employees over the next three decades. The region is faced with an enormous challenge of providing matching employment opportunities to its rising workforce (WEF, 2017b). The shortage of skilled workers in South Africa is perpetuated by the flexibility of highly-skilled labourers and their ability to migrate to other countries that offer higher earnings and security (NEDLAC, 2019).

According to Schwab (2017), although male-dominated occupations are more at risk of being automated, low-skilled female occupations that are at risk raise concern of a rising or stagnating gender gap if single-, female-headed income households lose their jobs to automation. The WEF (2017b) stated that, while the 4IR will create jobs in the technology sector, it is not limited to this sector alone. SSA has tremendous infrastructure needs which attract “hard” infrastructure investments. However, investments in “soft” infrastructures, such as education, caretaking of older persons, and childcare, can create more gender-equal jobs.

According to WEF (2017b), the International Trade Union Confederation found that an investment of two percent of South Africa’s GDP would create 511 000 direct and indirect jobs in construction. Of these jobs, 29,6 percent direct jobs would go to women. However, if such an investment is invested in the care economy, it would not only create an additional 414 000 jobs of which women will

gain 61,4 percent of direct jobs, but also develop human capital and create additional jobs in the education sector. Furthermore, the International Labour Organisation (ILO) estimated that a green economy could create 462 000 jobs in South Africa by 2025. An additional 861 000 jobs can be created through online talent platforms by 2025 (WEF, 2017b).

• Software and Applications Developers and Analysts
• Sales and Marketing Professionals
• Managing Directors and Chief Executives
• General and Operations Managers
• Data Analysts and Scientists
• Financial and Investment Advisors
• Assembly and Factory Workers
• Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products
• Industrial and Production Engineers
• Human Resources Specialists

TABLE 2: EMERGING JOB ROLES IN SOUTH AFRICA, 2018
Compiled by researcher (2021)
Sourced from WEF (2018: 96)

According to the WEF (2017b), the 4IR will not only disrupt many occupations, but it will also create new vacancies for professionals with the ability to mix digital and STEM skills with their specific traditional expertise in their relevant fields. To yield the greatest benefits, SSA must promote local, African, digital creators, designers, and manufacturers. Table 2 lists the emerging job roles in South Africa for 2018, compiled by WEF (2018).

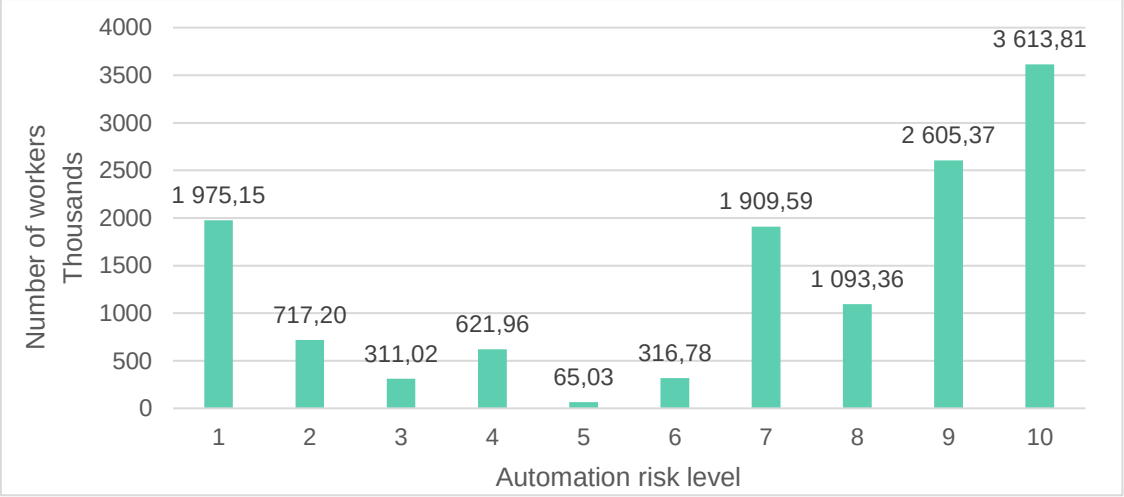


FIGURE 8-6: SOUTH AFRICAN WORKERS IN NUMBERS ACCORDING TO COMPUTERISATION RISK LEVEL, 2014
Compiled by researcher (2021)
Data from Le Roux (2018: 514)

Le Roux (2018) used data from the Labour Market Dynamics in South Africa (LMDSA) datasets to extend the estimations of Frey and Osborne (2017) to 285 South Africa occupations. **Figure 8-6** illustrates the number of workers in each risk category[19]. Around 3,6 million workers were highly susceptible to being replaced by computerisation. An additionally large proportion of the workforce fell in the risk levels 7 – 9. Although nearly 2 million workers were employed in level 1 categories, relatively low proportions of workers were employed in levels 1-6 compared to the high probability levels.

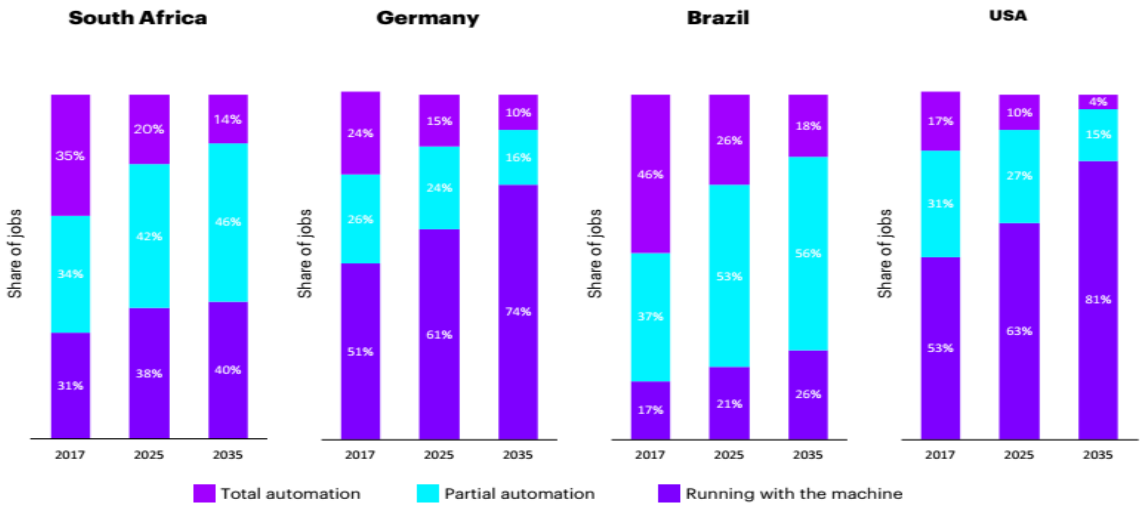


FIGURE 8-7: AUTOMATION RISK OF JOBS BY COUNTRY
Sourced from Accenture (2018: 8)

[19] The risk categories range from low probabilities 0,1 or less (level 1), to high probabilities of 0,9 or higher (level 10).

On the other hand, Accenture (2018) estimated that 35 percent of South African jobs were at risk of total automation in 2018 (5,7 million jobs). This would gradually be reduced to 20 percent by 2025 (**Figure 8-7**). Apart from Brazil, South Africa runs a significantly higher risk of job automation compared to Germany and the US.

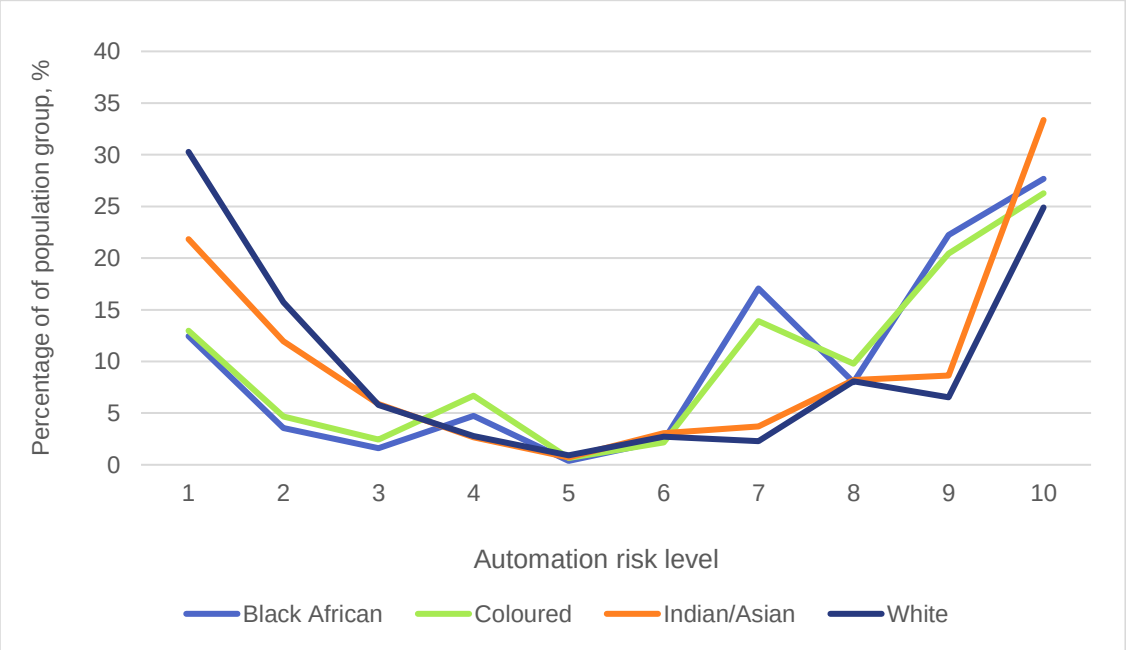


FIGURE 8-8: PERCENTAGE OF SOUTH AFRICAN WORKERS BY POPULATION GROUP AND RISK LEVEL, 2014
Compiled by researcher (2021)
Data from Le Roux (2018: 514)

A further investigation by le Roux (2018) pointed to higher risk levels in previously disadvantaged population groups. **Figure 8-8** illustrates the data from le Roux's study expressed as percentages of each population group's working population. The proportion of workers from the white population group in low-risk level employment was significantly higher than that of other population groups. At risk level 10, previously disadvantaged groups [20], especially the Indian/Asian population group, exhibited higher proportions than workers from the white population group.

[20] The spike evident at level 7 of black African and coloured workers is due to the high number of *domestic helpers and cleaners* in this category.

8.6.1.3. MEDIAN WAGES

To determine the wealth of the labour force, median wages serve as a better measure than mean wages. Brynjolfsson and McAfee explained its importance as follows:

> *"If 50 construction workers are drinking at a bar and Bill Gates walks in as the poorest customer walks out, the mean wealth of the customers would soar to $1 billion. However, the wealth of the median customer, the one exactly in the middle of the distribution, wouldn't change at all."*
>
> *(2011: 33)*

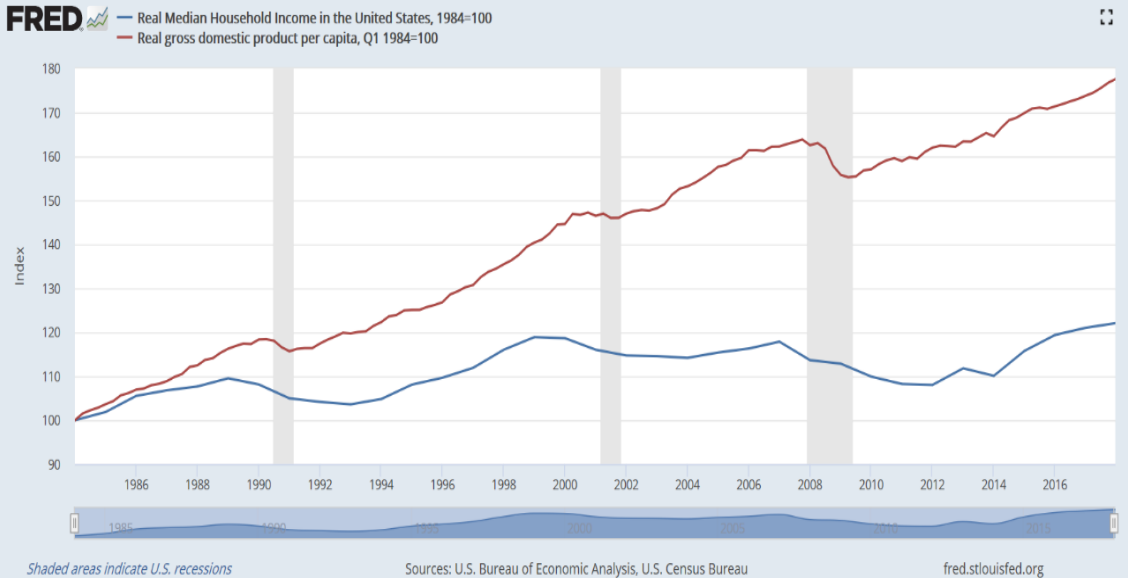


FIGURE 8-9: GROWTH INDICES OF REAL MEDIAN INCOME AND GDP PER CAPITA IN THE US, 1984-2017
Compiled by researcher[21](2020)
Sourced from US Census Bureau (2020)

Brynjolfsson and McAfee (2011) compared real median income and real GDP per capita growth to illustrate the rising gap between wealth creation and labour rewards. A reconstruction of their data (**Figure 8-9**), extended to more recent years, indicates that a rising gap between the growth indices of real GDP per capita and real median household income in the US emerged since 1984. While

[21] Instructions to recalculate the growth indices available at: <https://fredblog.stlouisfed.org/2016/12/the-puzzle-of-real-median-household-income/?utm_source=series_page&utm_medium=related_content&utm_term=related_resources&utm_campaign=fredblog >

real GDP per capita growth increased significantly for US citizens before the Great Recession, the real median income for households grew much slower and stagnated between 2000 and 2014. Although the median income has shown some recovery since 2014, GDP per capita continued to grow at a faster rate. The large difference between the two variables indicates that, although GDP per capita grew, it mostly benefited a small proportion of the US population.

The Federal Bank of St. Louis (FRED) (2016) noted that this gap could be attributed to the decreasing size of households relative to an increasing population. Yet, when both real GDP and median income were divided by the number of households, the gap did not shrink significantly. The FRED further noted that the gap could be explained by the exclusion of employer-provided benefits in household income surveys; and rising inequality which may cause the mean to remain stable, but the median to fall.

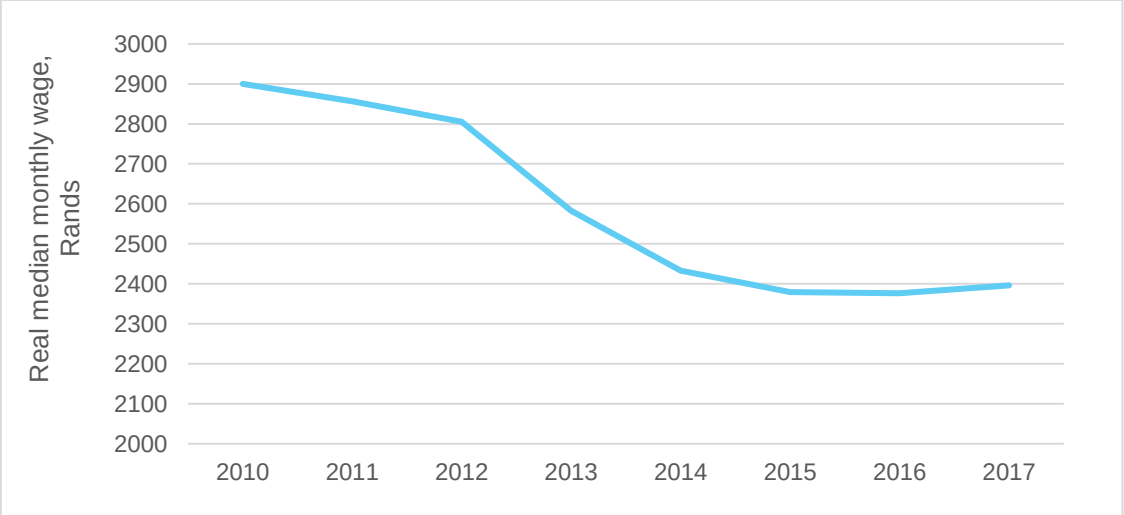


FIGURE 8-10: REAL MEDIAN WAGES FOR SOUTH AFRICAN EMPLOYEES, 2010-2017
Compiled by researcher (2021)
Data from STATS SA (2011: 4-54, 2017b: 60)

To the researcher's knowledge, no data is available for the median wage of households in South Africa. However, the *LMDSA* have been publishing the median wage of individual workers since 2010 (STATS SA, 2017b). After converting the data into real (2010) median wages, **Figure 8-10** was constructed. From the illustration, it is evident that the median worker in South Africa is not doing well. In fact, the South African median worker is doing much worse than in 2010.

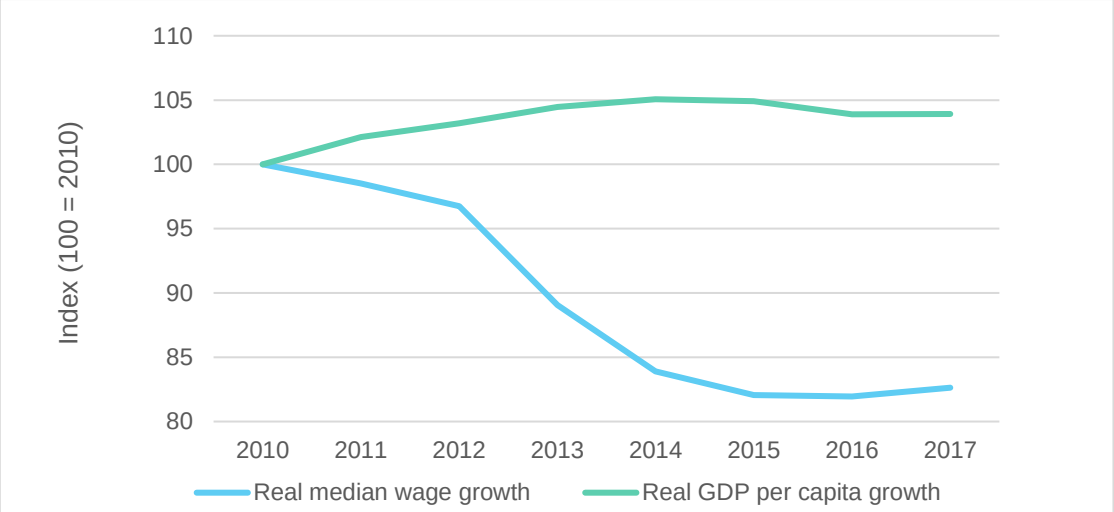


FIGURE 8-11: GROWTH INDICES OF REAL MEDIAN INCOME AND GDP PER CAPITA, SOUTH AFRICA, 2010-2017
Compiled by researcher (2021)
Data from STATS SA (2011: 4-54, 2017b: 60); SARB (2019d)

Figure 8-11 illustrates the rising gap between the GDP per capita and real median wage growth indices in South Africa for the period 2010 to 2017. Although the GDP per capita growth index stagnated for most of the period, the median wage growth index decreased significantly to below 85. This large gap, primarily due to declining median wages, indicates that a small proportion of the population is obtaining an increasingly large share of GDP.

A closer look into the real median wages of South African workers revealed an interesting trend. **Figure 8-12** illustrates that the median wage of skilled workers increased in line with the predictions of SBTC. The median wage of semi-skilled workers declined significantly during this period. However, the median wage of low skilled workers behaved contrary to SBTC by trending upwards. Interestingly, the median wage of domestic workers increased even more. It should be noted that low-skill wages may be distorted due to minimum wages. Rising minimum wages may also increase unemployment not reflected in the median wage.

FIGURE 8-12: REAL MEDIAN MONTHLY WAGE FOR SOUTH AFRICAN WORKERS, 2010-2017
Compiled by researcher (2021)
Data from STATS SA (2011: 4-54, 2017b: 60)

8.6.2. THE RISE OF THE SUPERSTAR

After World War II, the share of the wealthiest one percent of national income declined globally. Significant increases from the 1980s followed this due to globalisation, "winner-takes-all" structures, and trade openness (Bassier and Woolard, 2018).

According to Brynjolfsson and McAfee (2011), industries with inherent winner-takes-all competition are being magnified. In these industries, a small number of superstars take most of the prize. Although there might be an insignificant difference between the services provided by the market superstar and the runner-up, the runner-up gets only a small percentage of the rewards. Digitalisation has an augmenting effect on the magnitude and scope of these markets. Superstars can take home an even bigger share of the rewards than before, leaving little left for everyone else.

Brynjolfsson and McAfee (2011) explained that within the upper-income distribution, the effects of digital technologies could already be seen. Although the top ten percent's income has grown relative to the rest of the workers, inequality within the top ten percent has also grown. A faster growth of the top 0.1 percent and 0.01 percent reflects the magnified earnings of superstars.

8.6.2.1. SOUTH AFRICA'S SUPERSTARS

Bassier and Woolard (2018) studied the incomes of South Africa's top percentiles using tax data on personal incomes for the period 2003-2016. Because close to 60 percent of the population did not earn labour market income, the Post-Apartheid Labour Market Series (PALMS) was used to investigate incomes below the tax threshold. On the other hand, since PALMS is dependent on the willingness of respondents to disclose their income, aggregate personal income tax data from the South African Revenue Service (SARS) serves as a better measure to investigate the incomes of the top percentiles. The Pareto interpolation method was used to investigate income growth within the top and bottom percentiles.

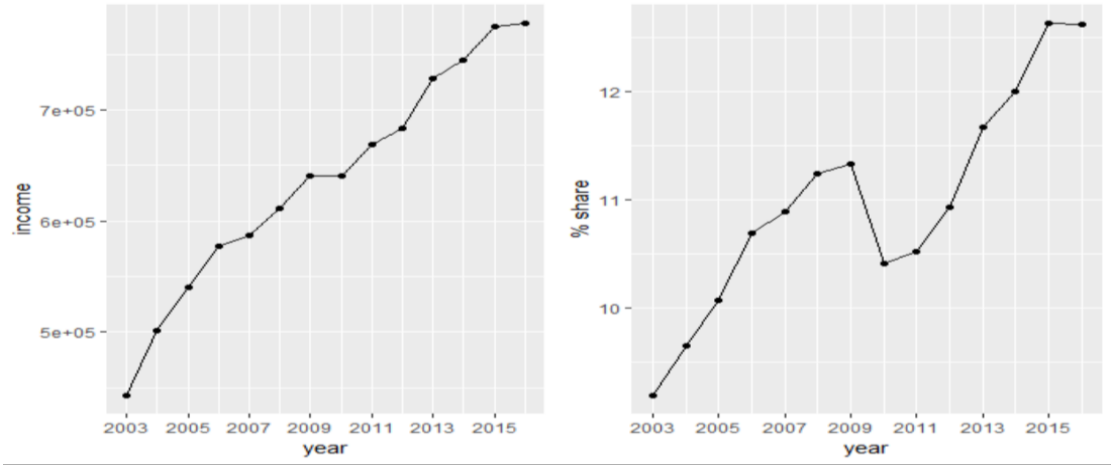


FIGURE 8-13: REAL INCOME & INCOME SHARES IN SOUTH AFRICA, 2003-2016
Sourced from Bassier and Woolard (2018: 12)

Bassier and Woolard's (2018) findings are consistent with some of the observations made by Brynjolfsson and McAfee (2011): First, a significant increase in incomes and income shares of Gross National Income (GNI) was observed in the top percentiles based on tax data. **Figure 8-13** shows the substantial increases in both the real income and income shares of the top one

percent. Although a brief decline in real income can be observed during the 2008 recession, it recovered swiftly and grew rapidly. The income shares of the top one percent fell significantly between 2009 and 2010 due to a spike in the GNI denominator but recovered rapidly thereafter. Over the period, the real income of the 99th percentile exhibited a 4,5 percent real compounded average growth rate (CAGR). Real income close to doubled for South Africa's superstars. These trends were similar in all top percentiles. Furthermore, Bassier and Woolard remarked that inequality is growing fast. Before the Great Recession, the 95th-98th percentiles' income grew consistent with average GNI growth. Growth of income beyond the 98th percentile was significantly higher than the average GNI growth of 5,74 percent. However, although the growth of top incomes fell considerably after the recession, the CAGRs from the 95th percentiles were more than double that of the average GNI growth rate.

Second, Bassier and Woolard (2018) found that the remaining population's real income, based on PALMS data, has stagnated. Up to the 65th percentile, real income tracked GNI growth. The 75th to 90th percentiles exhibited a CAGR well below GNI growth and income shares declined somewhat for these percentiles. However, lower percentiles showed no change in income shares over the period.

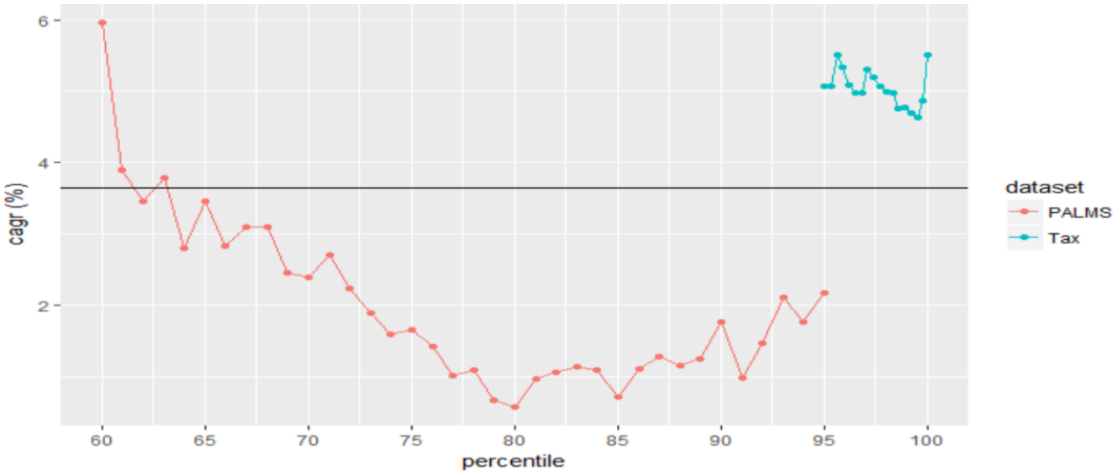


FIGURE 8-14: INCOME GROWTH, COMBINED SURVEY AND TAX DATA, 2003-15
Sourced from Bassier and Woolard (2018: 16)

Figure 8-14 illustrates the authors' calculation of income growth in South Africa above the 59th percentile. The exclusion of percentiles below the 59th percentile is due to individuals below this percentile earning zero income. Although the

growth rates up to the 65th percentile[22] followed the average GNI growth, indicated by the horizontal line, the growth of incomes dropped well below the average GNI growth rate for the remainder of the bottom percentiles. Incomes above the 95th percentile exhibited substantially higher growth rates than the average GNI growth rate.

Bassier and Woolard (2018) acknowledged the shortcomings of both survey and tax data. One possible explanation for the large differences between tax and survey data is that PALMS only includes labour market incomes. However, they noted that labour market incomes also grew over the period.

8.6.3. MAN VS MACHINE

According to Brynjolfsson and McAfee (2011), most types of output require efforts from both machines and humans. Bargaining theory states that each factor's contribution is determined by its bargaining power, which is apportioned according to their respective wealth generation. When technology diminishes the comparative significance of labour, capital owners will be able to make larger profits on the goods and services they produce.

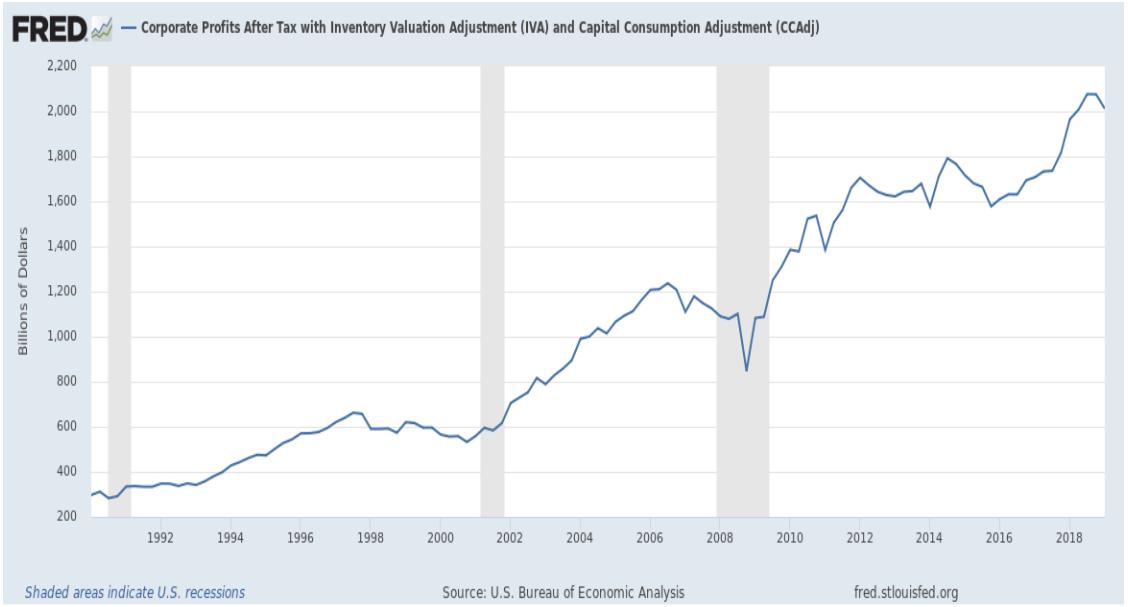


FIGURE 8-15: US REAL CORPORATE PROFITS AFTER TAX, 1990-2018
Sourced from US Bureau of Economic Analysis (2019)

[22] Due to the higher reliability of PALMS data for lower income groups and tax data from SARS for top income groups, the authors combined the two data sets.

Because capital owners are a smaller proportion of the population than labourers, income distribution will be distorted. This rise in the relative share in income - captured by capital equipment owners to labourers - is referred to as the classic bargaining battle between capital and labour (Brynjolfsson and McAfee, 2011). **Figure 8-15** illustrates the sharp rise in corporate profits in the US over the past two decades. Furthermore, Brynjolfsson and McAfee noted that, while corporate profits as a percentage of GDP reached historical highs in 2010, labour compensation's share reached historic lows.

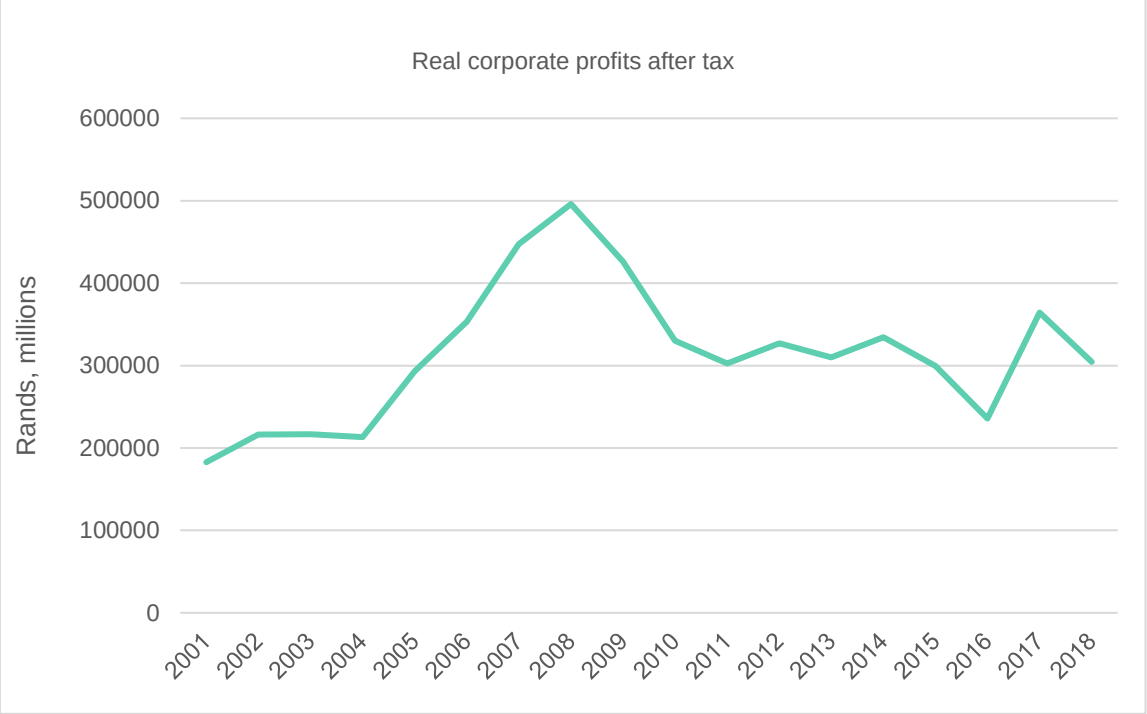


FIGURE 8-16: BUSINESS PROFITS IN SOUTH AFRICA, 2001-2018
Sourced from STATS SA (2019a, 2019b)

In South Africa, a stagnating real corporate profit can be observed after the Great Recession[23] (**Figure 8-16**). However, before the recession, corporate profits showed a steady increase. Although the past decade stagnated, an overall positive trend in corporate profits indicates the rising gap between capital and labour remuneration.

[23] STATS SA wrote an article on soaring business profits in 2017. However, on closer investigation the data used in the article contained nominal values. Although the real value spiked slightly in 2017, it was short lived. Article available at: http://www.statssa.gov.za/?p=11828

The increased bargaining power of capital is, however, not a reason for governments to create employment just for the sake of it:

> *"…remember that employment per se is not the end goal of an economy. Human labour employment in and of itself is not what creates wealth. Wealth is created when that employment is directed toward solving some unknown or undiscovered problem, producing value for oneself and for others through voluntary market exchange. If employment alone were an end in itself, then we could destroy all the machines and have a dictator split the population into ditch diggers and ditch fillers, with the first half of the population employed in digging ditches and the second half employed in refilling the ditches – all without shovels, mind you, because shovels are labour-saving devices. We should have 100 percent employment coupled with 100 percent poverty. When Milton Friedman was once told by government officials that it was better to dig ditches with shovels than bulldozers because more jobs are created that way, he rhetorically asked, 'Why not use spoons?'."*

(Lehman, 2015: 247)

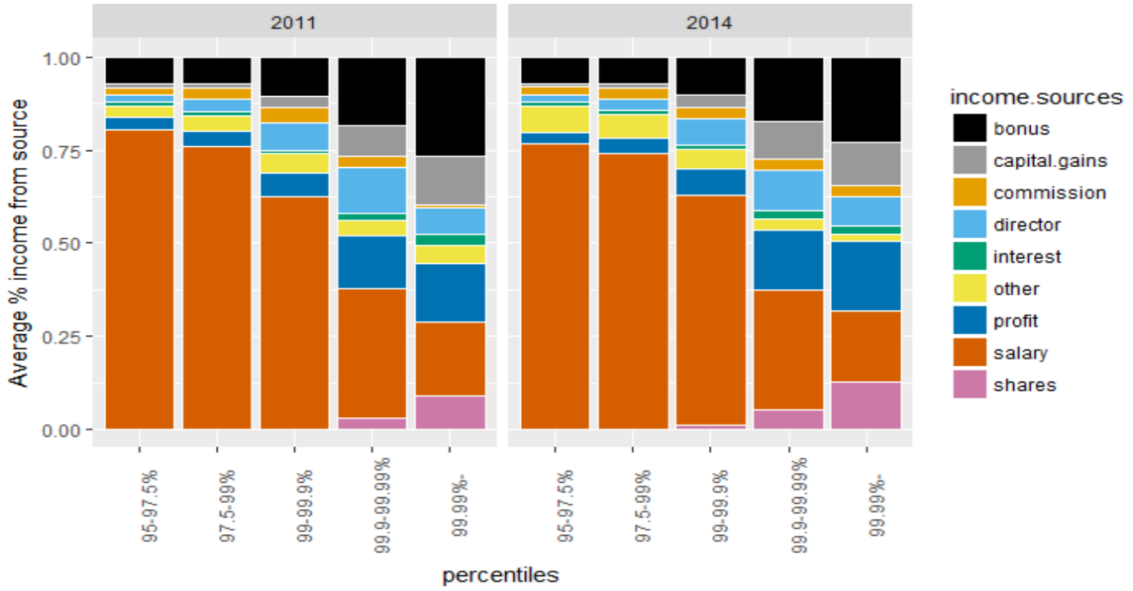


FIGURE 8-17: INCOME SOURCES BY PERCENTILES, SOUTH AFRICA, 2011 & 2014
Sourced from Bassier and Woolard (2018:17)

Bassier and Woolard (2018) used SARS tax data to disaggregate income sources of the top income percentiles in South Africa. Up to the 99th percentile, salaries and bonuses exceeded more than 80 percent of earnings. Thereafter it declined significantly as it is replaced by shares, profit, capital gains and bonuses above the 99th percentile. **Figure 8-17** illustrates the rapid differences in income sources among the top percentiles in 2011 and 2014. Moreover, Bassier and Woolard

observed a CAGR above 15 percent for real share option incomes for the top one percent during the period 2003 to 2015. During the period 2012-2014, when 95 percent of the population experienced zero growth in income, the remaining five percent experienced more than five percent income growth and 10-20 percent growth in capital income.

Capital deepening refers to a process by which the capital used for each worker rises (NEDLAC, 2019). Even though South Africa has an over-supply of unskilled labour, its relatively high labour costs have caused increased investments in labour-saving technologies since the mid-1970s. Consequently, NEDLAC found that production became more capital-intensive, especially in the finance sector. In order to absorb new job seekers, substantial capital formation would be needed annually. However, this would require significant improvements in domestic savings and the ability to attract foreign savings.

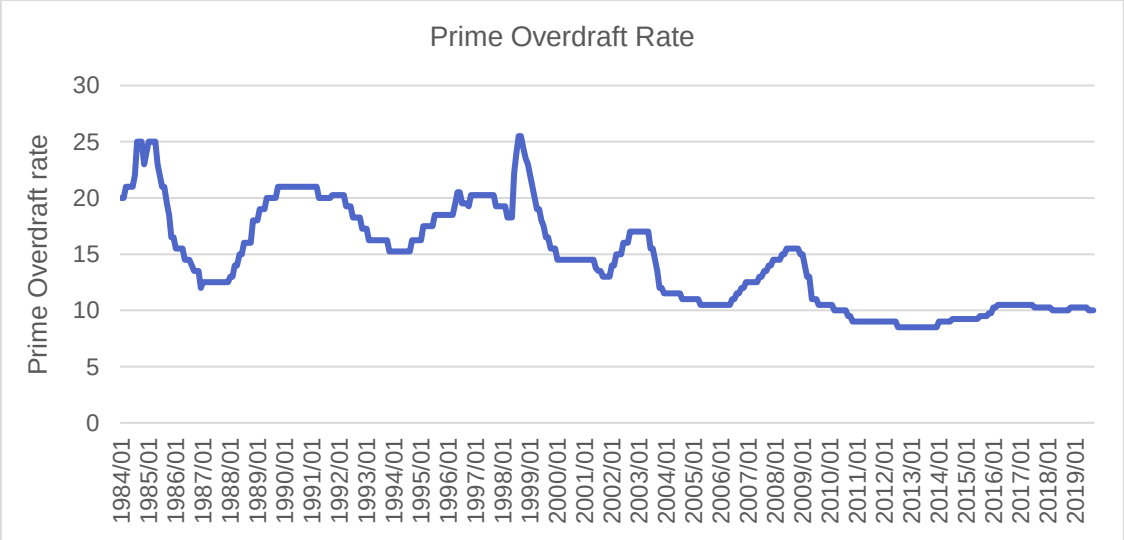


FIGURE 8-18: SOUTH AFRICA'S DECLINING COST OF CAPITAL, 1948-2019
Compiled by researcher (2021)
Data from SARB (2019c)

Capital gained relative attractiveness as a factor of production compared to labour. This is evident in the fall in the cost of capital and the rise in the cost of labour since the late 1990s (NEDLAC, 2019)**. Figure 8-18** illustrates the declining prime overdraft rate. Since 1948, there has been a long-term decline in the rate at which capital can be funded through borrowings. Since 2000, the cost of capital fell significantly relative to the pre-millennial era.

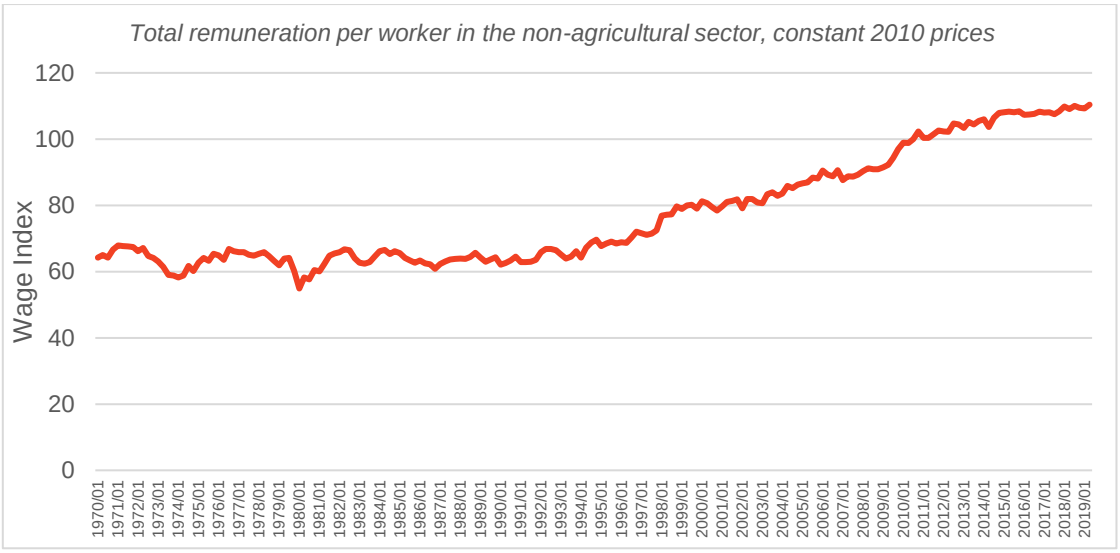


FIGURE 8-19: SOUTH AFRICA'S COST OF LABOUR, 1970-2019
Compiled by researcher (2021)
Data from SARB (2019e)

Conversely, **Figure 8-19** illustrates the increasing cost of labour since 1970. The remuneration per worker index stagnated until the late 1990s when it rose sharply. Since the beginning of the millennium, the index continued to grow, indicating labour's loss of attractiveness during the 4IR.

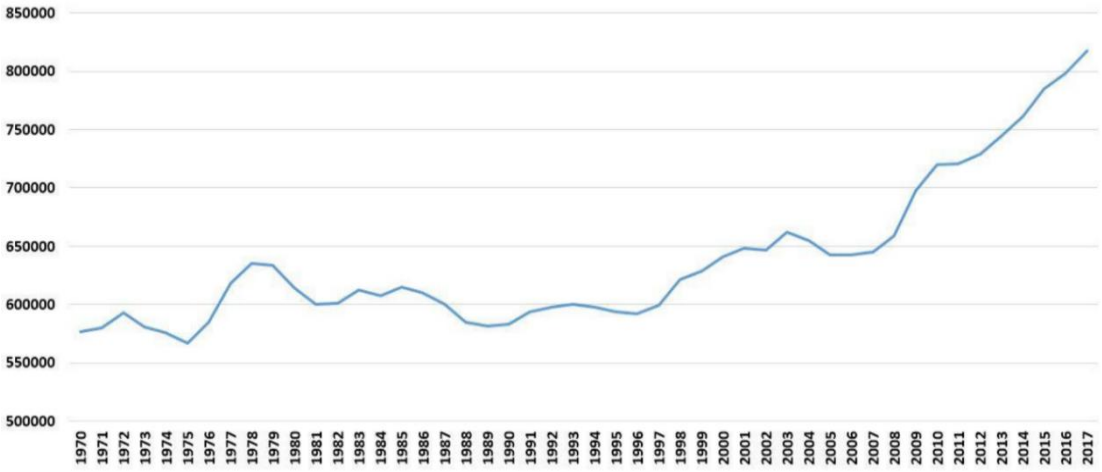


FIGURE 8-20: AVERAGE CAPITAL STOCK PER WORKER, SOUTH AFRICA, 1970-2017
Sourced from NEDLAC (2019: 41)

In 1975 a single job opportunity required R566 400 worth of capital stock. This figure stagnated over the next two decades until it reached R581 000 per worker in 1989. However, after 1989 a general rise in the capital stock per worker can be observed in **Figure 8-20**. In 2017 R817 460 was needed to support a single worker, 43 percent higher than in 1975.

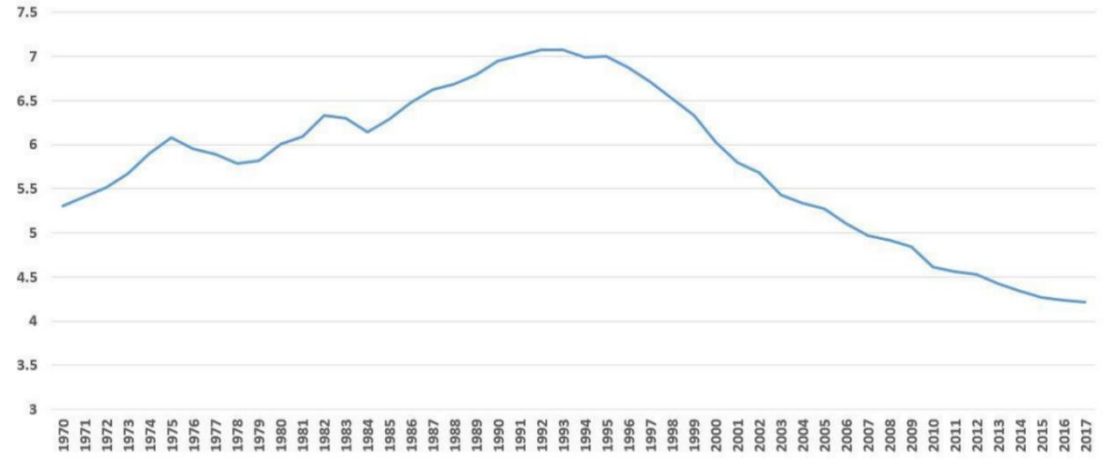


FIGURE 8-21: NUMBER OF WORKERS PER R1M GROSS VALUE ADDED, SOUTH AFRICA, 1970-2017
Sourced from NEDLAC (2019: 41)

Production in South Africa has become less labour intensive in the past decades. **Figure 8-21** shows that five to seven workers were employed for every R1 million value added in the non-agricultural sector before 2000. This figure fell sharply to 4,2 in 2017.

8.7. RACING WITH THE MACHINE

In 1997, IBM programmed supercomputer, Deep Blue, defeated chess master, Gary Kasperov, in a game of chess. As time went by, people became tired of computers winning against human competitors, and competitions started combining computers and humans. Surprisingly, the winners of one of the tournaments had neither the top chess players, nor the best computers (Brynjolfsson and McAfee 2011). Kasparov explained that the team consisted of:

> *"…a pair of amateur American chess players using three computers at the same time. Their skill at manipulating and "coaching" their computers to look very deeply into positions effectively counteracted the superior chess understanding of their grandmaster opponents and the greater computational power of other participants. … weak human + machine + edit process was superior to a strong computer alone and, more remarkably, superior to a strong human + machine + inferior process."*
>
> (Brynjolfsson and McAfee, 2011: 29)

Brynjolfsson and McAfee explained how the computerised chess game is the key to winning man's race against the machine:

> *"…the key to winning the race is not to compete against machines but to compete with machines…while computers win at routine processing, repetitive arithmetic, and error-free consistency and are quickly getting better at complex communication and pattern matching, they lack intuition and creativity and are lost when asked to work even a little outside a predefined domain. Fortunately, humans are strongest exactly where computers are weak, creating a potentially beautiful partnership."*
>
> (2011:29)

According to Accenture (2018), labour productivity can be increased worldwide by up to 40 percent in the next two decades by establishing AI as a factor of production. By doing this, South Africa can double its economy five years prematurely. However, South Africa will need to alter its economy and labourers to embrace digital technologies, create an environment that enables workers to collaborate with machines in customer engagements, and build new products, services, and markets.

The Accenture (2018) report pointed out that South Africa possesses firm groundwork to benefit from the 4IR. Not only does it boast a digital economy that is growing quickly, but it exhibits the right demographics, i.e., a large youth base. However, to use these tools to its benefit, it needs to rapidly increase the stride at which the workforce acquires skills that will enable them to run with the machine. At the current pace, the South African workforce will learn to collaborate with technology much slower than other developing countries. Essentially, through skill reallocation and doubling of skilling the workforce, the risk of automation can be drastically reduced from 20 percent to 14 percent by 2025.

The WEF (2017a) proposed key action areas for economies to prepare the labour force for the new world of work:

1. new work model recognition and reforming of labour regulations;
2. increased social protection to accommodate rising independent workers, such as basic income security covering illness, unemployment, maternity, and disability;
3. constant reskilling and adult learning; and
4. hands-on employment services that address geographic task-reallocation and concentration.

In order to prepare the South African workforce for the rapid changes it faces, Accenture (2018) recommended that leaders: first, accelerate the reskilling of individuals. This would include prioritising the skills that need to be developed, reskilling management, building on existing advantages, fostering life-long learning mindsets, using the boomer generation to transfer knowledge to new generations, and using digital technologies to teach new skills. Second, reappoint the workforce to new value-creating areas. This can be done by reinvesting savings on efficiencies into the workforce and encouraging more flexible workforce systems. Lastly, reinforce the talent pipeline at its basis. Reinforcement can be aided by national and cross-border programmes; company involvements and influences in public skilling; and collaborations with academics.

In order for the workforce and firms to keep up with the machine, Brynjolfsson and McAfee (2011) suggested that the pace and quality of firms' innovation be enhanced, and human capital be expanded.

Accenture (2018) listed four main characteristics of work in the 4IR. First, productivity will be driven by human-machine collaboration. Humans need to collaborate with machines in order to comprehend and interpret AI algorithm outputs (explainers); maximise AI system effectiveness (sustainers); and insert language, empathy, and judgement into AI systems (trainers). Second, new technologies are changing the way humanity cooperates and collaborates. Third, work will progressively be divided into tasks that employ the distinctive skills and knowledge of the individual. Finally, work is becoming more flexible and fluid.

Technology eliminates geographical and time limits. Flexibility and fluidity of work will allow fresh talent to enter the workforce.

8.7.1. ENTREPRENEURS

According to Brynjolfsson and McAfee "creative destruction" is the key to competing with machines. Creative destruction refers to "co-inventing new organizational structures, processes, and business models that leverage ever-advancing technology and human skills" (2011: 29). The authors explained that creative entrepreneurs should see static median wages and polarising labour growth as an opportunity to create new business models that create value by combining growing mid-skilled workers and affordable technology.

> *"Entrepreneur energy in America's tech sector drove the most visible reinvention of the economy. Google, Facebook, Apple, and Amazon, among others, have created hundreds of billions of dollars of shareholder value by creating whole new product categories, ecosystems, and even industries. New platforms leverage technology to create marketplaces that addressed the employment crisis by bringing together machines and human skills in new and unexpected ways."*
>
> (Brynjolfsson and McAfee, 2011: 56)

In the US, these businesses collectively created millions of new employment opportunities. Google chief economist, Hal Varian, referred to the opportunities technologies enable as "micromultinationals" (Brynjolfsson and McAfee, 2011: 30). Brynjolfsson and McAfee further noted that, whilst the traditional 20th-century multinationals were characterised by a few large firms with high fixed costs and many employees, micromultinationals are characterised by many small multinationals with little fixed costs and a few workers. However, both types of multinationals create similar employment opportunities, although micromultinationals are less rigid.

Fears have emerged that we have exhausted innovation (Gordon, 2000, 2010), but Brynjolfsson and McAfee noted that "innovation often relies heavily on the combining and recombining of previous innovations, the broader and deeper the pool of accessible ideas and individuals, the more opportunities there are for

innovation" (2011:31). The authors further explained that even if technology came to a complete standstill, there are still endless possibilities in combining different innovations.

According to Brynjolfsson and McAfee, technology opens opportunities for entrepreneurs to operate their businesses nationally and globally. This would increase the number of superstars. Although a winner-take-all economy can increase inequality in rewards, there is no limit to the number of new markets that can be created. It may be possible that "tens of millions of people could each be a leading performer…in tens of millions of distinct, value-creating fields. Think of them as micro-experts for macro-markets." (2011: 31).

8.8. CONCLUSION

The third headwind to South Africa's ability to exploit economic growth opportunities presented by the 4IR is its unemployment crisis. Already struggling to create employment for its current workforce, South Africa will be challenged tremendously during the 4IR - characterised by major labour market disruptions. Unemployment and inequality are expected to soar due to SBTC, the emergence of superstars, and the rising attractiveness of capital versus labour. In order to reduce, or at least stabilise, the rising unemployment rate in South Africa, the labour market must learn to race with the machine – not against it. This will entail investments in AI and significant increases in the speed of skilling its workforce.

South Africa would additionally need to invest in entrepreneurship in order to enhance innovations and create employment opportunities. Moreover, human capital must be expanded by reassessing the quality and relevance of the future workforce's education. Education promises to reduce South Africa's inequality and unemployment. The next chapter discusses the fourth headwind: education.

CHAPTER 9 : EDUCATION

9.1. INTRODUCTION

One of the major reasons for South Africa's high unemployment rate is its lack of skilled labour supply. Education promises to be the key ingredient of future labour productivity. The purpose of this chapter is to argue that South Africa's failure to educate and skill its future workforce is its fourth headwind to economic prosperity. This chapter will provide a background to the education landscape in South Africa, followed by an explanation of education's relevance to economic growth. The remainder of the chapter will analyse South Africa's position within a proposed education ecosystem designed for the 4IR.

9.2. BACKGROUND

It is hard to imagine South African schools equipped with technologies that will gear them for the 4IR while many schools currently still lack crucial necessities, such as toilets and running water. Although some schools provide quality education, they are mostly reserved for the rich. Not only does this highlight the severity of South Africa's inequalities, but it perpetuates into more inequalities later in learners' lives when they participate in the labour market.

Spaull (2013) described South Africa's education as the worst performer of all middle-income countries and in some cases, low-income countries. Regardless of the measures employed, South African learners of all ages and levels, on average, were performing below the targets of the curriculum and failed to reach important numeracy and literacy milestones. The author further found the entire education system to be severely inefficient, underachieving, and unfair.

Although South Africa's government spent more than most countries on education, it yielded little returns. According to UNICEF (2019), more than 20 percent of South Africa's budget and more than six percent of its GDP were allocated to education. Keswell and Poswell (2004) found that returns to education in South Africa increased with the level of education. This might explain why South Africa's budget for higher education has been growing rapidly.

However, this rapid growth was at the expense of a stagnating basic education budget.

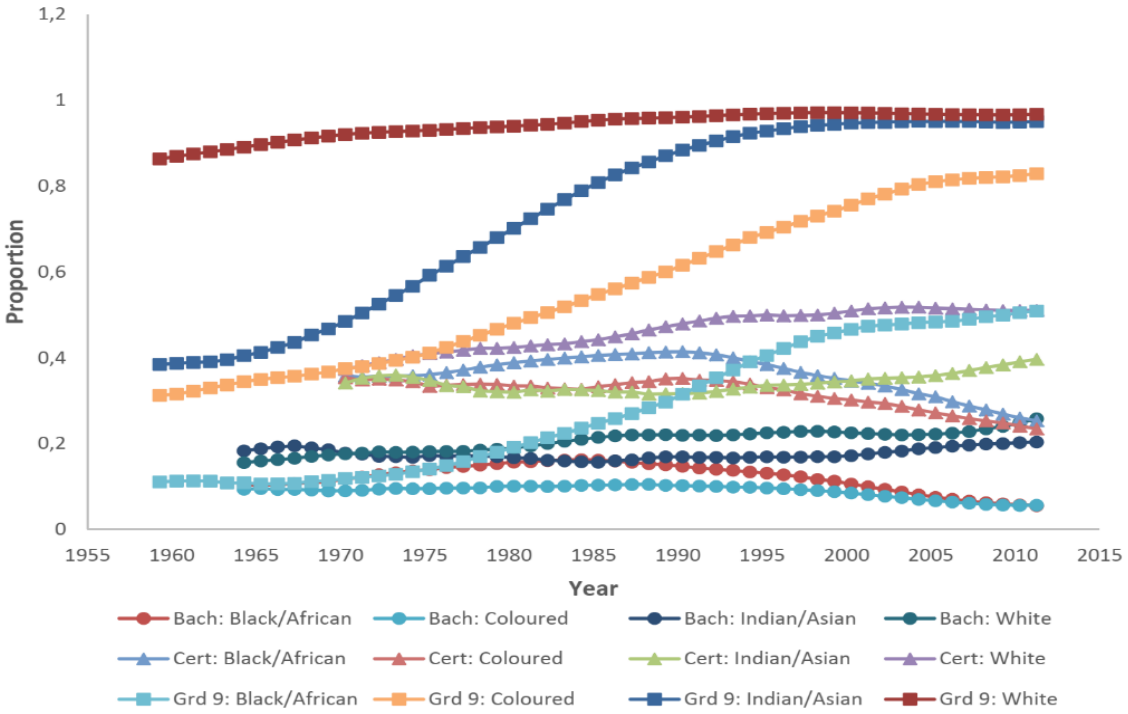


FIGURE 9-1: ATTAINMENT RATIOS OF GRADE 9, AT LEAST CERTIFICATE, AND AT LEAST A BACHELOR'S DEGREE, BY POPULATION GROUP, 2011
Sourced from STATS SA (2017a: 13)

Figure 9-1 illustrates the educational attainment ratios of the different population groups in South Africa for 2011. The figure illustrates that Grade 9, at least a certificate and at least a bachelor's degree throughputs were the highest among the white population group, followed by the Indian/Asian population group. In all three categories, the Indian/Asian population group has made significant progress since the 1950s. On the other hand, the coloured and black African population groups have shown progress in completing Grade 9[24]. Interestingly, the attainment ratios for at least a certificate and at least a bachelor's degree after completing Grade 12 for both these groups were well below its initial ratios during the Apartheid-era. STATS SA (2017a) noted that these puzzling figures may be due to:

1) the inability of tertiary institutions to accommodate the fast growing Grade 12 attainment;
2) high drop-out rates due to poor educational foundations;

[24] Grade 12 progression ratios among coloured and black African persons showed significant progress.

3) high drop-out rates due to unaffordable higher education; and
4) many home surroundings lacking favourable studying environments.

The figure illustrates tremendous racial inequalities in the educational system due to past Apartheid policies and the failure of the current post-Apartheid government, despite sufficient budget allocations, to remedy these social injustices.

As South Africa enters the 4IR, it will not only have to re-design its education system for the new era, but it will also have to remedy these past injustices and level the playing field.

9.3. THE EDUCATION-GROWTH NEXUS

The importance of education in economic growth is well established in the literature (Barro, 1991; Mankiw, Romer & Weil, 1992; Fischer, 1993).

Bloom, Canning, Chan & Luca (2014) challenged the belief that tertiary education was less important for poverty reduction in SSA using panel data within a Cobb-Douglass specification. The authors found that tertiary education had a positive impact on technological catch-up, which encourages economic growth.

Bhorat, Cassim & Tseng (2016) investigated the impact of higher education on South Africa's post-Apartheid economic growth. The authors applied an Olley and Pakes regression to a Cobb-Douglas production function to make their estimations. The paper found a positive correlation between the degree cohort and economic growth. However, other higher education qualifications did not contribute to economic growth, including technical and vocational education and training (TVET).

Malangeni and Phiri (2018) employed the autoregressive distributive lag approach (ARDL) to determine the relationship in post-Apartheid South Africa between education and economic growth. The results indicated that there is an insignificant relationship between education and economic growth. Consequently, the author noted that economic growth is impacted by the quality of education – not the quantity.

Akinwale and Grobler (2019) investigated the relationship and causality between education, trade openness and economic growth. They investigated the period 1984-2015 in South Africa by employing the vector error correction model (VECM). The authors established a long-run positive relationship between the variables. The relevant results from the causality investigation indicated long-run bi-directional causality between education and economic growth.

9.4. EDUCATION IN THE 4IR

9.4.1. SKILLS

To fully benefit from fast-paced technological change, countries need to invest in education and skills. Entrepreneurs continue to find ways to make profits with fewer skilled employees. Most importantly, it is easier to profit from high-skilled than low-skilled workers (Brynjolfsson and McAfee, 2011).

To prepare for the 4IR, countries will need to develop talents specific to the era. According to the WEF (2017a), talent development is affected by three key features.:

1. the momentum of job destruction and creation is increasing faster due to technology and globalisation's impact on business models;
2. static education and training systems are insufficient and unable to fulfil the changing skill demands; and
3. static and outdated cultural norms and institutions serve as a barrier for gender equality in the workforce.

FIGURE 9-2: THE NEW SKILLS NOW TAXONOMY
Sourced from Accenture (2018: 16)

Accenture's (2018) taxonomy, *New Skills Now,* sets out skill categories needed for the 4IR. **Figure 9-2** illustrates the six types of skills that workers can learn regardless of age. *Learn to Earn* refers to basic skills such as literacy, numeracy, entrepreneurship, fundamental employability skills and digital literacy. These are the basic skills required for digital workers. *Build Tech Know-How* refers to technology and data skills increasingly becoming required skills for various occupations. Thirty percent of jobs will require these skills by 2025. These skills require individuals to comprehend the building, manipulation and applications of technology and data. Social and relationship-building skills are gaining momentum due to the increasing task-based and collaborative nature of work. Accenture (2018) refers to these skills as *Apply We-Q.* They include self-regulation and power over emotion and behaviour when working in teams. *Create and Solve* emphasises the importance of creativity and problem-solving in the workplace. Skills include creative problem-solving, critical thinking, assessment and analysis of problems using reason and logic, and strong entrepreneurship abilities. To remain relevant in the workforce, individuals would need to update their skills continuously. This category is referred to as *Cultivate a Growth Mindset.* Individuals will have to adopt a growth mindset and embrace skills such as curiosity and life-long learning. *Specialise for Work* refers to the increasing needs of skills that are specialised, timely, and relevant to each market. These skills change continuously as factors such as industries and market demand evolve.

In order to prepare the future workforce for the skills that the 4IR will require, the entire education ecosystem will need transformation.

9.4.2. TRANSFORMING EDUCATION ECOSYSTEMS

The WEF (2017a) explained that the majority of education models globally are older than a century. These models are increasingly distanced from modern life and labour markets. The WEF compiled a blueprint consisting of eight key areas to transform education ecosystems:

9.4.2.1. EARLY CHILDHOOD EDUCATION

> *"The first 1 000 days of a child's life are critical to their future life chances. By the time children from disadvantaged backgrounds reach age five, they have already had a 30 million word exposure gap in terms of linguistic and brain development."*
>
> (WEF, 2017a: 7)

ECD refers to "the processes by which children from conception to at least nine years grow and thrive physically, mentally, emotionally, spiritually, morally and socially " (Berry, Biersteker, Dawes & Smith, 2013: 25). However, Mbarathi, Mthembu & Diga defined ECD as "cognitive, emotional, physical, mental, communication, social and spiritual development of children that takes place from birth until formal pre-schooling (i.e. Grade R)" (2016: 8). For the purpose of this study, ECD will refer to the development of children aged 0-5.

From birth up to the age of five, cognitive and emotional development in children grows rapidly and forms a crucial foundation for primary and secondary learning – the effects extending into adulthood (Mbarathi, Mthembu & Diga, 2016). According to STATS SA (2016), stimulation is important in forming the foundation for early learning, socio-emotional, and linguistic progress. By investing in ECD, South Africa can raise school performance, productivity, long-run economic growth, and social cohesion (UNICEF, 2013).

After accounting for welfare expenses through tax funding, García, Heckman, Leaf & Prados (2016) found that providing comprehensive ECD programmes to disadvantaged children in North Carolina yielded a 13,7 percent return on

investment and a benefit/cost ratio of 7,3 when beneficiaries' life outcomes were tracked to their mid-30s. Although costly, quality comprehensive ECD programmes yielded worthwhile returns that exceeded the welfare expenses of taxation financing.

According to STATS SA (2016), a significant portion of children in South Africa were not exposed to stimulating learning through communication or play techniques. ECD centres included nurseries and preschools that offered formal education and aided in the transition to schools; crèches and educare centres aimed at children aged 0-6 years; and mother and gogo services that provided informal care essential for nurturing. Among children aged 0-6, 47 percent did not attend ECD centres.

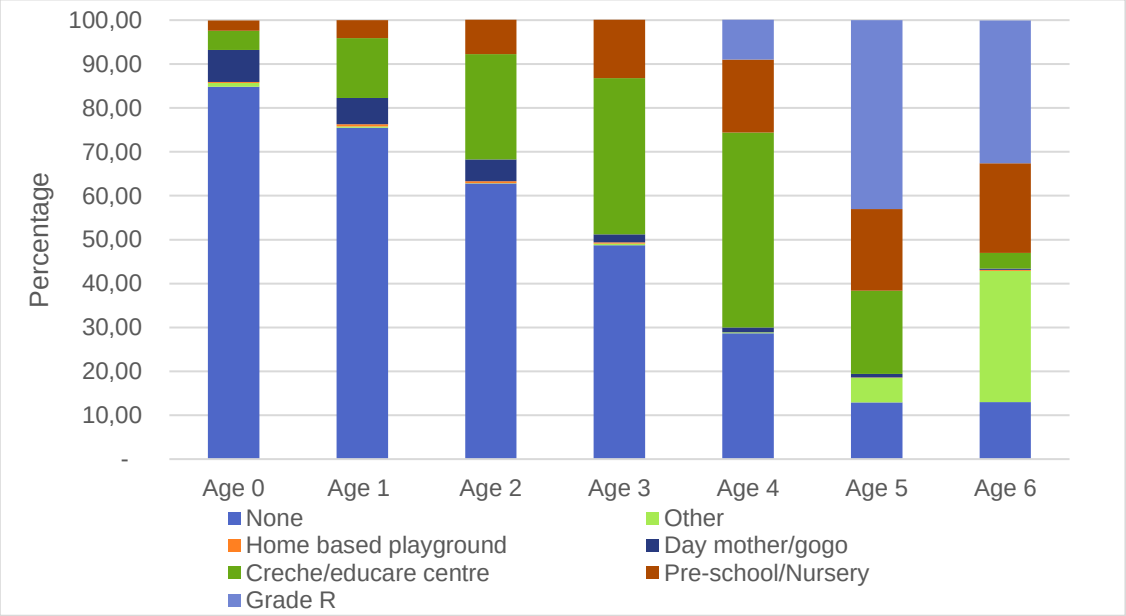


FIGURE 9-3: ECD ATTENDANCE BY AGE, 2016
Compiled by researcher (2021)
Data from STATS SA (2016)

Although the government has increased investments and policies related to ECD over time (STATS SA, 2019c), **Figure 9-3** illustrates that 84,8 percent of infants still did not attend any ECD centre in 2016. At the age of three, 48,7 percent of children did not attend ECD centres. This percentage fell gradually until it reached 13,0 percent for six-year olds. However, while 32,5 percent of children at this age were attending grade R, 20,4 percent were still attending pre-school.

ECD programmes are a crucial tool in preventing poverty from passing from parent to child (Mbarathi, et al., 2016). However, in low-income households, 49,5 and 49,2 percent of children belonging to the first and second household income quartiles respectively did not attend ECD centres compared to only 41,2 percent in the highest income quartile (STATS SA, 2016).

Racial inequality in South Africa threatens the development of both children and the economy (UNICEF, 2013). Whilst 46,6 percent of children aged 0-6 from the black African population group, 55,5 percent from the coloured population group, and 48,7 percent from the Indian/Asian population group did not attend ECD centres, merely 37,7 percent of children from the white population group did not attend them (STATS SA, 2016).

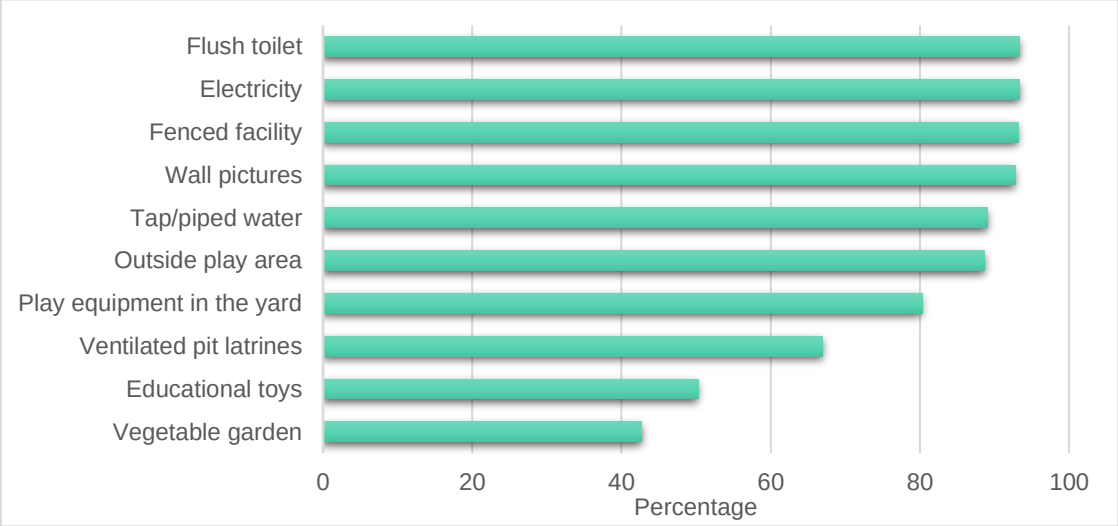
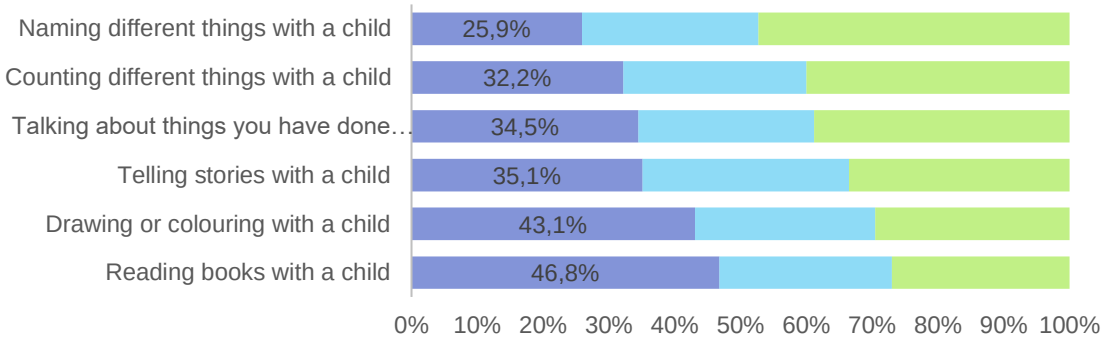


FIGURE 9-4: AVAILABLE INFRASTRUCTURES AT ECD CENTRES, 2016
Compiled by researcher (2021)
Data from STATS SA (2016:70)

Figure 9-4 illustrates that in 2016 most ECD centres had the necessary infrastructure. However, where children had access to ECD centres, only 88,7 percent of ECD centres had outside play areas, 80,3 percent had play equipment in the yard, and 50,3 percent had educational toys. These tools provide crucial sensory experiences that develop fine motor skills.



	Reading books with a child	Drawing or colouring with a child	Telling stories with a child	Talking about things you have done with a child	Counting different things with a child	Naming different things with a child
Never	46,8%	43,1%	35,1%	34,5%	32,2%	25,9%
Sometimes	26,2%	27,4%	31,4%	26,7%	27,8%	26,8%
Often	27,0%	29,5%	33,5%	38,8%	40,0%	47,3%

FIGURE 9-5: ECD STIMULATION RECEIVED BY CHILDREN AGED 0-4, 2018
Compiled by researcher (2021)
Data from STATS SA (2019c: 11)

STATS SA (2019c) reported that nearly half of parents or guardians have not read a book, made a drawing, or coloured with their child aged 0-4; around a third did not participate in telling stories, talked about activities they have done, or counted diverse objects with their child; and 25,9 percent did not name different objects with their child (**Figure 9-5**). ECD is further threatened by malnutrition. In 2016, approximately a third of children in South Africa were stunted due to malnutrition (STATS SA, 2016).

According to Mbarathi, et al. (2016), South Africa has succeeded in integrating Grade R children into ECD programmes, but there is still a lack of access to quality ECD facilities for children aged 0-4. Many ECD centres in informal settlements, where government assistance is crucial, are failing to conform with the impossible standards set by the Department of Social Development. Consequently, these centres are unable to access much-needed government funding.

The WEF (2017a) reported that literacy rates of children are highly correlated with that of their mothers. Many governments increase or encourage women's participation in the labour force, yet the responsibility of government to provide education merely starts at primary level. This puts significant pressure on women

who have entered the workforce and often prevents them from providing crucial support to children.

The role of caregivers is critical to ensure children receive a healthy, nurturing, and stimulating environment. Caregivers face many challenges, such as poverty, illness, and violence (UNICEF, 2013). Heckman (2017) noted that ECD programmes not only improved the economic prospects of children but allowed mothers to enter the workforce and improve their income. Additionally, the high incidence of *skip-generation-parenting* in South Africa may yield benefits that affect three generations.

ECD forms the foundation of education, much like the foundation of a building. Without a strong foundation, the best quality plaster, windows, roof, and other components will be of no use. South African building regulations are strict on this, and authorities inspect the progress at various stages starting from the foundation. On the other hand, when building human capital, little emphasis is placed on the foundation and funding is often focussed on the quality of the roof – neglecting the foundation.

Because human capital investments yield exceptional returns, it requires inter-ministerial synchronization (WEF, 2017a). It is not a task that can be taken on by the government alone. It must be planned and supported by various stakeholders, such as private companies, parents, and communities. Indeed, as the African proverb goes: *It takes a village to raise a child.*

9.4.2.2. CURRICULA FOR THE FUTURE

Although advancing STEM-literacy in an economy is advantageous, Nesta warned that teaching methods often reinforce the detachment between humanities and sciences, strengthens education gender inequality, and stresses theory over application and exploratory learning (In WEF, 2017a). The WEF further noted that science, technology, engineering, and mathematics (STEM) - occupations would partly require a high degree of creativity, critical thinking, and non-cognitive abilities.

Additionally, softer skills, such as leadership and creative writing, are less likely to be automated. Arts combined with STEM will boost innovation. Consequently, technology and systems must be designed to prepare the workforce for science, technology, engineering, arts, and mathematics (STEAM) (Brynjolfsson and McAfee, 2011).

According to the WEF (2017a), skills and knowledge taught by educational institutes must sustain long-term careers in the economies of the future. Relying on only one skill set and narrow expertise would likely not provide sustainable future careers. To compile future-relevant curricula, institutions must focus on two components. First, which skills and knowledge to include. The WEF lists the following focus areas:

- future-job required linguistics, mathematical, and technological literacies;
- safeguarding scope and complexity in subject familiarity and the skills to make links between disciplines;
- global citizenship standards;
- character and empathy; and
- noncognitive skills, for example problem-solving, creativity, and critical analysis.

Second, how these skills and knowledge must be taught. Curricula that prepare for the future workforce should be:

> *"1) updated and adapted on a rolling basis, based on insights and forecasting regarding the evolution of local and global labour markets and trends in skill demands;*
>
> *2) developed and revised collaboratively, with input from all relevant stakeholders, including businesses; and*
>
> *3) subject to regular review, in order to avoid the disruption and implementation time-lag associated with major but infrequent curricular overhauls."*
>
> (WEF 2017a: 8)

The WEF (2017a) pointed out that learners must be taught how to learn. This must be taught through approaches led by experience as well as instructions.

Learners must be enabled to become lifelong learners. In addition, a new type of decolonisation of the curriculum is needed. When studying basic and applied sciences, students will require an additional understanding of the political and social landscapes of their surroundings (Adefila and Pillay, 2019).

9.4.2.3. INVESTING IN EDUCATORS

The WEF (2017a) remarked that, in order to meet the Sustainable Development Goals (SDG), a further 26 million educators would be required by 2030 globally. Although teachers are responsible for teaching critical thinking and curiosity – the foundation of learning how to learn – they do not receive proper re-skilling or opportunities to develop themselves professionally.

The WEF (2017a) explained that, due to the important role teachers play in the 4IR, investments must be made to ensure that teaching plays a high-productivity and high-quality part. Institutions will need to ensure that teachers have access and make use of research in order to become evidence-informed professionals; and enable teachers to foster their own professional development. Technology can aid in this.

The WEF (2017a) suggested professionalising the teaching profession, improving social value and attracting talent by increasing teachers' remuneration and accrediting educator training. To professionalise the teaching profession in South Africa, the South Africa Council for Educators (SPACE) was established. However, the Midrand Forum reported in 2013 that the highest qualification of 7076 teachers employed by the Department of Education (DoE) was grade 12; and 2647 had 1-2 years of tertiary training (De Wet, 2016). Moreover, de Wet remarked that South African teachers did not receive competitive remunerations and lacked prestigious status.

Interestingly, the WEF (2017a) noted that the perception of who qualifies as a teacher need not be limited. This refers to the growth of, for example, peer-to-peer learning and mentoring in the workplace. These types of teaching must be recognised for its crucial role in future education.

9.4.2.4. WORKPLACE EXPOSURE AND CAREER GUIDANCE

The WEF (2017a) advocated the view that, in order to professionalise the future workforce, education should incorporate workplace exposure. Workplace exposure, such as internships, mentoring and site visits, enables learners to visualise different career options, raises awareness of the returns on education, and arms them with appropriate skills. Together with career counselling, workforce exposure eases the transition from school to work and levels the playing field by exposing learners to different career paths and discrediting stereotypes.

According to Reinhard, Pogrzeba, Townsend, & Pop (2016), work-integrated learning (WIL) refers to the combination of work experience and academic education. Universities of technology (UoTs) (previously known as Technikons) in South Africa started implementing WIL programmes in 1979. The authors compared WIL programmes in Germany, South Africa, and Namibia; and found that WIL rated highest in Germany, followed by South Africa. Furthermore, merely around 30 percent of students from traditional South African universities found employment in their industry within a year of graduation. However, 70-80 percent of students from UoTs were employed within a year of graduation. Most importantly, the authors found that WIL in South Africa can be encouraged through the establishment of community engagement partnerships using a multi-stakeholder approach.

Jonck (2014) investigated the effects of WIL on the unemployment rate amongst graduates at a South African higher education institution (HEI). The author found that while the overall unemployment rate on the day of graduation was 46 percent in 2011, unemployment was 63 percent amongst graduates who did not receive WIL. On the other hand, only 26 percent of graduates who received WIL were unemployed.

9.4.2.5. DIGITAL FLUENCY

According to WEF (2017a), technology has evolved into a language that must be mastered at a young age in order to prepare for the future workforce. Bell and

Gilliam defined digital fluency as the “aptitude to effectively and ethically interpret information, discover meaning, design content, construct knowledge, and communicate ideas in a digitally connected world.” (2011:1). Wang, Myers & Sundaram explained digital fluency as “the ability to reformulate knowledge and produce information to express oneself creatively and appropriately in a digital environment.” (2012: 1).

Both teachers and students need to be digitally fluent in the 21st century (Chigona, 2018). Digital literacy is a prerequisite in order to become digitally fluent. It is only when a person becomes digitally fluent, that he/she can become a digital creator (Reinsfield, 2018).

Digital citizenship refers to “the ability to use technology safely, responsibly, critically, productively and civically” (Takavarasha, Cilliers & Chinyamurindi, 2018: 3). While *digital natives* suggest that “a generation of young people born into the digital age, are inherently technology-savvy”; *digital immigrants* refers to “those who learnt to use computers at some stage during their adult life” (Wang, et al., 2012: 2). However, Wang, et al. found that digital natives exhibited heterogeneous digital fluency and were not incontrovertibly more digitally fluent than digital immigrants. While there existed a positive correlation between the use of technology and fluency thereof, the authors found that the intention of technology use was dependent on demographic, psychological, organisational, and social factors. More importantly, digital fluency increased the frequency of technology usage.

According to Takavarasha, et al., (2018), South African previously disadvantaged millennials had inadequate exposure to digital devices and internet connections; giving them weaknesses similar to digital immigrants. Yet, they are expected to behave like digital citizens in their future careers. Chigona (2018) found that digital fluency among educators in the Western Cape was underdeveloped and therefore slowed down the implementation of connected classrooms. Most importantly, the Education Department did not provide sufficient digital resources and internet connectivity in order for teachers and learners to become digitally fluent.

In March 2019, the department of basic education (DBE) announced that it would pilot a new coding and robotics curriculum for Grades R to 9 between 2020 and 2022 (DBE, 2019). Coding skills may soon become obsolete as a result of rapid developments in machine learning. It is more important to provide fundamental computational training, fostering logical thinking. This reinforces the case for generalised digital fluency that will empower learners to harness and innovate technology (WEF, 2017a). However, the new curriculum is not limited to coding and would include application-, internet-, e-communication-, information management-, and computational thinking-skills (DBE).

Takavarasha, et al., (2018) investigated the challenges facing South African university students from previously disadvantaged backgrounds on their way to digital citizenship. The authors found that although students were obtaining digital literacy at university, their digital citizenship was compromised by poor mentorship, digital access at home, and soft skills training at the institution.

9.4.2.6. QUALITY TVET

The analysis of the WEF (2017a) report suggests that technical and TVET is a driving force of economic growth but has been neglected globally due to the premium placed on university qualifications. TVET provides training that enables opportunities in technical and skilled jobs. Some of the major barriers to TVET includes inadequate employer and industry contributions, lack of qualified teachers, and facilities and infrastructure deficiencies.

In South Africa, TVET colleges are struggling to create skills that meet the needs of communities. This is mainly because enrolment quantities are prioritised over the quality of TVET education (Akoojee, 2016). Due to privatisation of TVET colleges, TVET systems in South Africa have become supply-led systems focussed on increasing enrolments instead of its intended focus of filling the skill demands of employers (Needham, 2019).

Through questionnaires, interviews and observations, Makgato (2019) investigated the readiness of South African TVET colleges for the 4IR. The study found a mismatch between the workplace and TVET pedagogy and practical skill

training. TVET teachers were not appropriately skilled and needed to be reskilled, and theory and practice were not combined appropriately. Furthermore, in order to reduce unemployment and poverty, TVET colleges must provide short courses providing occupational skills, such as plumbing, welding, 3D additive manufacturing, and robotics.

In order to promote TVET education ecosystems, the WEF recommended the following actions:

> *"1) increase access to well-developed and modern TVET study and qualifications.*
>
> *3) evolve certification and credentialing systems based on agreed industry standards and the identified needs of both learners and employers and updated on a rolling basis to insure continued relevance; and*
>
> *3) improve the social status of TVET as a viable education pathway among learners, families, employers, policymakers and other stakeholders."*
>
> (WEF, 2017a: 9)

9.4.2.7. LIFELONG LEARNING

The WEF (2017a) pointed out that the shelf lives of skills in the 4IR are increasingly shortened. By 2022, the average person will need 101 days of education in order to keep up with the rapidly changing nature of work (WEF, 2020). Consequently, the labour market would need to continuously reskill during their working lives. Most education models are aimed at children and individuals rather than adults and the collective workforce (WEF, 2017a).

The WEF (2017a) set out the following priorities in order to reform education ecosystems into systems that accommodate and facilitate lifelong learning (LLL):

1. shifting education from 'front-loading', early education models to learning during all life stages with the focus on "second chances" and multiple pathways;
2. adopting a learning structure of accreditation that assumes "micro-credential" skills that can be assumed at various stages of an individual's life; and
3. relocating the ownership of learning to students/workers.

According to the WEF (2020), LLL can be fostered by creating a love for learning in children from a young age. A love for learning can be instilled by:

1. encouraging *Student agency* as an important feature, i.e., enabling learners to take determined initiative;
2. shifting the system of learning for rewards or the passing of standardised tests to a system of learning for the sake of learning;
3. making use of inquiry-based or open-ended teaching methods;
4. using digital courseware to give learners the flexibility of what, how, and when they want to learn;
5. using learning management systems to track the various learning journeys created by students;
6. government facilitation. E.g., Finland uses random samples of students' work to evaluate instead of a standardised testing system; and
7. public-private collaboration to ensure the transfer of skills throughout the phases of learning.

9.4.2.8. INNOVATIVE EDUCATION

Brynjolfsson and McAfee (2011) observed that the US educational progress has stagnated because the educational sector has failed to keep up with technology. The educational sector is a poor adopter of ICT and conventional methods of teaching to a lecture hall of passive students have not progressed much over the past few centuries. The authors commented that "it's a system for transmitting information from the notes of the lecturer to the notes of the student without going through the brain of either." (2011: 61).

Pedagogy refers to "the combination of teaching approaches and learning principles that underpins education systems" (WEF, 2020: 10). The WEF listed five key approaches to drive innovative pedagogy. These approaches are briefly defined in **Table 3.**

Key Approach	Description
1. *Playful*	Elated experiences permitting children to find meaning by way of active thinking and group interplay
2. *Experiential*	Amalgamation of theory into real-world implementation
3. *Computational*	A problem-solving approach which teaches learners how computers resolve problems
4. *Embodied*	Education by way of movement of the body
5. *Multiliteracies*	Focused on diversity and the various ways of language use and sharing. It links education with cultural awareness.

TABLE 3: KEY APPROACHES TO INNOVATIVE PEDAGOGIES
Compiled by researcher (2021)
Sourced from WEF (2020)

According to the WEF (2017a), technology opens up opportunities to innovative and personalised learning strategies. The role of educators can drastically change, and learning may evolve to much deeper and broader experiences using technology. Adefila and Pillay (2019) explained that it is not the student or technology that plays a significant role in the classroom, but rather the educator who uses current technology in an interactive and creative manner.

Moreover, access to education in rural areas can be obtained by bypassing traditional infrastructures. For instance, according to WEF (2020), Vodacom, a mobile communication company in South Africa, delivers an e-school to its subscribers.

The WEF (2017a) further noted that new research in fields, such as pedagogy, psychology and neuroscience, show prospects for innovation and the transformation to more evidence-based teaching.

According to Brynjolfsson and McAfee (2011), the 4IR brings new opportunities through digitization to improve education. Teachers can experiment, measure, share and replicate new educational approaches. Moreover, ICT can significantly improve the scale and customisation of education. Universities, such as Stanford and Massachusetts Institute of Technology (MIT), have used ICT to provide low-cost programmes to students across the globe. Not only do these programmes provide quality education that would otherwise be inaccessible to these students,

but it has increased the productivity of the course instructors and expanded the scale of students.

At secondary level, Khan Academy provides thousands of videos and hundreds of self-assessment modules for students around the globe free of charge (Brynjolfsson and McAfee, 2011). The authors noted that educators are increasingly using Khan Academy's tools to reinvent the classroom. Students are given these videos to watch at their own individual pace at home and then do the practice questions in class under the supervision of a teacher. This approach allows educators to spend less time lecturing students with different needs at the same pace, and more time assisting students individually with their specific needs.

Furthermore, the fusion between "videoconferencing, software and networks" with teachers and tutors allows the duplication of "superstar" educators, giving more students access to quality education while learning on their individually comfortable pace (Brynjolfsson and McAfee, 2011: 33). The authors further explained that software could detect the progress of students, while teachers, tutors, and peer tutoring can provide emotional support and individual assistance.

9.5. CONCLUSION

The fourth identified headwind to South Africa's ability to exploit economic growth opportunities during the 4IR is education. Going into the 4IR, South Africa will not only face changing educational demands, but also its own past failures. Education for the 4IR entails much more than digital literacy and teaching children to code – it begs an entire redesign of the education ecosystem that focusses on transformations in ECD, curricula, workplace exposure and career guidance, digital fluency, quality TVET, LLL, and innovative education.

Education designed on this inclusive blueprint will reduce rising inequalities, the age-related digital divide, and structural unemployment. If South Africa wishes to run with the machine, it must redesign the education system and provide quality education which levels the playing field.

In 2020, various disruptions in education and the labour market were experienced due to the Covid-19 pandemic. Inequalities were highlighted, and the 4IR's technologies leapt into homes. Chapter 10 discusses the final headwind: the Covid-19 economic shock.

CHAPTER 10 : THE COVID-19 ECONOMIC SHOCK

10.1. INTRODUCTION

So far, the current dissertation has identified four headwinds: inequality, demographics, unemployment, and education. More recently, a fifth headwind geared against South Africa's economic growth potential. The current chapter will analyse the relevance of COVID-19 as a headwind to the country's future economic growth. The chapter will provide an overview of the pandemic up to 8 September 2020. It will explain its relevance as an economic shock and investigate its impact on South Africa's demographics, unemployment, education and the 4IR.

10.2. THE PANDEMIC

In 2019, the SARS-CoV-2 virus triggered the COVID-19 outbreak (initially known as 2019-nCoV) which started in Wuhan city, China. On 11 March 2020, the World Health Organisation (WHO) declared the COVID-19 outbreak a global pandemic. By this time, COVID-19 had already spread to South Africa, and on 15 March the government declared a national state of disaster, summoning drastic measures to protect its citizens against the pandemic. These measures included travel bans from high-risk countries and the closing of several land- and seaports of entry.

On 23 March 2020, President Cyril Ramaphosa announced a 21-day hard lockdown. Citizens were not allowed to leave their homes unless they required essential goods and services. This was also the start of a nearly five-month-long ban on tobacco products and intermittent periods of alcohol bans and restrictions. On 27 March, Moody's became the final credit rating agency to downgrade South Africa to a rating of Ba1 – better known as "junk status". On 9 April, the lockdown was extended for an additional two weeks.

On 1 May 2020, South Africa found some economic relief when the country entered level four of lockdown. Prior to this, the government announced its

intention to inject R500 billion into the economy – sparking fears of rising debt levels. A month later, on 1 June, the country moved to level three lockdown, with more eased restrictions. However, restrictions on alcohol and tobacco sales, curfews and travel bans continued to take a heavy toll on certain industries. In the coming months, the COVID-19 pandemic entered its peak, and by August the country seemed to have passed the peak. On 18 August, the country entered lockdown level two – unbanning the sale of alcohol and tobacco, and interprovincial travel. For the first time in nearly five months, the most hard-hit industries were seeing a glimmer of hope for financial survival.

> *"COVID-19 is spreading human suffering worldwide; that is what we should all be focussed on. But we are not doctors. We are economists – and COVID-19 is most definitely spreading economic suffering worldwide. The virus may in fact be as contagious economically as it is medically."*
>
> (Baldwin and Weder di Mauro, 2020: 1)

The impact of COVID-19 on the global economy is uncertain. Many are hoping that its impact will be like the common flu – an uncomfortable, but short-lived, discomfort. Such an impact would be V-shaped, and the economy would quickly return to its prior growth. However, it is still too soon to determine the severity of the economic impacts of the pandemic (Baldwin and Weder di Mauro, 2020).

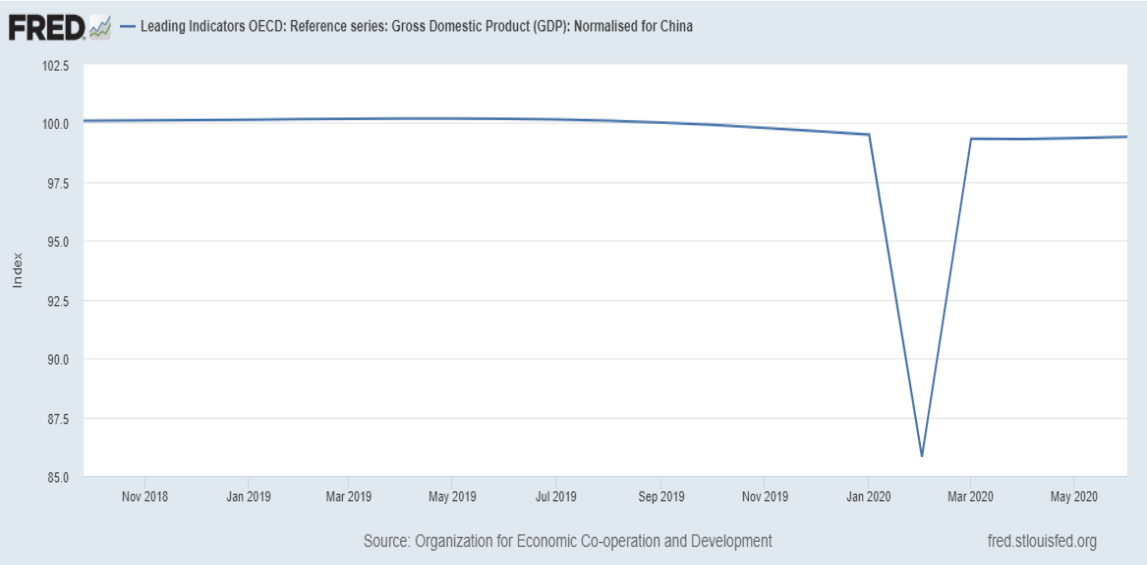


FIGURE 10-1: CHINA'S POST-LOCKDOWN RECOVERY
Sourced from the OECD (2020b)

If the behaviour of the Chinese economy is anything to go by, then South Africa can expect a swift economic recovery post-lockdown (**Figure 10-1**). However, the negative economic consequences may differ from country to country depending on the harshness of measures, such as lockdowns, duration, and level of compliance (Brodeur, Gray, Islam & Bhuiyan, 2020). South Africa's lockdown was much longer and its economic growth much more vulnerable in the period leading up to the pandemic.

Prior to the COVID-19 pandemic's arrival in the country, South Africa experienced two consecutive quarters of negative GDP in the last quarters of 2019. This was followed by a two percent negative GDP growth rate in the first quarter of 2020 (STATS SA, 2020a). The first quarter captured only a small fracture of the extend of the country's lockdown. Consequently, South Africa's real GDP growth[25] declined by a historic 16,4 percent during the second quarter characterised by strict lockdown measures.

During the early stages of the pandemic, Baldwin and Weder di Mauro (2020) noted that the worst-hit countries were the G7 countries: the US, China, Japan, Germany, Britain, France, and Italy. Together they accounted for 60 percent of global GDP, 65 percent of global manufacturing, and 41 percent of manufacturing exports. The authors noted that "when these economies sneeze, the rest of the world catch a cold." (2020: 2). While China has recovered from its cold, it has infected the entire world.

Covid-19 has hit South Africa at a time where it had little to cushion the impact. As South Africa enters the 4IR, it will not only need to recover from its decade-long economic stagnation, but also from the economic destruction left by the pandemic.

10.3. Economic Shocks

Carlsson-Szlezak, Reeves & Swartz (2020) used "shock geometry" to explain the different shapes recoveries may take after COVID-19-induced shocks. An optimistic viewpoint sees a V-shaped recovery (such as **Figure 10-1**) wherein the

[25] Measured at market prices. Quarter-to-quarter, seasonally adjusted.

economy quickly bounces back to its pre-COVID-19 output levels. A U-shaped recovery is characterised by a prolonged recovery period where output quickly drops, due to a shock, but does not bounce back to pre-COVID-19 output levels. In this case, the gap between the old and new path is significant. The much more pessimistic viewpoint sees an L-shaped recovery where output drops and then continues on a downward path. In this case, the gap between the old and new output paths widens over time. According to Carlsson-Szlezak *et al.,* (2020b), whilst previous pandemics exhibited V-shaped recoveries, the COVID-19 recovery is expected to be more complicated due to the extent of lockdown measures.

Researchers have estimated the impact COVID-19 will have on economies using various methodologies. For instance, Ludvigson, Ma & Ng (2020) used quarterly US data from 1980 to 2020 to investigate the impact of economic shocks on economic activity and uncertainty using VAR. The authors found that the impact of COVID-19 will not be short-lived (V-shaped) and will span over multiple periods. Moreover, they estimated a 12,75 percent decline in industrial production in the US, a 17 percent decline in service employment, and five months of persistent macroeconomic uncertainties. Baker, Meyer, Pagel & Yenelis (2020) argued that forward-looking measures were needed to estimate the impact on the economy. Using real business cycle models, they estimated an 11 percent contraction in US economic growth.

Baldwin and Weder di Mauro listed three sources of economic shocks that COVID-19 is likely to cause: first, the medical shock of sick workers who cannot contribute to GDP; second, the economic impact of containment measures, such as travel restrictions, business closures and lockdown measures; finally, the shock sourced from our psychological reaction to the pandemic or 'belief-based economic shocks' (2020: 11).

10.3.1. BELIEF-BASED ECONOMIC SHOCKS

The human brain uses linear estimations of past performances to make future approximations. Baldwin and Weder di Mauro (2020: 12) called this "straight lining the future" which could lead to an under-estimation in the earlier stages and

an over-estimation in the later stages of a disease. **Figure 10-2** illustrates the under- and over-estimations that the human brain can make at the various stages of the epidemiologic curve. Belief-based shocks can also be sourced from herd behaviour or panic, such as the global panic buying of toilet paper.

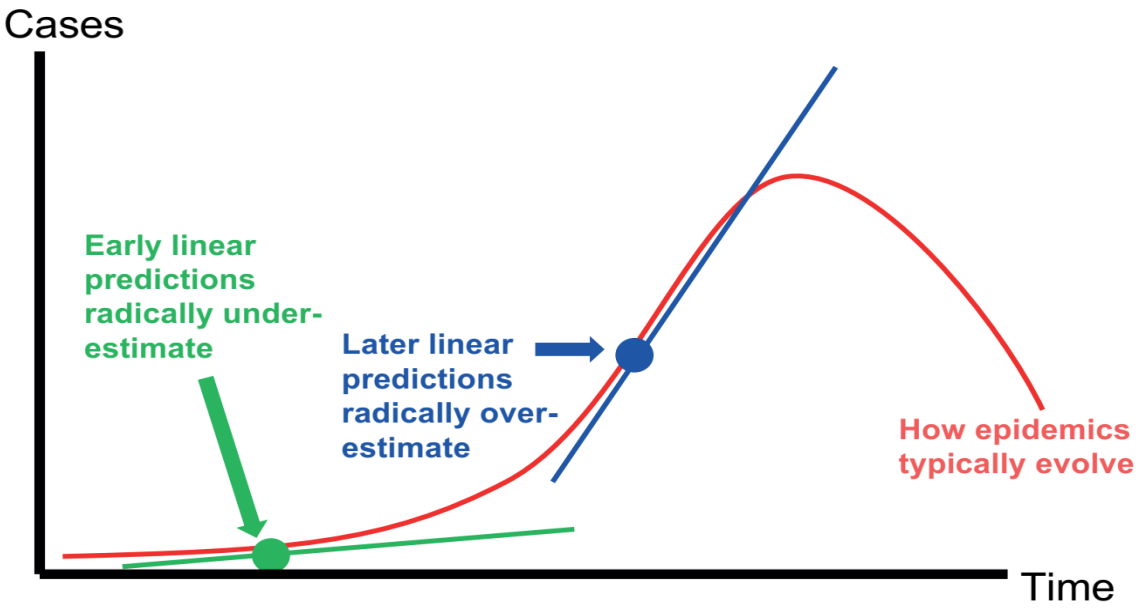


FIGURE 10-2: HUMAN BRAIN ERRORS MADE WHEN STRAIGHT LINING THE FUTURE
Sourced from Baldwin and Weder di Mauro (2020: 12)

10.3.2. SUPPLY-SIDE SHOCKS

Supply-side shocks refer to the impact of human reactions on the supply-side, such as the closure of schools and businesses or travel restrictions. Economically, these restrictions directly reduce productivity and cause temporary unemployment (Baldwin and Weder di Mauro, 2020). Furthermore, the authors added that the quarantine measures needed when a person encountered an infected person could cause further productivity losses.

To some extent, the impact of productivity losses was cushioned by remote-working made possible by digital technologies and collaborative cloud-based technologies (Baldwin and Weder di Mauro 2020). However, not all jobs could be performed remotely.

10.3.3. THE AMBIGUITY OF THE HEALTH-SHOCK'S PROLIFERATION

According to Baldwin and Weder di Mauro (2020), the COVID-19 health shock's geographical spread is ambiguous. Therefore, there is much uncertainty as to when, how and where the supply shocks will be prominent. The authors predicted that the proliferation of these shocks would be closer to entangled web representations than concentric circles – the more common proliferation pattern of supply shocks.

Furthermore, Baldwin and Weder di Mauro (2020) added that the uncertainty of the proliferation of a supply shock is further strengthened by its dependence on human nature and the uncertain lethality of the virus.

10.3.4. SUPPLY-CHAIN SHOCKS

Baldwin and Weder di Mauro (2020) explained that the global supply-chains could be severely impacted, especially when large players, such as China and the US, are hard hit. At the time of their writing, China was the hardest hit country globally. However, the US has surpassed China in subsequent months with the highest infections and fatalities. Nevertheless, the US is also one of the major players in the supply chain. When these countries experience supply-shocks, many dependent countries are almost guaranteed to feel the impact.

10.3.5. DEMAND-SIDE SHOCKS

According to Baldwin and Weder di Mauro (2020), aggregate demand shocks within the COVID-19 pandemic can be sub-divided into the practical and psychological aspects. The practical aspect refers to when consumers cannot visit stores, for instance, due to illness, wiping out demand.

The psychological aspect refers to when consumers or firms adopt a 'wait-and-see' point of view when facing Knightian uncertainties (Baldwin and Weder di Mauro, 2020). The psychological aspect of demand shocks is evident in the global financial crisis of 2008-2009. Strengthened by the power of the internet, the global community watched as the crisis unfolded in the US. Not many

countries were directly or severely impacted by the crises, but they postponed purchases and investments due to the psychological shock. This became known as the North Atlantic financial shock that transpired into a worldwide demand shock.

The most common casualties of demand-side shocks are the hospitality and transport sectors (Weder di Mauro, 2020). Moreover, the size of the demand shock will depend on the risk of infection or the measures taken by governments. The level of caution will be determined by fear and uncertainty.

South Africa's Department of Tourism (2020) reported that in the first quarter of 2020, income from accommodation dropped 10,4 percent compared to the first quarter of 2019. The drop in income can be attributed to a 41,6 percent decline in March, which was accompanied by the first week of a five-week complete lockdown, followed by months of severe restrictions on the tourism industry. Similarly, the food and beverage industry experienced a 9,1 percent drop in income, with catering services hit hardest with a 14,7 percent drop. Moreover, aviation movements declined significantly in March. Arrivals declined by 44,5 percent and departures by 71,3 percent. According to Knoema (2019), South Africa's tourism industry contributed 8,6 percent of South Africa's GDP in 2018.

10.3.6. STRENGTH AND DURATION OF SHOCKS

"Government reactions create more and longer-lasting disruptions than the virus" (Baldwin and Weder di Mauro, 2020: 17). The strength of the shock will be dependent on the actions taken to limit the spread of the virus (Weder di Mauro, 2020).

The magnitude of the COVID-19 economic shocks is difficult to determine due to the lagged availability of data. However, Demirguc-Kunt, Lokshin & Torre (2020) estimated the magnitude of the economic impact on Europe and Central Asia during the initial phase of the COVID-19 pandemic using high-frequency proxies, such as electricity consumption and mobility records. The study concluded that lockdown and social distancing measures caused a ten percent deterioration in

economic activity, and early interventions (e.g., social distancing) led to better health and economic results.

10.3.7. THE ECONOMIC SHOCK IN SOUTH AFRICA

Ataguba (2020) concluded that African countries would most likely carry more microeconomic and macroeconomic costs as a result of the COVID-19 pandemic. Microeconomic costs include mortality and morbidity burdens, additional health-related costs, work restrictions, productivity losses, increased health expenditure by governments, and possible crowding-out effects when health expenditure is rerouted to COVID-19 from other critical health priorities. The impact on Africa would be greater due to its poor health systems, insufficient health budgets, and a high proportion of informal workers. Macroeconomic costs refer to the demand and supply shocks in the economy. Although it is difficult to determine the magnitude of these costs to African economies, it is more certain that the impact will be significant.

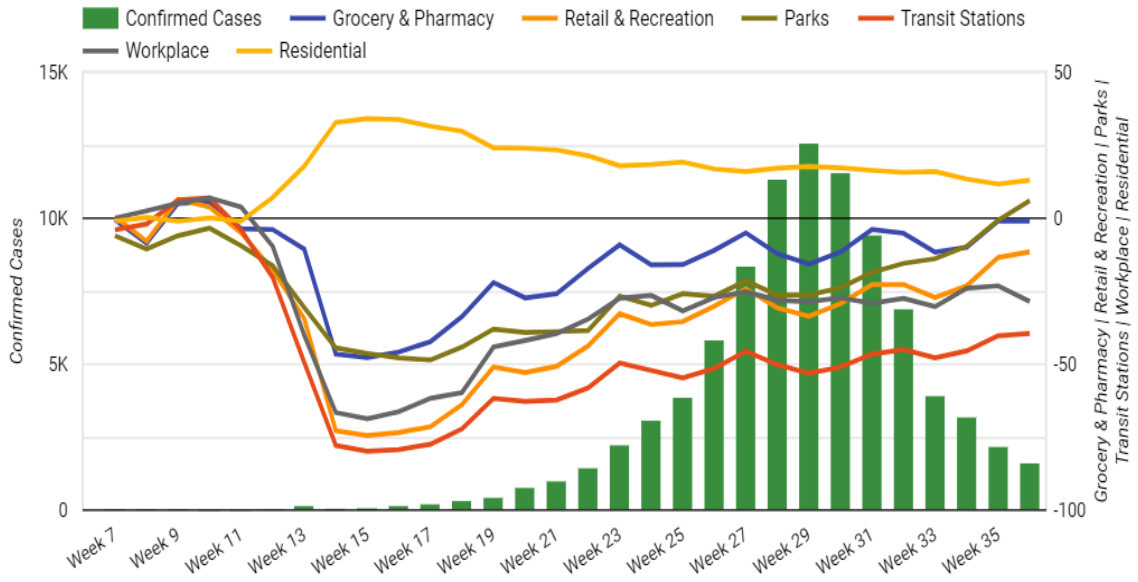


FIGURE 10-3: SOUTH AFRICA'S AVERAGE DAILY INCREASE AND MOBILITY INDICES
Sourced from Google Data Studio (2020)

Figure 10-3 illustrates Google's mobility indices for South Africa. The figure illustrates that in week 15 (6 – 12 April), the peak of the period and the second week of the lockdown, South Africans spent 34,14 percent more time at home than during the baseline period (3 January – 6 February 2020). In contrast, other

countries such as the US and New Zealand have consistently spent around 10 percent more time at home. Grocery and pharmacy locations experienced a 47,71 percent decline during the same week; retail and recreation (including restaurants and tourism) experienced a significant decline in visits of 74,43 percent; park visits declined by 46,29 percent; transit by 79,86 percent; and visits to workplaces declined by 68,71 percent. The daily average increase in COVID-19 cases peaked in week 29 (13 – 19 July) and declined steadily thereafter. By 25 August 2020, these figures had improved but were still well away from the baseline. These figures are significantly different from other countries. For instance, in the US, visits to pharmacies and grocery stores fell only around five percent and were consistent over the entire period. Visits to parks increased significantly and remained within the 40-80 percent range above the baseline.

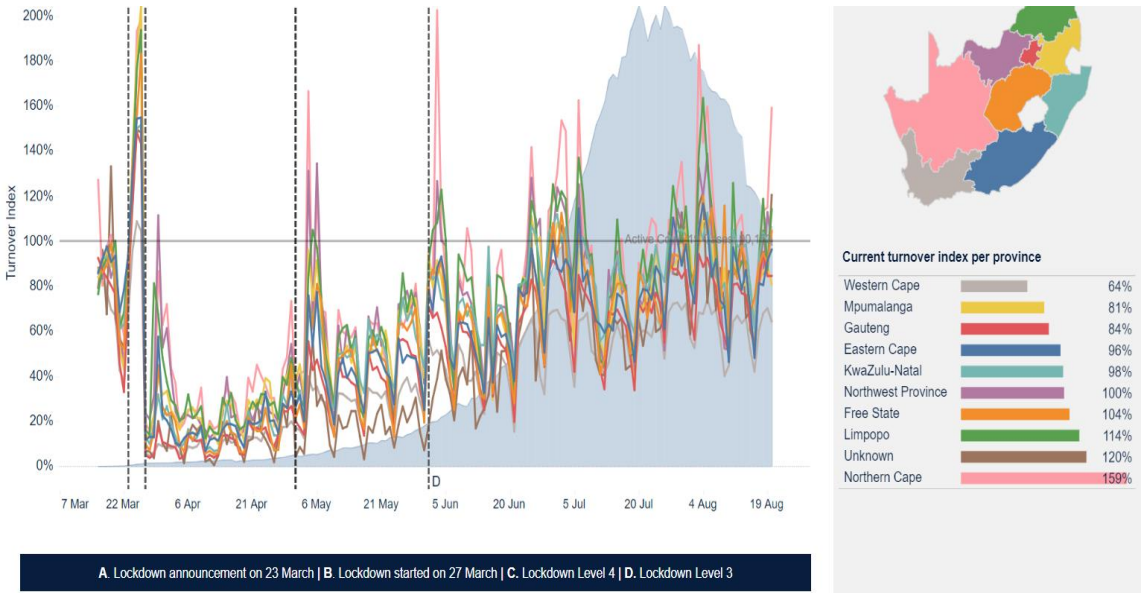


FIGURE 10-4: YOCO'S SMALL BUSINESS INDEX, SOUTH AFRICA
Sourced from Yoco (2020)

Figure 10-4 illustrates the activity of small businesses measured by Yoco's[26] credit- and online sales for the period 7 March – 20 August 2020. The shaded area represents the active COVID-19 cases in South Africa. A clear spike in activity can be seen after the announcement of the lockdown on 23 March up until the start of the lockdown on 27 March when activity dropped significantly. Activity gradually increased as the lockdown was downgraded to lower levels with

[26] Yoco is a credit card machine and online payment company.

spikes evident on days when lockdown regulations changed, or new levels were implemented. Level 2 lockdown started on Monday, 18 August at midnight. On 10 April, the index reached its lowest level of five percent, but by 20 August it had recovered to 79 percent.

10.4. Population Ageing and Inequality

The COVID-19 pandemic has a larger impact on older persons than previous pandemics (Brodeur *et al.*, 2020). The current study has already established that the Indian/Asian and white populations in South Africa are much older than the black African and coloured population groups. It is therefore expected that these ageing population groups will be disproportionately affected in terms of health by the COVID-19 pandemic.

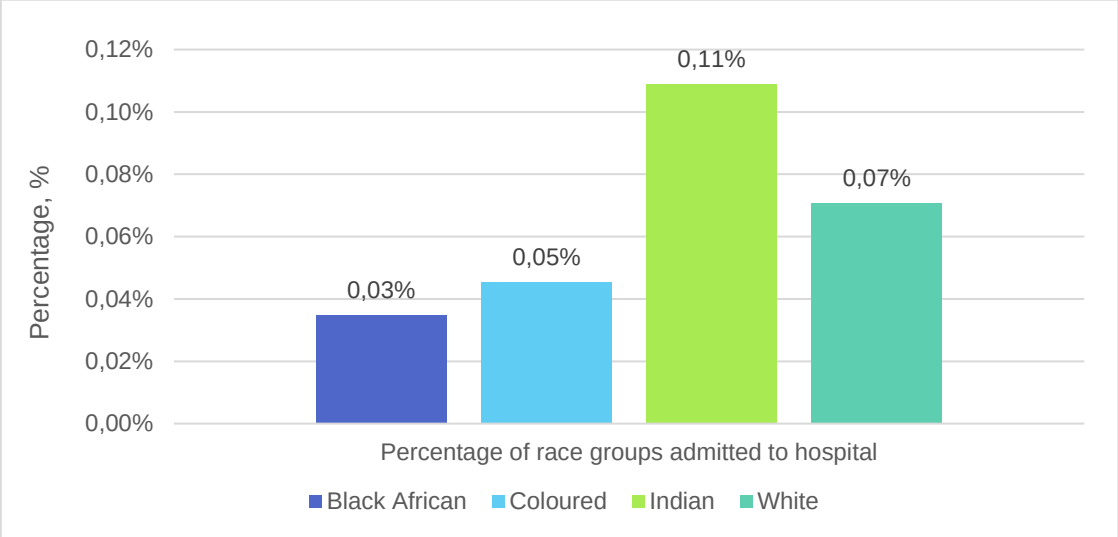


FIGURE 10-5: COVID-19 HOSPITAL ADMISSIONS AS A PERCENTAGE OF POPULATION GROUPS, SOUTH AFRICA
Compiled by researcher (2021)
Data sourced from Stats SA (2019d); National Institute for Communicable Diseases (NICD) (2020)

Figure 10-5 illustrates the percentage of each major population group in South Africa that was admitted to hospital due to COVID-19 up until 8 August 2020. The figure illustrates that the older population groups – i.e., the Indian/Asian and white population groups – were more prone to be hospitalised due to the virus. This observation is consistent with the population pyramids of the different population groups. It should be noted that this does not mean that these groups exhibited increased likelihoods to be admitted to hospital because of their race – such an

observation would require controlling for factors such as age and comorbidities. In fact, the NICD (2020) found that black African and coloured persons had higher risks of mortality than Indian/Asian and white persons. The fatality rate of those admitted to hospitals were 19,8 percent for both white and coloured persons, 17,6 percent for Indian/Asian persons, and 17,4 percent for black African persons. However, after making adjustments, the odds of mortality compared to white persons were 1,2 times for Indian/Asian persons, 1,3 times for black African persons, and 1,4 times for coloured persons.

10.5. UNEMPLOYMENT

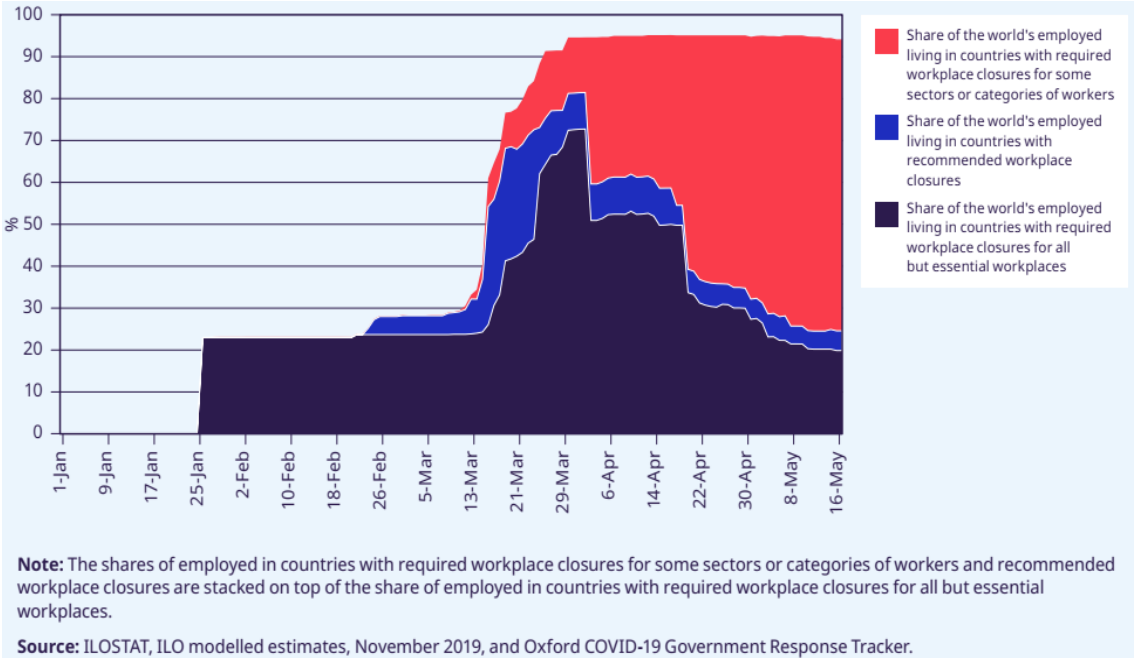


FIGURE 10-6: GLOBAL WORKPLACE CLOSURES
Sourced from ILO (2020: 3)

On 17 May 2020, the ILO (2020) reported that 94 percent of the global workforce resided in countries where some form of workplace closure measures were implemented. Twenty percent resided in countries where only essential workers could return to their workplaces. **Figure 10-6** illustrates how lockdown measures were relaxed from the beginning of 2020 to 16 May 2020.

The ILO (2020) projected that working hours globally fell by 10,7 percent in the second quarter of 2020. This percentage is equivalent to 305 million full-time[27]

[27] Based on a 48-hour working week.

jobs. At the time, most losses occurred in the Americas, Europe, and Asia. To curb these losses, the ILO recommended more extensive testing and tracing.

In the first quarter of 2020, the unemployment rate in South Africa declined one percentage point from 29,1 percent in that last quarter of 2019 to 30,1 percent (SARB, 2020c). The subsequent results are expected to be much worse due to the harsh lockdown measures that followed.

10.6. THE LOCKDOWN GENERATION

An analysis of the ILO (2020) suggests that younger persons are at risk of being scarred throughout their working lives. The COVID-19 crisis affects them disproportionally; with manifold shocks, such as the disruptions in education and employment. This could lead to a new phenomenon – the lockdown generation.

The ILO (2020) additionally noted that 178 million[28] young workers worked in sectors that were hard hit when the crisis unfolded. Nearly 77 percent of them were employed in the informal sector. On the other hand, merely 60 percent of workers, aged above 25, worked in hard-hit, informal, sectors. Moreover, this rate ranges from merely 32,9 percent in Europe and Central Asia, to a significant 93,4 percent in Africa. These figures exclude the 267 million young persons globally who were already not in employment, education, or training (NEET) before the pandemic.

In South Africa, STATS SA (2020b) reported that the youth aged 15-24 years who were NEET increased from 33,2 percent in the first quarter (Q1) of 2019 to 34,1 percent in the same quarter of 2020. Moreover, in both years, the NEET rate was higher for females. The NEET rate for youths between 15 and 34 years increased from 40,7 in 2019(Q1) to 41,7 in 2020(Q2). The impact was particularly hard on females who experienced a NEET rate increase of 1,1 percentage points to 45,4 percent. On the other hand, the male NEET rate for this age group increased by one percentage point to 38,1 percent.

[28] More than 40 percent

In April 2020, UNESCO reported that all educational institutions in 192 countries had been closed. This affected around 1,6 billion, or 90 percent of learners worldwide (Psacharopoulos, Patrinos, Collis, & Vegas, 2020). By June, less than 1,2 billion learners were affected as schools and universities reopened gradually (UNESCO, 2020a). In addition, while around half of students globally expected delays in completing their studies due to COVID-19, ten percent expected that they would not be able to complete their studies at all. More than half of respondents have fallen prone to anxiety or depression following the outbreak of the pandemic (ILO, 2020).

In South Africa, UNESCO reported that more than 14 million learners, from pre-school to tertiary, were completely or partially out of school. Where many countries localised school closures to outbreak areas, South Africa closed its schools country-wide.

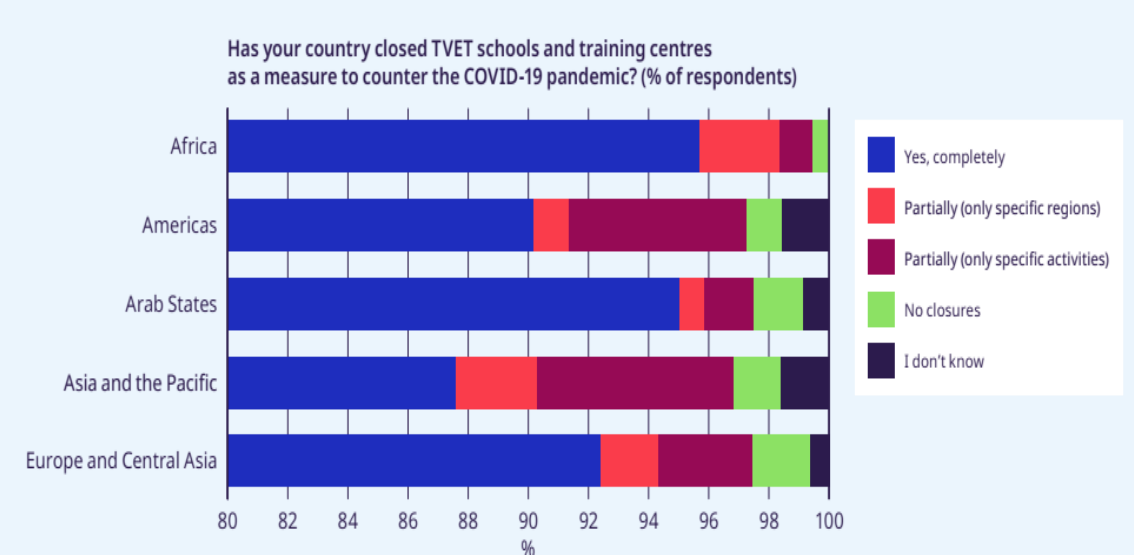


FIGURE 10-7: THE CLOSURE OF TVET SCHOOLS AND TRAINING CENTRES
Sourced from ILO (2020:9)

The pandemic disrupted both TVET and on-the-job training. An ILO-UNESCO-World Bank survey recorded that 98 percent of respondents stated that the TVET institutions they were attending had completely or partially closed (ILO, 2020). While most of the training had shifted online, low-income countries were struggling to implement online learning. **Figure 10-7** illustrates the regional difference in TVET school and training centre closures. Africa, perhaps the region

most in need of TVET, was particularly hard hit by closures in the second quarter of 2020.

Psacharopoulos *et al.* (2020) developed preliminary evidence to approximate the expected losses of future income of the lockdown generation in the US due to COVID-19 school closures. The authors approximated the loss in marginal future income by assuming that each year of education adds to ten percent of future income. Based on a 45-year working-life, three percent discount rate, and average annual earnings of $53 490, the investigation estimated that the lockdown generation would lose $1 337 per person per year or $33 464[29] accumulated over their working-lives due to a four-month closure of schools. These figures might seem like insignificant sacrifices by young individuals to curb the pandemic, but a snapshot of the possible impact on the entire US economy paints a different picture. The cost of four months' education to the US is estimated to be $2,5 trillion or 12,7 percent of GDP. Extrapolated to the world economy, as much as $10 trillion may be lost in future income.

Another survey by ILO and the *Global Initiative on Decent Jobs for Youth* found that among pre-COVID-19, employed, young workers globally, more than a sixth could no longer work by May 2020; and those who were still employed reported a 23 percent decrease in working hours (ILO, 2020). The ILO further highlighted a large rise in unemployment globally since the start of the pandemic, especially for young females. For instance, in Canada, the employment rate for adults deteriorated by six percentage points. In contrast, the unemployment rate for young men and women increased by 14,3 and 20,4 percentage points, respectively.

10.7. COVID-19 AND THE 4IR

The COVID-19 pandemic has forced the human race to adopt technologies rapidly. The lockdown implemented in March 2020, gave businesses three days to prepare for work-from-home systems. Employees were forced to adopt

[29] These figures are expressed in present values.

technologies such as Zoom and WhatsApp. The word is that the 4IR will accelerate due to this push in technology acceptance.

According to Karr, Loh & Andres (2020) the acceleration of the 4IR due to the pandemic could possibly eliminate certain jobs due to automation. The withdrawal of older workers, lower interest rates or subsidies for automation can accelerate the accumulation and adoption of technologies. Therefore, policymakers would need to carefully consider the jobs that are at risk of automation given this new development in the global economy. Post-pandemic economic considerations, new challenges faced by employees, and the resultant impacts of COVID-19 responses will need to be incorporated in policies.

Dwolatzky and Harris (2020) explained that 70 percent of digital transformations fail mostly due to a lack of buy-in. Humans have an inherent propensity to resist change – the major characteristic of technological transformation. In South Africa, these barriers are magnified by other issues, such as the quality of connectivity, digital illiteracy, and access to technology. The lockdown that accompanied COVID-19 leapt some sectors significantly towards the 4IR. For instance, the health sector adopted tools such as WhatsApp, Zoom and Google's Data Studio. Although was been a significant increase in the adoption of e-learning and distance education tools and methods in the education sector, the digital divide was highlighted with poor connectivity, access to technology, and digital literacy. Interestingly, one of the most resistant professions to technological change, the legal industry, adopted new technologies and formed "virtual courtrooms".

However, given the large inequalities in education, digital divide, and unskilled workers discussed in this dissertation, it is more likely that COVID-19 has pushed skilled, high-income groups further into the 4IR while leaving the rest behind. It is, therefore, more likely that COVID-19 has increased the digital divide.

10.8. CONCLUSION

The final headwind to South Africa's economic growth during the 4IR is the economic shocks arising from the COVID-19 pandemic. The impact that the COVID-19 pandemic has had on South Africa's economy is expected to be

significant. In South Africa, lockdown restrictions were particularly severe and are expected to deeply impact its already frail economy. The harshness of the lockdown is evident in the significantly high decrease in mobility of South Africans; and will most likely be evident in a deep economic recession. Moreover, although older persons' health is disproportionately affected by the pandemic, preliminary evidence indicates that the economic impact on the younger generation will most likely be severe. Even though the pandemic has leapfrogged many into the 4IR, the result in South Africa will most likely be a leap into a much larger digital divide.

The COVID-19 pandemic is possibly a temporary headwind for most countries. However, due to South Africa's already frail economic performance, it will significantly challenge the country's recovery.

The COVID-19 pandemic, and its resulting economic shocks, therefore, serves as South Africa's fifth, and final, headwind to economic growth during the 4IR. Chapter 11 will investigate the relative severity of South Africa's headwinds to economic growth during the 4IR.

CHAPTER 11 : THE RELATIVE SEVERITY OF SOUTH AFRICA'S HEADWINDS

11.1. INTRODUCTION

The current study has thus far identified five headwinds to South Africa's ability to exploit economic growth opportunities during the 4IR. Chapter 11 will conduct a CA in order to evaluate the severity of these headwinds relative to other developed and developing countries.

The fifth headwind, COVID-19, does not form part of the comparison since not enough research and data is available to determine its impact. The data used in the comparison can be found in Appendix A.

11.2. INEQUALITY

The income Gini coefficient quantitatively measures the degree of income inequality. Perfect inequality would be indicated by a Gini coefficient of 1, and a coefficient of 0 would indicate perfect inequality (Mohr, 2008). A detailed breakdown of the data is provided in Appendix A.

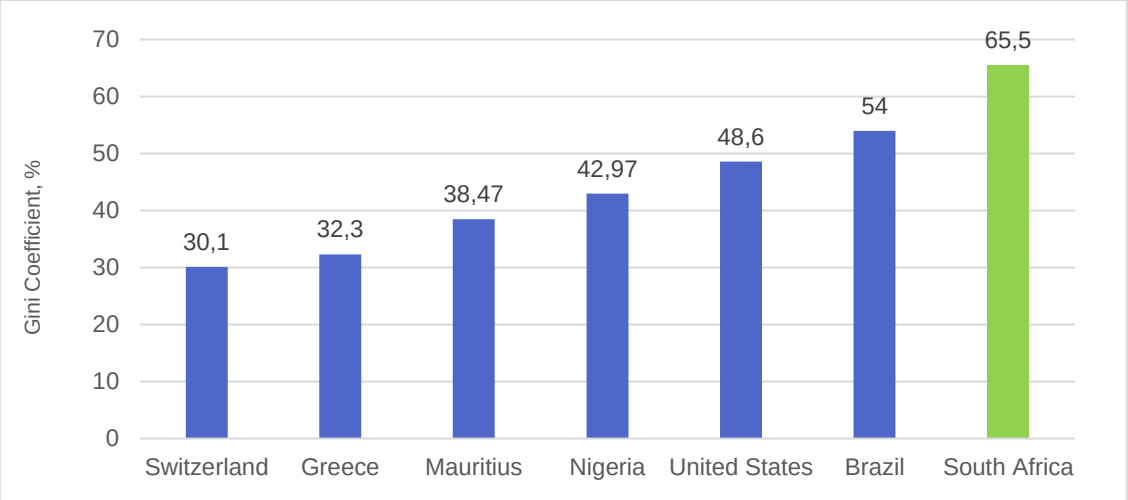


FIGURE 11-1: GINI COEFFICIENT OF SELECTED COUNTRIES
Compiled by researcher (2021)
Data sourced from UNU-WIDER (2020)

Figure 11-1 illustrates South Africa's Gini coefficient, expressed as a percentage, relative to the selected countries in this study. Switzerland had the lowest degree

of income inequality of the countries under comparison with a Gini coefficient of 30,1 percent; followed by Greece with a coefficient of 32,3 percent. Mauritius was not only the most equal developing country with a Gini of 38,47 percent, but its Gini coefficient ranked lower than that of the US with 48,6 percent. Nigeria similarly achieved a lower Gini than the US of 42,97 percent – lower than that of the US. Brazil had the second highest degree of income inequality amongst the countries under comparison, with a Gini coefficient of 54 percent. However, the poorest performer, not only amongst the selected countries but also globally, was South Africa with a Gini coefficient of 65,5 percent – more than twice that of Switzerland and Greece.

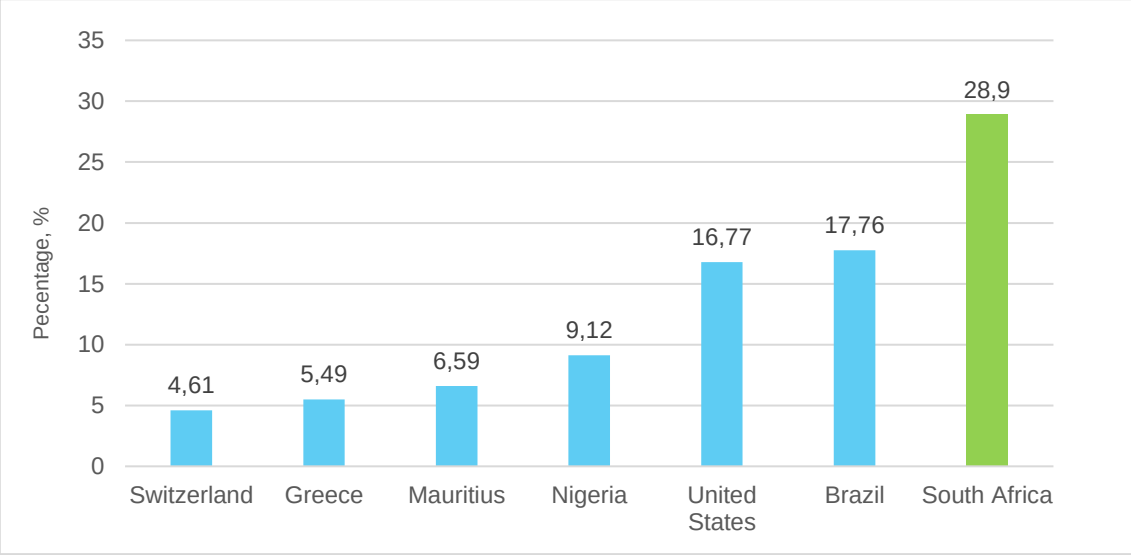


FIGURE 11-2: THE SHARE OF THE TOP 20% EXPRESSED AS A PERCENTAGE OF THE BOTTOM 20%
Compiled by researcher (2021)
Data sourced from UNU-WIDER (2020)

On the one end of the spectrum, the top 20 percent in Switzerland earned merely 4,61 percent as much as the bottom 20 percent. On the opposite side, South Africa's richest 20 percent earned 28,9 percent as much as the poorest 20 percent. Greece, Mauritius, and Nigeria's top 20 percent earned between 5-10 percent, and the US and Brazil obtained 16,77 percent and 17,76 percent, respectively.

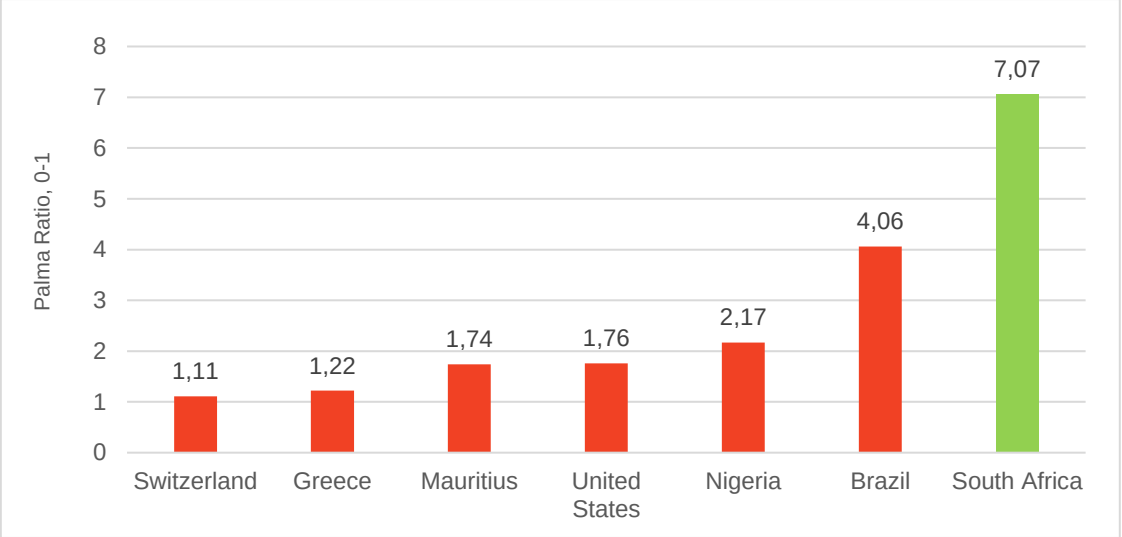


FIGURE 11-3: PALMA RATIO
Compiled by researcher (2021)
Data sourced from UNU-WIDER (2020)

The Palma ratio represents the income share of the top ten percent divided by that of the bottom 40 percent (UNU-WIDER, 2020). The Palma ratio indicates how many times the top ten percent earned the income of the poorest 40 percent of a country. The top ten percent in Switzerland and Greece earned just above the same as the bottom 40 percent. In Mauritius, the top ten percent earned 1,74 times the income of the bottom 40 percent. The US followed with a Palma ratio of 1,76. Nigeria's rich earned 2,17 times the income earned by the poorest 40 percent. In Brazil, the Palma ratio was nearly four times that of Switzerland, at 4,06. However, South Africa's richest ten percent earned an astonishing 7,07 times that of the bottom 40 percent.

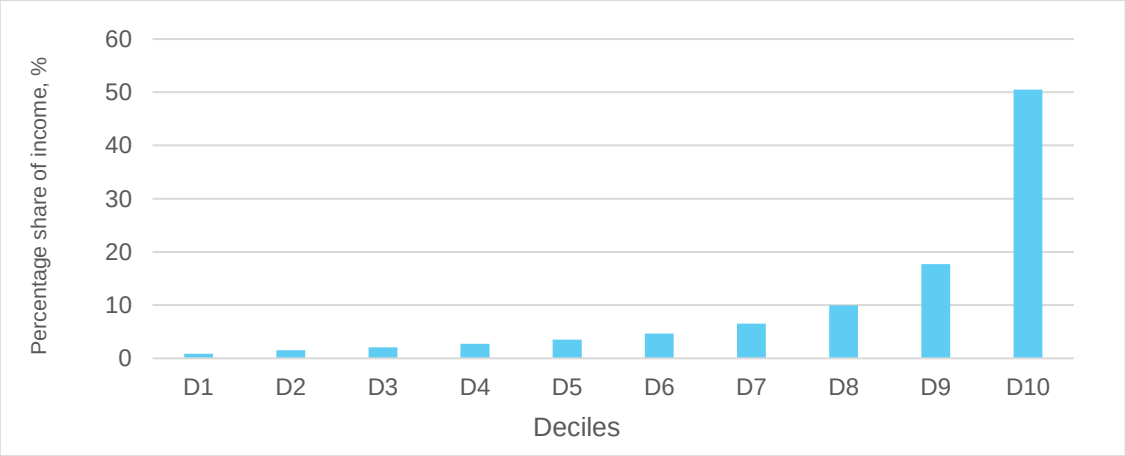


FIGURE 11-4: INCOME SHARE CATEGORISED BY DECILES, SOUTH AFRICA
Compiled by researcher (2021)
Data sourced from UNU-WIDER (2020)

The above results clearly indicate that South Africa has a higher degree of income inequality than any of the countries under comparison, including the developing countries. It is, therefore, necessary to investigate the income shares earned by the different deciles to determine the source of South Africa's inequality**. Figure 11-4** illustrates the large difference in income shares of the top 20 percent and the bottom 80 percent. South Africa was the only country in the comparison where the poorest ten percent earned less than one percent of income (Table 4). In fact, it was also the only country where the 8th decile earned less than ten percent of total income. The 9th decile earned slightly more than other countries, but the top ten percent earned 50,5 percent of income – around double that the top ten percent in Greece and Switzerland earned.

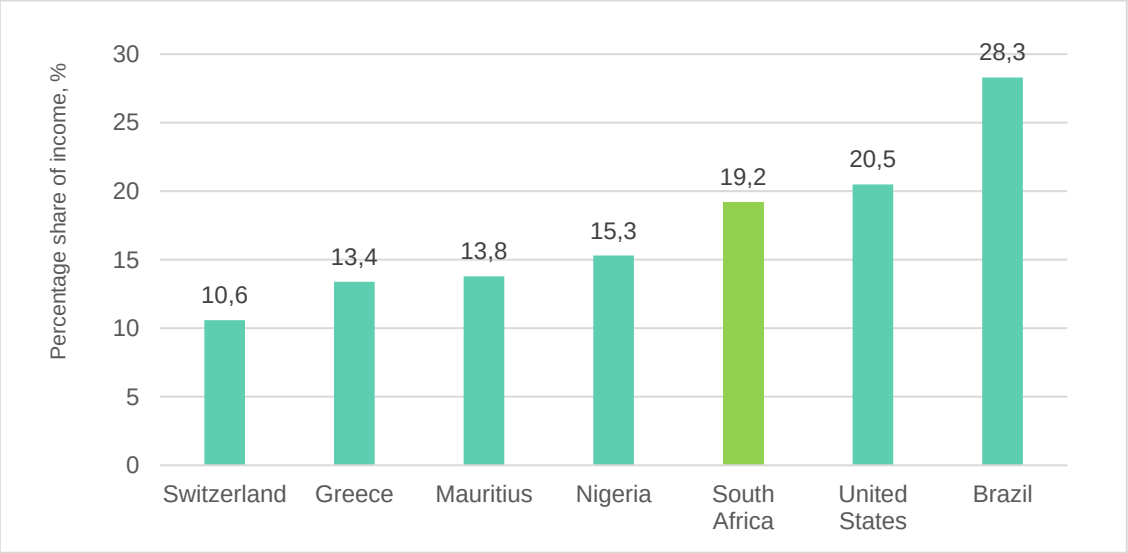


FIGURE 11-5: INCOME SHARE OF THE TOP 1%
Compiled by researcher (2021)
Data sourced from World Equality Database (WID) (2019)

Now that the different income shares of different deciles in South Africa have been established, the focus can be narrowed down to the top percentile – presented in **Figure 11-5** - in order to determine whether a winner-takes-all inequality is evident in countries. Surprisingly, Brazil took the lead as the country where the top one percent earned nearly 30 percent of income. In the US, the top one percent earned 20,5 percent. South Africa's top one percent earned 19,2 percent, whilst Nigeria, Mauritius and Greece's superstars earned around 14 percent on average. Switzerland's top one percent earned the lowest share of 10,6 percent.

11.3. DEMOGRAPHICS

This section compares South Africa's relative ability to overcome the second headwind, demographics, to other countries. Refer to Appendix B for the complete dataset.

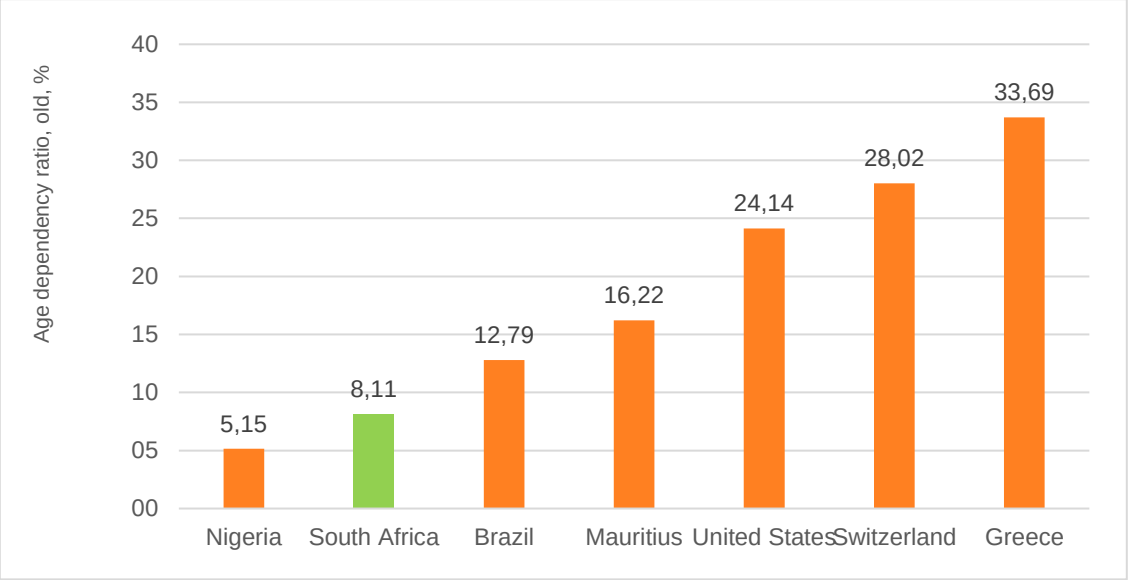


FIGURE 11-6: AGE DEPENDENCY RATIO, OLD, 2018
Compiled by researcher (2021)
Data sourced from World Bank (2019a)

The age dependency ratio for the selected economies is demonstrated in **Figure 11-6**. Greece was the most aged country with a population of older persons consisting of 33,69 percent of the working-age population. In fact, Greece was ranked the 5th oldest country in the world, according to the Population Reference Bureau (PRB) (2020). Switzerland's old dependency ratio was second highest at 28,02 percent – but the PRB ranked it the 25th oldest country globally. The US' ratio was 24,14 percent. Of the developing countries analysed, none of the countries ranked within the top 50 oldest populations compiled by the PRB. Mauritius is the only country that scored above 15 percent. Brazil scored a ratio of 12,79 percent, but South Africa and Nigeria were the youngest populations with old dependency ratios of 8,11 and 5,15 percent, respectively.

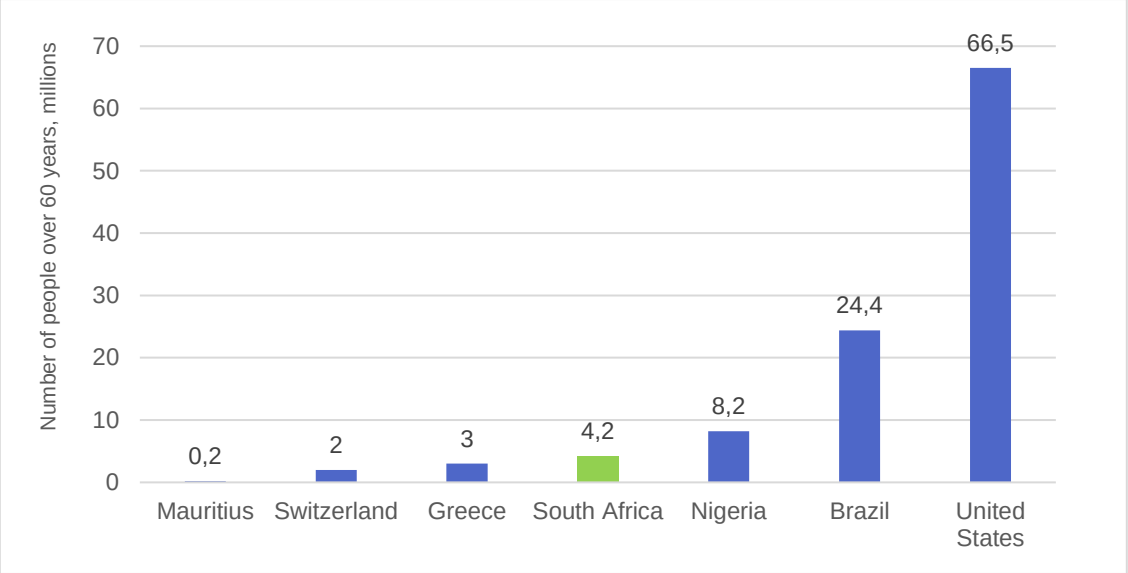


FIGURE 11-7: NUMBER OF OLDER PERSONS
Compiled by researcher (2021)
Data sourced from HelpAge International (2015); PRB (2020)

Conversely, when the number of persons above the age of 60 was investigated, the picture changed significantly (**Figure 11-7).** Approximately 66,5 million older persons lived in the US. Brazil, identified as the third youngest population, housed around 24,4 million older persons. Nigeria, the youngest population, was home to just over 8 million older persons – almost as much as the entire Greek population of roughly 10 million individuals. While Greece had the oldest population in the study, it merely housed around 3 million older persons. Despite South Africa's comparatively low proportion of older persons to the total population, it is home to around 4,2 million older persons – more than Switzerland or Greece. Mauritius, with a population of less than 1,3 million, held the lowest number of older persons of around 200 000. Therefore, due to its relatively large total population, South Africa had a large population of older persons despite being a young population.

The overall index compiled by HelpAge International (2015) measures each country's performance in providing for its population of older persons based on four sub-measures – the capability, health status, enabling environment, and income security sub-indices.

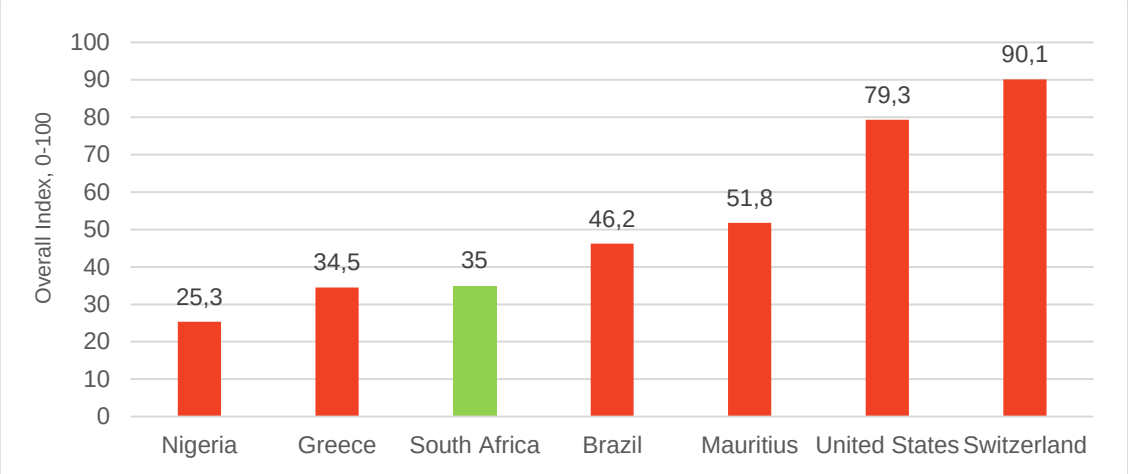


FIGURE 11-8: OVERALL INDEX, 2015
Compiled by researcher (2021)
Data sourced from HelpAge International (2015)

The overall index is illustrated in **Figure 11-8**. Not surprisingly, Switzerland is the leader, ranking 1st globally among 96 countries, followed by the US, ranking 9th. Nigeria, being the youngest population in the sample, ranked lowest with an overall index of 25,3 and a global ranking of 86th. Interestingly, the oldest country in the sample – Greece - ranked 79th with an index of 34,5. South Africa ranked higher than Greece at 78th. As far as Mauritius is concerned, it managed to outperform its developing counterparts, obtaining an overall index of 51,8 and ranking 42nd. Brazil, with the second largest number of older persons in the sample, ranked second highest among the developing countries in this study. The remainder of this section investigates the sub-indexes responsible for the overall index results.

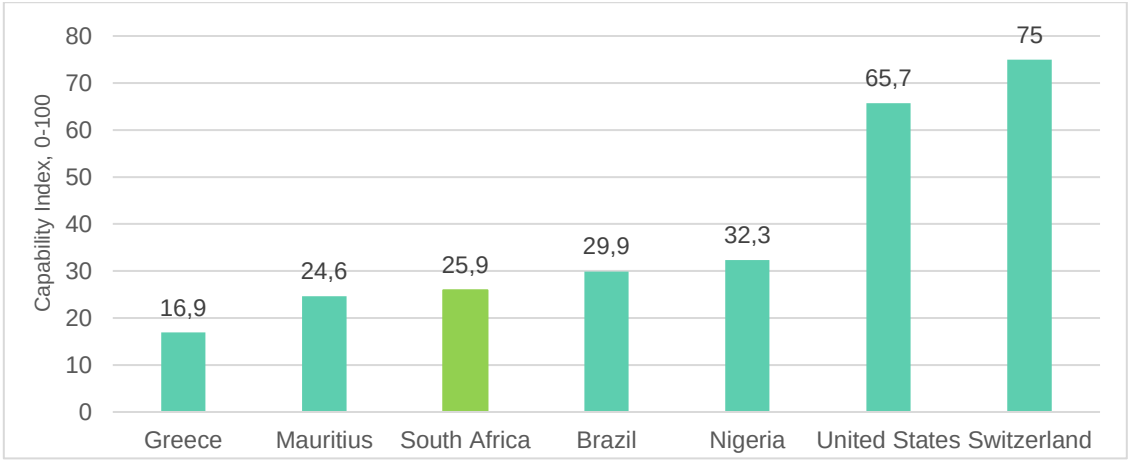


FIGURE 11-9: CAPABILITY SUB-INDEX, 2015
Compiled by researcher (2021)
Data sourced from HelpAge International (2015)

The capability sub-index, illustrated in **Figure 11-9**, measures the older population's labour market engagement and educational engagement. Switzerland ranked highest in the capability index, mostly because 71,7 percent of Swiss aged 55-64 are in employment. However, HelpAge International (2015) noted that there is still much room for improvement – for instance, age discrimination is still legal in the country. Nevertheless, Switzerland ranked 1st in the world with a capability index of 75. Switzerland is followed by the US, ranking 4th with an index of 65,7. Nigeria obtained the highest index of 32,3 among the developing countries under consideration – less than half that of the US Brazil and South Africa obtained indices of 29,9 and 25,9, respectively. Interestingly, the more aged developing and developed countries, Mauritius, and Greece, ranked lowest. In these countries, both the employment and educational attainment rates among older persons were low.

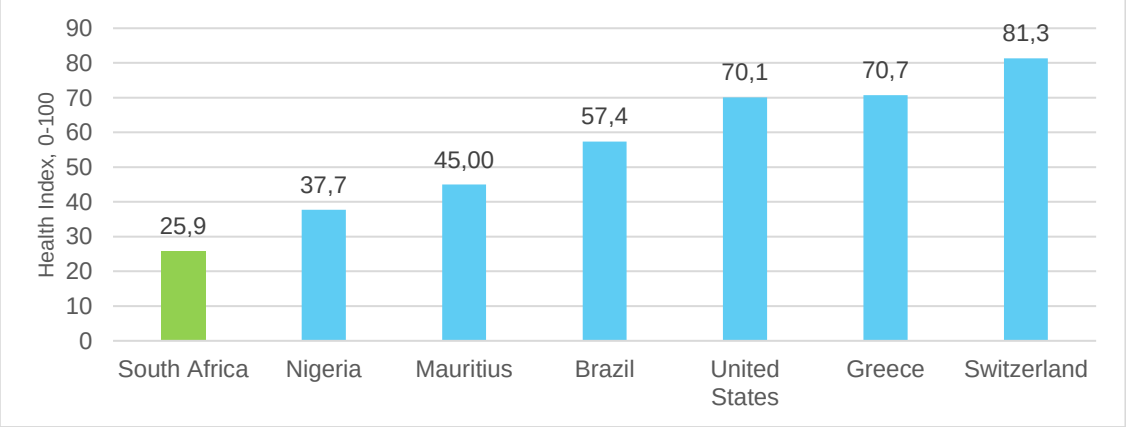


FIGURE 11-10: HEALTH STATUS SUB-INDEX, 2015
Compiled by researcher (2021)
Data sourced from HelpAge International (2015)

The health status sub-index (**Figure 11-10**) measures each country's life expectancy at 60, relative psychological wellbeing, and healthy life expectancy at 60 (HelpAge International, 2015). South Africa's life expectancy at 60, of 16, was below the regional average of 17. Consequently, South Africa ranked the lowest in this category with a health status sub-index of 25,9. In comparison, Nigeria, Mauritius, Brazil, the US, Greece, and Switzerland obtained health status sub-indices of 37,7 45; 57,4; 70,1; 70,7 and 81,3, respectively. Brazil's ranking was the highest of the developing countries due to its life expectancy at 60 being merely one year less than the regional mean.

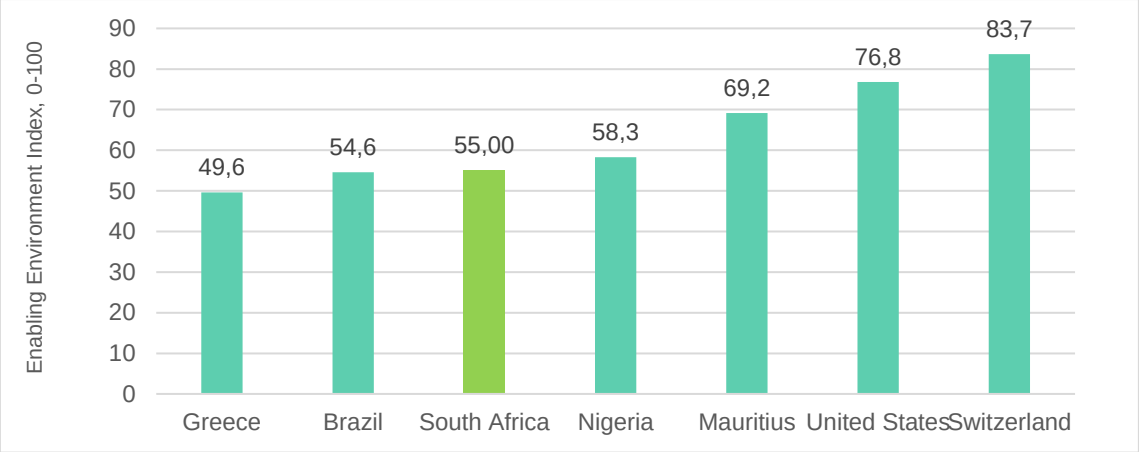


FIGURE 11-11: ENABLING ENVIRONMENT SUB-INDEX, 2015
Compiled by researcher (2021)
Data sourced from HelpAge International (2015)

The enabling environment sub-index (EESI), illustrated in **Figure 11-11**, measures a country's population over 50 in terms of social connections, physical safety, civic freedom, and access to public transport (HelpAge International, 2015). South Africans had a low satisfaction with safety of 31 percent. As a result, the country ranked 83rd in this domain with an EESI of 55,0. Similarly, Brazil ranked lower at 87th, with a safety satisfaction rate of 28 percent. Once again, Mauritius outperformed its developing competitors at a ranking of 38th and an EESI of 54,6. The US ranked 17th, while Switzerland was the world leader in this domain. Conversely, Greece performed worse than the developing countries under consideration (and 91st globally) due to its aged population's dissatisfaction with transport, safety, and civic freedom.

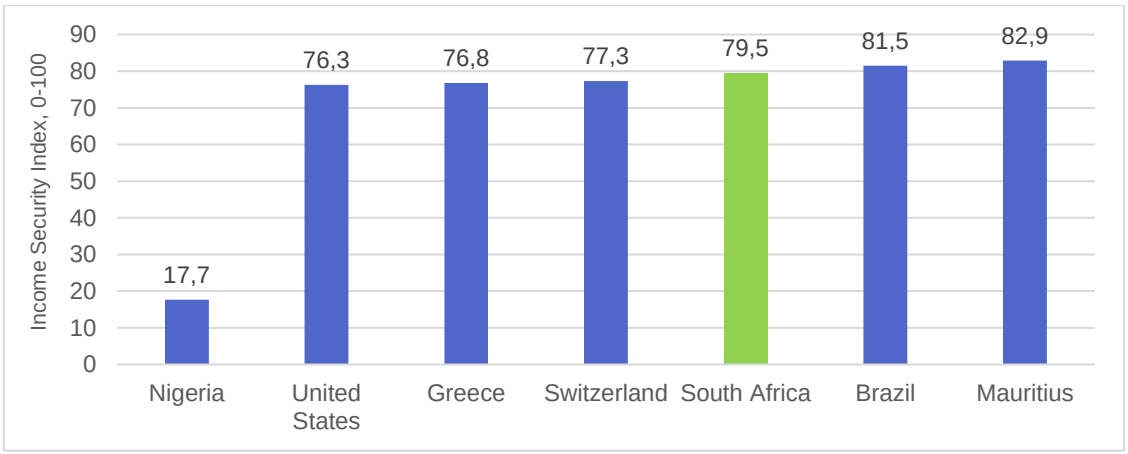


FIGURE 11-12: INCOME SECURITY SUB-INDEX, 2015
Compiled by researcher (2021)
Data sourced from HelpAge International (2015)

The income security sub-index (ISSI) measures each country's pension income coverage, poverty rate amongst older persons, comparative welfare of older persons, and per capita gross national income (GNI) (HelpAge International, 2015). **Figure 11-12** reports the relative differences in the income security domain. Due to data unavailability, the relative welfare of South Africa's older persons was not measured. Nigeria ranked lowest with a pension coverage of merely 5 percent. Surprisingly, South Africa ranked 19th in this domain due to its high pension coverage of 92.6 percent, its low poverty rate of 12 percent, and its high regional GNI per capita. It obtained an ISSI of 79,5. However, except for Nigeria with an ISSI of 17,7, it could not outrank its developing rivals. Mauritius, with an ISSI of 82,9, ranked 9th place with an impressive 100 percent pension coverage, an old age poverty rate of 6.4 percent, and the highest regional GNI per capita. Brazil's ISSI of 81,5 ranked 13th with a lower pension coverage than South Africa of 86.3 percent, but a lower old-age poverty of 8,8 percent. Interestingly, the developed countries were outperformed by the developing countries.

The US ranked lowest of the selected countries at 29th with a pension coverage of 92.5 percent, but an old age poverty rate of 18 percent. Greece was closely-ranked to the US in 28th place. Although it had a relative welfare rate of older persons of 106 percent for its region, it had a low GNI per capita and a pension coverage of only 77 percent.

Switzerland ranked 27th in this domain, with a 100 percent pension coverage and the third-highest per capita GNI. However, its old age poverty rate was 16,1 percent. HelpAge International (2015) explained that Switzerland has a three tiered-social safety scheme that consists of state, employer, and personal contributions. A recent study by its government found that the one percent value added tax (VAT) contribution should be increased to 3,8 percent, and the current contributions by employers and employees of 4,2 percent should be lifted to 11,3 percent collectively.

11.4. UNEMPLOYMENT

In order to compare the second headwind across countries, data from the *Global Competitiveness Report (GCR) 2019* (WEF, 2019) were used. The GCR employs the Global Competitiveness Index 4.0, which acknowledges the impact of the 4IR and globalisation in its design when benchmarking the drivers for long-run competitiveness.

This section employs the 8th pillar of the GCR, *labour market*, to compare South Africa's second headwind with the selected countries in this study. First, the unemployment rate, provided in the GCR's *Social and environmental performance* section for each selected country, is compared. Thereafter, the overall labour market index will be compared, followed by its two components, the *Flexibility* and *Meritocracy and incentivization* sub-indices. The detailed results are presented in Appendix C.

The *Flexibility index* measures the redundancy costs, hiring and firing practices, cooperation in labour-employer relations, flexibility of wage determination, active labour market policies, workers' rights, ease of hiring foreign labour, and internal labour mobility. The *Meritocracy and incentivization index* measures reliance on professional management, pay and productivity, the ratio of wage and salaried female workers to male workers, and the Labour tax rate. Together, these two sub-indices, contributing equal weights, form the *Labour market index (*WEF, 2019).

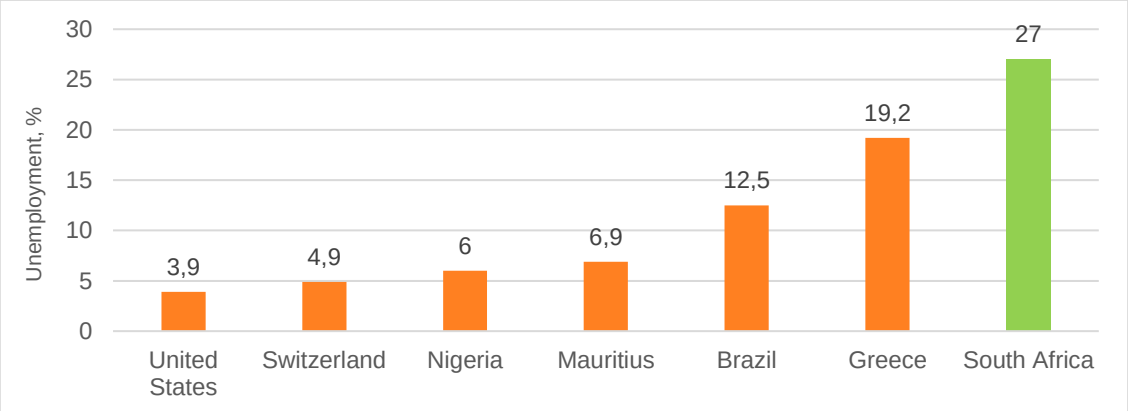


FIGURE 11-13: UNEMPLOYMENT RATE
Compiled by researcher (2021)
Data sourced from WEF (2019)

Ultimately, the results of the various labour market sub-indices should impact unemployment. **Figure 11-13** illustrates the unemployment rates, according to the strict definition, of the countries under consideration. South Africa had the highest unemployment rate among both developed and developing countries included in the sample. Twenty-seven percent of South Africans were unemployed, followed by 19,2 percent of Greeks. South Africa's fellow BRICS counterpart, Brazil, exhibited an unemployment rate of 12,5 percent - less than half that of South Africa. Nigeria's unemployment rate is surprisingly low compared to the other developing countries – only around six percent of Nigerians were unemployed. Mauritius was head-to-head with Nigeria at a rate of 6,9 percent. The US and Switzerland lead the race with much more impressive unemployment rates of 3,9 and 4,9 percent, respectively.

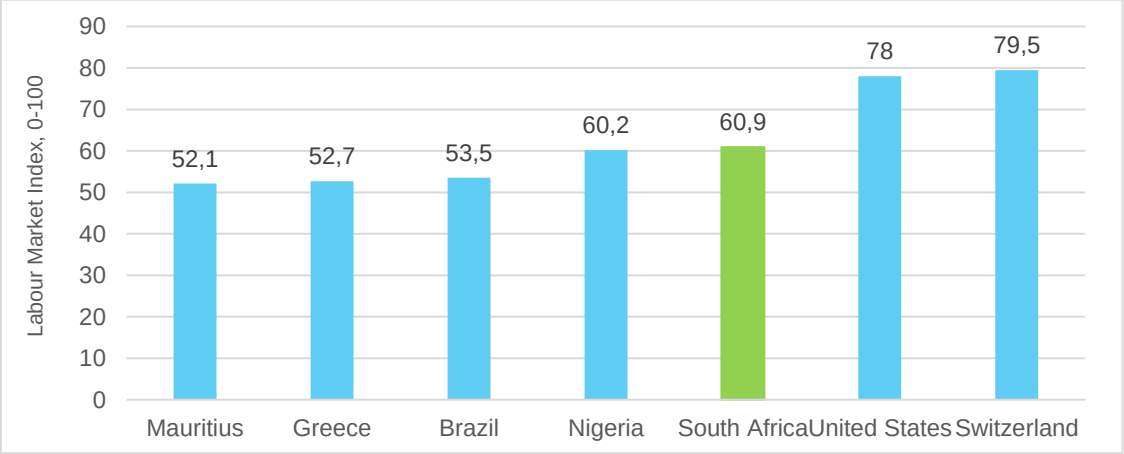


FIGURE 11-14: LABOUR MARKET INDEX, 2019
Compiled by researcher (2021)
Data sourced from WEF (2019)

The results of the overall labour market index are illustrated in **Figure 11-14**. Despite South Africa's high unemployment rate, it still managed to outperform its developing counterparts and Greece, with an index of 60,9. However, Nigeria was close on its tail at 60,2. Brazil and Greece followed with 53,5 and 52,7 respectively, and Mauritius ranked last with an index of 52,1. Switzerland ranked 2nd out of 141 countries and among the selected countries in this study with an index of 79,5, followed by the US with 78.

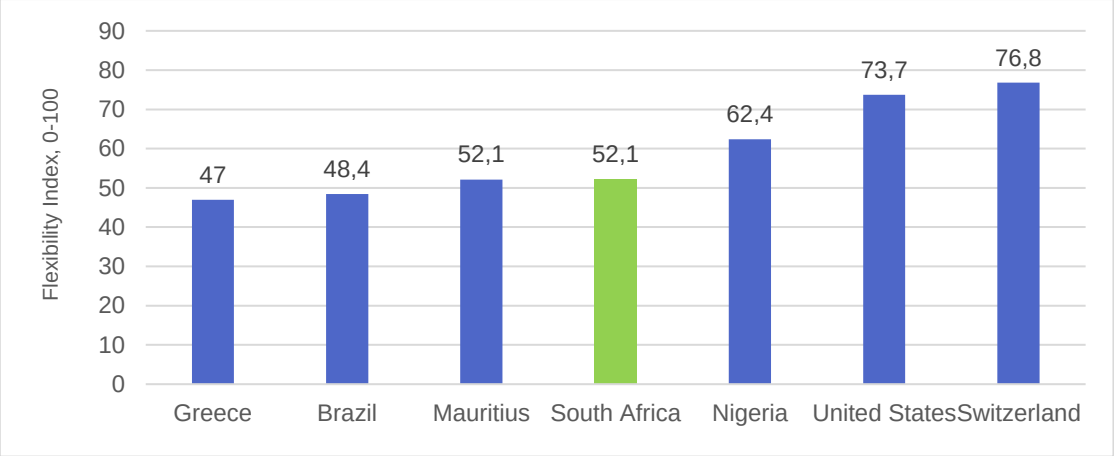


FIGURE 11-15: FLEXIBILITY INDEX, 2019
Compiled by researcher (2021)
Data sourced from WEF (2019)

The flexibility index (FI) indicates the flexibility of the labour market. The results of the comparison are illustrated in **Figure 11-15**. Switzerland scored highest with a value of 76,8. Despite ranking only 76th and 42nd in *Internal labour mobility* and *Ease in hiring foreign labour,* it ranked 1st globally in *Active labour market policies* and 2nd in both *Hiring and firing practices* and *Cooperation in labour-employer relations.* The FI for the US was 73,7, ranking it 3rd globally. The US ranked 1st in *Redundancy costs* and *Internal labour mobility*, but only 81st in *Workers' rights.*

The developing forerunner was Nigeria with a FI of 62,4. It was the only developing country in this study ranking within the top 50 (41st). It ranked 7th globally in *Redundancy costs*; and 15th, 18th and 21st in *Internal labour mobility*, *Hiring and firing practices* and *Flexibility of wage determination,* respectively.

Far behind Nigeria were South Africa and Mauritius, both obtaining FI's of 52,1. The only category where Mauritius scored within the top 50 globally was *Hiring and firing practices* (21st). It performed worst in *Redundancy costs,* scoring 0,0 and ranking 138th.

South Africa performed either in the top 50 or bottom 50 in the various categories. It scored 18th globally in *Internal labour mobility*, and 25th and 26th in *Redundancy costs* and *workers' rights,* respectively. Conversely, it ranked 139th and 134th in *Cooperation and labour-employer relations* and *flexibility of wage determination,* respectively. The remaining categories all ranked from 110th to 129th.

Brazil did not rank in the top 50 in any of the categories. Its highest ranking was 68th for *Redundancy costs*. The country ranked within the bottom 50 in the remaining categories. Surprisingly, despite ranking lowest in the selected sample of this study and 133rd globally, Greece managed to position itself 43rd in *Ease of hiring foreign labour*. The country ranked within a range of 71st to 119th in the remaining categories – its poorest ranking being much higher than South Africa.

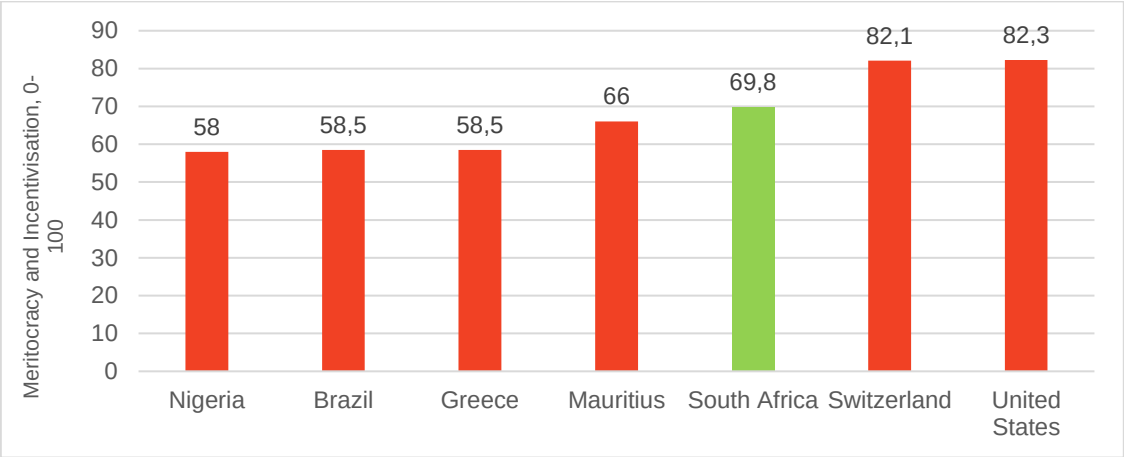


FIGURE 11-16: MERITOCRACY AND INCENTIVISATION INDEX, 2019
Compiled by researcher (2021)
Data sourced from WEF (2019)

Meritocracy and incentivisation as an index refer to the ability of a country to select, reward and motivate workers according to merit. The US leads the Meritocracy and incentivisation index (MII) with a value of 82,3; followed by Switzerland, 82,1. The US was 5th globally in *Pay and production*; 10th in *Reliance and professional management,* and in the top 40 countries globally in the remaining categories. Switzerland was the 2nd best-performing country globally in *Pay and production and 5th* in *Reliance and professional management*. However, its overall score was reduced by its lower standing of 74th for the category *Labour tax rate.*

South Africa's MII ranked 39th globally and outranked all the developing countries in the sample significantly. Its *Labour tax rate* positioned highest in this sample and 13th globally, and *Reliance on professional management* ranked 47th. However, *Pay and productivity*, ranking 83rd, is its biggest challenge.

Mauritius came in at 56th place globally in the MII. It ranked 25th in *Labour tax rate* but ranked between 67th and 77th in the other categories. Greece's MII was 34 places lower than Mauritius, at 90th place. It did not rank within the top 50 in any of the performance measures. Brazil ranked 91st and managed to rank within the top 50 in its *Ratio of wage and salaried female workers to male workers*, but its *Labour tax rate* ranked 137th of 141 countries. Nigeria ranked the poorest in the MII at 93rd with none of its performance measures ranking in the top 50.

11.5. EDUCATION

In order to evaluate South Africa's relative performance with the selected sample of countries, the sixth pillar, skills, in the GCR is employed. The Skills Index (SI) shows how skilled a country's workforce is and will be. Therefore, it is subdivided into the current and future workforces. For a more detailed view of the data and indicators included, refer to Appendix D.

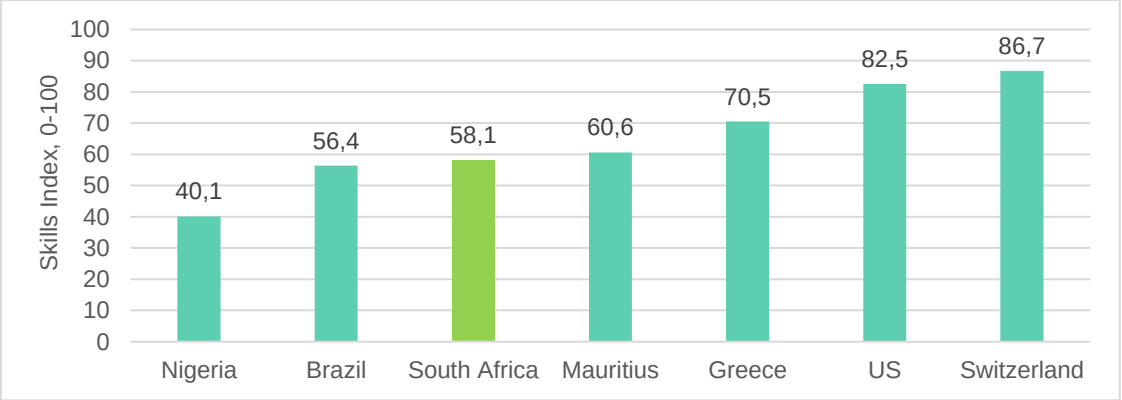


FIGURE 11-17: SKILLS INDEX, 2019
Compiled by researcher (2021)
Data sourced from WEF (2019)

Figure 11-17 demonstrates the overall skills index of the countries under consideration. Switzerland ranked the highest in the overall skills index (SI) and globally with a score of 82,5. In second place, the US scored 82,5 - ranking 9th in the world. Greece scored 70,5 and managed to place itself in the global top 50, at 41st place.

None of the developing countries in the sample made it to the top 50. Mauritius, the leader among developing countries in this sample and category, scored 60,6 and rated 79th globally. Mauritius is followed by South Africa with a score of 58,1,

ranking 90th. Brazil is on its tail scoring 56,4 and ranking 96th. Nigeria performed poorest, scoring, and ranking 40,1 and 129th place, respectively.

In order to determine the main causes of the overall performance of the sample countries, this dissertation takes a closer look at the current and future workforce indices in the remainder of this section.

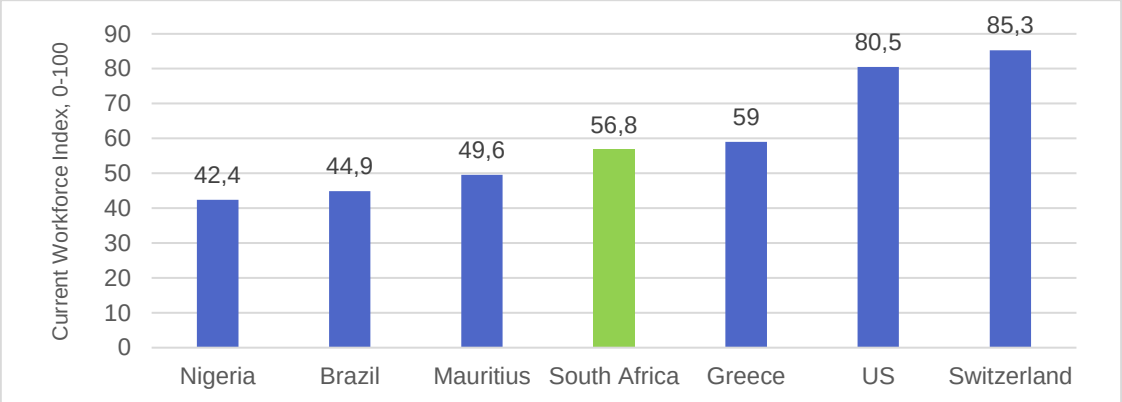


FIGURE 11-18: CURRENT WORKFORCE INDEX, 2019
Compiled by researcher (2021)
Data sourced from WEF (2019)

The current workforce index (CWI) measures each country according to the educational performance of those who are currently in the workforce. Switzerland not only ranks highest among the selected sample countries, but also worldwide with a score of 85,3. It has the highest *Mean schooling years* of 13,9 years. It is closely followed by the US, scoring 80,5, which ranked 3rd globally.

The 3rd ranked country in this study, Greece, ranks 61 places lower than the US at 64th place with a CWI of 59. The labour force received 10,3 years schooling on average. South Africa scored 56,8 and 72nd globally. The *Mean schooling years* of its labour force were 10,1 years. In Mauritius, the average worker received only 6,8 years of schooling – scoring the country a value of only 49,6. Brazil and Nigeria performed poorest with scores of 44,9 and 42,4 respectively.

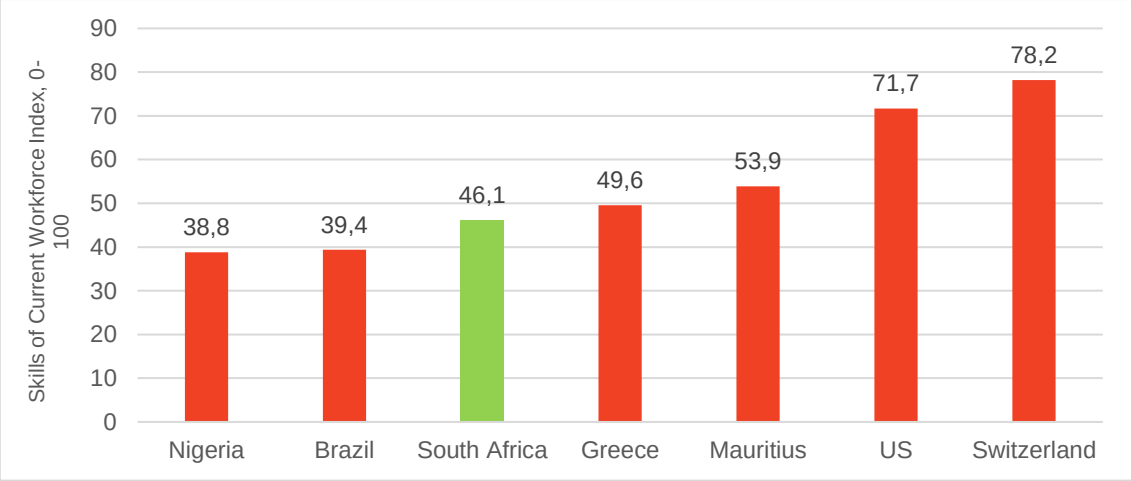


FIGURE 11-19: SKILLS OF THE CURRENT WORKFORCE INDEX, 2019
Compiled by researcher (2021)
Data sourced from WEF (2019)

The WEF (2019) compiled a *Skills of the current workforce index* (SCW) to measure the skills of the labour force. This index measures the extent of staff training, quality of vocational training, skillset of graduates, digital skills among active population, and ease of finding skilled employees.

Switzerland obtained the highest SCW of the sample countries and globally, scoring 78,2. It ranked 1st in various performance measures, namely the *Extent of staff training, Quality of vocational training* and *Skillset of graduates.* Furthermore, it ranked in the top 10 for four other measures and in the top 10 and top 30 for the last two measures.

The US scored 71,7, ranking 3rd globally. Its greatest strength was its *Ease of finding skilled employees*, ranking 1st in this measure globally. It ranks in the top 10 for five other measures, and its poorest ranking was 12th for its *Digital skills among active population.*

Mauritius ranked 58th, scoring 53,9, and led the developing country rankings in this sample. It scored within the top 50 for *Extent of staff trading*, but 82nd for its worst-performing measure, *Ease of finding skilled employees.* Greece ranked 82nd with a score of 59. None of its measures made the top 50, and its *Extent of staff training* and *Quality of vocational training* ranked 108th and 109th, respectively.

South Africa ranked 101st globally and scored only 46,1. However, its *Extent of staff training* managed to score 40th place and within the top 50, the remainder of its measures scored within the bottom 50. Its graduates possessed the 102nd best skillsets; quality of vocational training ranked 119th, and *Digital skills among active population* ranked 126th.

Brazil and Nigeria came in last with SCW scores of 39,4 and 38,8 respectively. In addition, they ranked 131st and 132nd in the same order. Both countries scored four of the five measures within the bottom 50.

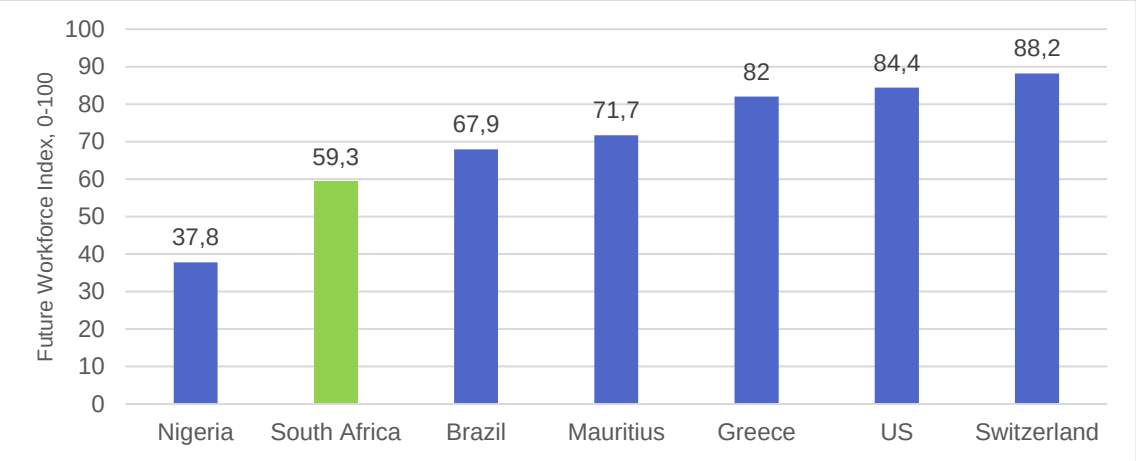


FIGURE 11-20: FUTURE WORKFORCE INDEX, 2019
Compiled by researcher (2021)
Data sourced from WEF (2019)

Figure 11-20 portrays the results of the *Future workforce index* (FWI) comparison. South Africa ranked second to last, scoring 59,3 and ranking 99th worldwide. Its *School life expectancy* (SLE), the number of years within which a person starting school at entrance level can expect to complete, was 13,7 years. Only Nigeria scored less in the sample – scoring 37,8 and a SLE of only 8,7 years. Mauritius outperformed its developing counterparts, ranking 76th.

Greece scored 82 and ranked 21st. Its SLE was 17,9 – 4,2 years more than South Africa's. The US ranked 14th with a SLE of only 16,3 years; similarly, Switzerland ranked 8th but obtained an SLE of 16,2. However, the SLE should be interpreted with care. It does not measure the quality of education and includes the number of years that learners repeat (UNSCO, 2020b).

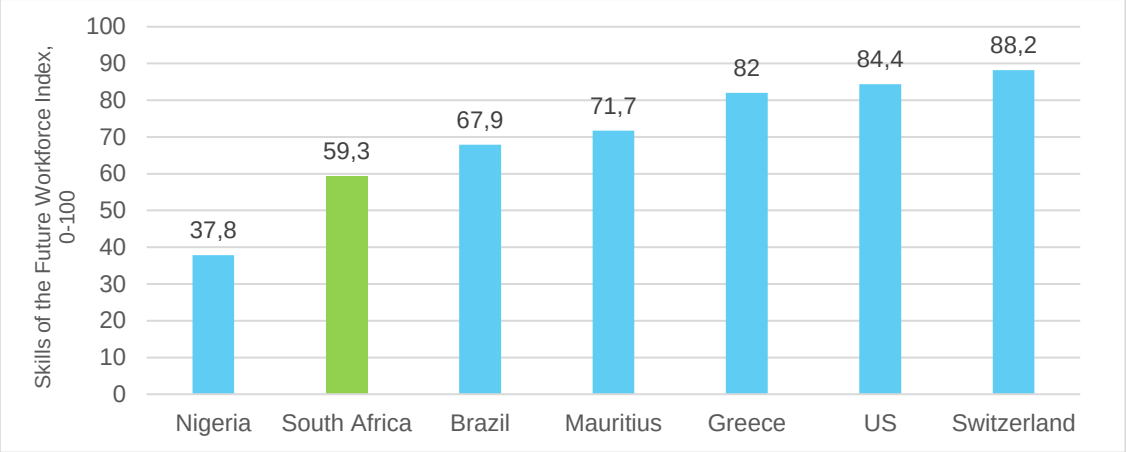


FIGURE 11-21: SKILLS OF THE FUTURE WORKFORCE INDEX, 2019
Compiled by researcher (2021)
Data sourced from WEF (2019)

The *Skills of the future workforce index* (SFW) illustrated in **Figure 11-21** consists of two major indicators, *Critical thinking in teaching* (CTT) and *People-to-teacher ratio in primary education* (P2P). Not surprisingly, Switzerland scored 88,2 and ranked 2nd in the world in the SFW. It scored 4th and 8th globally in CTT and P2P, respectively.

Second to Switzerland in the sample, was the US, scoring 84,4 with a rank of 12th, globally. Both its CTT and P2P ranked within the top 50, ranking 9th and 45th respectively. Greece did not make the top 50 and ranked 53rd scoring an SFW of 82. Although its CTT was ranked 122nd, it managed to rank its P2P 5th – outperforming Switzerland.

Among the developing countries chosen for this study, Mauritius had the highest SFW of 71,7 (ranking 66th). Its CTT and P2P ranked 73rd and 66th respectively. Brazil scored 67,9 and ranked 92nd.

South Africa ranked second to last in the sample with a score of 59,3 and a rank of 107th. Its CTT ranked 95th and its P2P 109th – both within the bottom 50. Nigeria ranked 128th globally, and both its CTT and P2P ranked within the bottom 50.

11.6. CONCLUSION

Chapter 11 employed a CA to determine the severity of South Africa's headwinds relative to other developed and developing countries. The results indicate that

South Africa had a higher degree of income inequality than any of the countries under comparison. However, inequality was less concentrated in the top one percent than the US and Brazil.

Even though South Africa had a relatively young population, the number of older persons exceeded that of Mauritius, Switzerland, and Greece. However, it had an overall poor relative performance in providing for its population older persons. Its population of older persons exhibited poor labour market and educational engagement. South Africa was worst in providing healthcare for older persons; and could not adequately provide social networks, physical safety, civic liberty, and access to transport to its over-50 population.

South Africa's current workforce was skilled relative to other developing countries, but relatively unskilled when compared to, except for Greece, developed countries. The country had a significantly higher unemployment rate than all countries in the sample, despite having the highest labour market index of the developing countries and Greece. It had a rigid labour market similar to Mauritius; and performed reasonably well relative to other developing countries in selecting, rewarding, and motivating workers. South Africa's had a slightly higher-skilled current workforce than the developing countries and Greece. However, it was much less skilled than the US and Switzerland. The educational performance of its current workforce was significantly lower than the developed countries, but relatively higher than the developing countries in the sample. The South African labour force was relatively unskilled compared to the developed countries and Mauritius. However, it was more skilled than that of Nigeria and Brazil.

South Africa's education metrics performed poorly compared to developed and developing countries. Except for Nigeria, it had a significantly lower FWI and SFW than all countries in the sample.

In conclusion, South Africa performed worst in the inequality and future workforce headwinds. It was ill-prepared for an ageing population and its current workforce was skilled compared to other developing countries, but unable to compete with developed countries. Chapter 12 provides a discussion of the results.

CHAPTER 12 : DISCUSSION OF THE RESULTS

12.1. INTRODUCTION

In the preceding chapters the five headwinds to South Africa's ability to exploit economic growth opportunities presented by the 4IR were identified and analysed; and its relative performance was compared with select developing and developed countries. These findings are summarised in the present chapter, followed by a discussion of the results.

12.2. SUMMARY OF FINDINGS

The major findings of the study are summarised below:

Finding 1: South Africa faces five major headwinds to its economic growth prospects during the 4IR:

1. Inequality
2. Demographics
3. Unemployment
4. Education
5. The COVID-19 economic shock

Finding 2: South Africa's inequality and education headwinds are the most severe relative to the select developed and developing countries in this study.

Finding 3: South Africa is ill-prepared for an ageing population.

Finding 4: South Africa's workforce is relatively skilled compared to the developing countries under study but unable to compete with the developed countries.

12.3. DISCUSSION OF THE RESULTS

The above findings must be interpreted with care and within context. The results and their implications are discussed below.

12.3.1.1. INEQUALITY

The present study identified South Africa's high and rising inequality as its first and most significant headwind. It supports Gordon (2014a), who similarly found rising inequality to be a headwind to US growth.

The study further found that inequality adversely impacts economic growth through the following channels:

- CMIA;
- fiscal;
- socio-political unrest;
- human capital investment; and
- fertility.

On the other hand, although the present study identified that inequality could have a positive impact on economic growth via the savings channel, the study could not confirm the validity of the savings channel in South Africa due to the contradictory savings-behaviour of its citizens.

The findings indicated that South Africa was significantly unequal compared to developed and developing countries. The implication of such a finding is that the predicted strength of inequality proposed by Gordon (2014a) would be much more severe in South Africa than the US. However, inequality was less concentrated in the top one percent than the US and Brazil, implying that wealth is biased towards superstars similar to the analysis of Brynjolfsson and McAfee (2011), except inequality within the top percentiles are less severe than in the US. However, it could also imply that superstars in the US dominate global markets. For instance, no superstar in Africa dominates the social media sector. Mark Zuckerberg enjoys global superstardom, and Africa's top talent cannot compete.

12.3.1.2. DEMOGRAPHICS

The second headwind identified by the present study is South Africa's demographics. Contrary to Gordon (2014a), who found that an ageing population is a headwind to US growth, South Africa's demographic transition is a headwind

due to its inability to yield its first demographic dividend so far; and its consequently poor future prospects to yield a second demographic dividend. These are low-hanging fruit that South Africa could have picked without much effort. Gordon argued that the US has already picked its low hanging fruit; However, South Africa's failure to create employment has made it impossible to pick even the lowest hanging fruit. The findings highlight the urgency of addressing South Africa's unemployment crisis in order to yield what is left of the first demographic dividend.

In addition, the analysis of South Africa's demographic structure brings to light various secondary findings: First, its racial inequalities are strikingly evident in its population pyramid. Second, South Africans were found to be poor savers. Third, similar to the warnings by Mbeki *et al.* (2018), OAGs are not sustainable. Fourth, South Africa faces rising pressures to provide long-term care and healthcare for older persons. Finally, an age-based digital divide presents a new challenge to the country. Ageing in South Africa summons the need to provide equal retirement services, such as healthcare and education; while actively addressing the savings crisis faced by the future population of older persons.

South Africa had an overall poor relative performance in providing for its population of older persons. Its population was still relatively young, but the number of older persons exceeded that of Mauritius, Switzerland, and Greece. Its older population exhibited poor labour market and educational engagement. It performed worst in providing healthcare for older persons; and could not adequately provide social networks, physical safety, civic liberty, and access to transport to its over-50 population. This implies that a forward-thinking strategy is needed when dealing with the current working-age population.

12.3.1.3. UNEMPLOYMENT

South Africa's third headwind is its high and growing unemployment rate. Gordon, (2014a) did not identify unemployment as a headwind in the US because it does not suffer from a similar crisis to South Africa. Rising unemployment is a characteristic threat of the 4IR; which is a concern for South Africa due to its already high unemployment rate. The study additionally identified Okun's law as

the underlying framework which predicts that rising unemployment will have a negative impact on economic growth.

The paper supports Brynjolfsson and McAfee's (2011) predictions by crediting South Africa's rising unemployment and labour market inequalities to SBTC, rising superstars, and capital deepening. Moreover, the literature indicated that previously disadvantaged population groups were found to be more at risk of automation of employment. Consequently, racial inequalities are under severe threat from the 4IR.

South Africa's current workforce was found to be skilled relative to the select developing countries; but relatively unskilled when compared to the select developed countries, except for Greece. This was despite having a significantly higher unemployment rate than all countries in the sample. The main reason for its relative performance to other developing countries was its relatively higher *mean schooling years.* However, *mean schooling years* do not address the quality of the schooling provided. The exponential growth in technologies explained by Moore's law is bound to accelerate the rise in unemployment if the exponential growth of technologies is not accompanied by similar growth in skills.

12.3.1.4. EDUCATION

The fourth headwind that South Africa will face going into the 4IR was identified as its inability to strengthen its future workforce through the educational system.

The present study identified eight key areas South Africa must focus on in to transform educational ecosystems: invest in ECD; reinvent curricula for STEAM careers; invest in educators; provide workplace exposure and career guidance; foster digital fluency; provide quality TVET; offer more LLL opportunities; and transform education with innovative approaches. The analysis of the state of South Africa's ECD centres pointed out that South Africa could greatly benefit from investing in ECD as highlighted by García *et al.*, (2016). South Africa's future workforce was not being prepared well for their participation in the workforce in future compared to the developed and developing countries under study. Except

for Nigeria, it had a significantly lower FWI and SFW than all countries in the sample.

The future workforce can be South Africa's greatest hope for economic growth during the 4IR. Not only will the educational system need restructuring for the 4IR, but it will need to address past failures despite significant investments in education. The past poor educational performance is evident in the rising inequalities and unemployment rate. A solid foundation starts at birth. Yet, the South African government and other stakeholders neglect investments in ECD centres. Until this is addressed, current under-investments in ECD will continue to pour over to the performance of primary, secondary, and tertiary learners; and ultimately the workforce and economy.

12.3.1.5. The COVID-19 Economic Shock

The final headwind to South Africa's economic growth during the 4IR was identified as the COVID-19 pandemic. The pandemic has caused economic shocks that will hamper the acceleration of GDP in at least the near future. The age group most severely impacted economically so far was the younger generation. The pandemic will most likely increase the digital divide, and therefore inequality.

The relative severity of the economic shock could not be determined due to the unavailability of data across the sample.

12.3.1.6. The Significance of the Headwinds

The current study found that real GDP per capita has been growing at an average of one percent since 1946. More importantly, it has only been growing 0,4 percent on average in the last four decades. The 4IR will accelerate the strength of the headwinds, which negatively impacts the SOLI; and therefore, real GDP per capita growth may decline even further. Therefore, South Africa may not be able to realise its economic potential during the 4IR.

Considering the above discussion, the current dissertation joins Cowen (2010) and Gordon (2014a) and adopts a techno-pessimist view and predicts that South

Africa will not grow during the 4IR. Its growth will be hampered by five headwinds. Its relative performance to the select developed and developing countries indicates that these headwinds are severe, especially in terms of inequality and education. However, in contrast to the arguments of Gordon and Cowen on the US economy, the current dissertation does not condemn South Africa to permanent secular stagnation; but rather argues that South Africa will continue on this path of secular stagnation going into the 4IR if it does not urgently address the headwinds.

Prior to conducting the current dissertation, the literature was mainly focused on the growth prospects of the US during the 4IR. Most of the literature were overly-positive and failed to recognise the hard realities highlighted by techno-pessimists. The current study filled this gap by providing a techno-pessimistic viewpoint of South Africa's growth prospects during the 4IR. The study added to the literature by identifying the major headwinds South Africa will face during the 4IR.

12.4. CONCLUSION

The chapter summarised the findings which identified five headwinds that South Africa may face during the 4IR. These headwinds were found relatively severe compared to the other developed and developing countries under study. South Africa was relatively stronger in terms of its current workforce compared to other developing countries. However, its education was weak, and its inequality was rising. The chapter concluded that, without addressing the existing headwinds, South Africa would not be able to exploit the economic growth opportunities presented by the 4IR.

The next and final chapter will conclude the study.

CHAPTER 13 : CONCLUSION

13.1. INTRODUCTION

In the previous chapter the results were summarised and discussed. The current, and final, chapter will summarise the study's objectives, methodology and findings. Thereafter, it will highlight the limitations of the study, provide recommendations and directions for future research.

13.2. SUMMARY

The first objective of the study was to determine which main headwinds to economic growth South Africa will face during the 4IR. Second, it intended to compare these headwinds relative to other developed and developing countries. Finally, it aimed to conclude whether South Africa will be able to exploit economic growth opportunities presented by the 4IR based on its current trajectory.

In order to identify and analyse the headwinds, an ITA was conducted. The results identified five major headwinds to South Africa's economic growth going into the 4IR. These headwinds were identified as: inequality, demographics, unemployment, education, and the COVID-19 pandemic. In order to determine the severity of the headwinds, a CA was conducted. The sample consisted of South Africa, Mauritius, Nigeria, Brazil, the US, Greece, and Switzerland. Relative to these countries, South Africa performed poorly in all the headwinds, especially inequality and its future workforce. Furthermore, based on the results of the ITA and CA, it was found that South Africa would not be able to exploit economic growth opportunities presented by the 4IR based on its current trajectory.

13.3. LIMITATIONS

The current study faced several limitations:

First, the unavailability of data related to the COVID-19 pandemic excluded it from the comparison study. Second, the 4IR is a future concept. Therefore, any analysis or investigation must rely on predictions that may not be accurate. Third,

population data was limited to four population groups which may lead to generalised conclusions.

13.4. RECOMMENDATIONS

Based on South Africa's current growth trajectory, it is set to continue its path of secular stagnation. Over the past decade, real GDP per capita growth has stagnated at less than one percent. Furthermore, the SOLI indicated that five headwinds are depressing South Africa's economic growth. Consequently, South Africa would gain by redefining its economic growth strategies going into the 4IR towards reducing the impact of the five headwinds.

13.4.1. REDUCE INEQUALITY AT THE CORE

South Africa's income inequality has not improved since the abolishment of Apartheid and has increased from 0,60 in 1990 to 0,63 in 2014. Its wealth Gini coefficient stands at 0,81. Even more concerning, the 4IR is characterised by rising inequality. Surprisingly, educational attainment among disadvantaged population groups has deteriorated since 1994. Critical to reducing inequality is to level the playing field from birth by providing quality ECD programmes. However, the South African government's budget is biased towards, and growing in favour of, higher education – despite low attainment ratios. Funding for ECD centres is either absent or severely limited due to impossible standards. This is despite the significant returns that ECD investments yield.

It is recommended that the South African government continues its funding towards education but direct more funding towards quality ECD centres for children aged 0-4 years in geographical areas where poverty remains problematic. Funding should focus on the quality of education by providing infrastructure, meals, and extensive caretaker training. Since this is the foundation of education, it should be made priority and consume most of the funding towards education.

13.4.2. UTILISE POPULATION GROUP DIFFERENCES

The country is, to date, failing to yield its demographic dividend due to its high unemployment rates. At the same time, unemployment is rising due to the increase of winner-takes-all inequalities in the labour market. Interestingly, significant differences exist between South Africa's various population groups' population pyramids. The black African and coloured population groups are much younger than the Indian/Asian and white population groups. The population of older persons in South Africa consists of 4,2 million people – much more than many advanced economies. Therefore, the size of South Africa's older population is large enough to create and benefit economically from a silver economy.

It is recommended that the government and the private sector collaborate in order to create a silver economy. This could not only improve the lives of older persons but create employment for the young. It is advised that the younger black African and coloured populations are re-skilled towards skills that can be offered within a silver economy. These include digital and entrepreneurial skills for start-ups, caretaking, and other employment opportunities. This will have the dual effect of taking care of the older persons while employing the young.

13.4.3. CREATE EMPLOYMENT AND RESKILL THE WORKFORCE

Unemployment recently reached 30,1 percent during the initial stages of the COVID-19 crisis. However, it had already grown to 29,1 percent in the preceding quarter. Additionally, the 4IR will magnify SBTC, superstar inequalities, and capital deepening.

It is recommended that South Africa doubles its reskilling of the workforce efforts. It is critical, and it must be handled with the utmost urgency. Skills should not merely be focussed on digital literacy or coding. It must incorporate emerging skills, such as analytical thinking and innovation, creativity and problem-solving. Additionally, inter-ministerial cooperation is necessary to improve the technological infrastructure to create a growth environment for tech start-ups. This will increase the number of South African superstars and create job opportunities. Lastly, the government should subsidise at least part of the cost of

purchasing capital by SMMEs and provide tax incentives to businesses that provide training related to the operation of machines. This way, South Africa would not only grow the size of its capital-owners but also gain skilled workers that can run with the machine. Moreover, the government is recommended to abolish minimum wages and relax its rigid labour regulations if it wants to encourage firms to employ humans rather than machines.

13.4.4. TRANSFORM THE EDUCATION ECOSYSTEM

In order to transform South Africa's education ecosystem, it is advised that South Africa adopt the eight key areas of transformation suggested by the WEF (2017a). This implies that the government, citizens, and firms work together to:

- ✓ provide quality ECD programmes and infrastructure for all children aged 0-4;
- ✓ create curricula for the future focussed on preparing the future workforce for STEAM occupations;
- ✓ expose learners to the workplace and provide career guidance;
- ✓ professionalise the teaching profession by offering prestigious accreditation and an accompanied increase in remuneration;
- ✓ increase the speed of providing digital infrastructure and access for learners in order to speed up digital fluency;
- ✓ redesign TVET colleges to provide quality, modern, and evolving education which includes plumbing, welding, 3D additive manufacturing, and robotics.
- ✓ redesign tertiary education to increase short-courses tailored for the working-age population;
- ✓ remove age-based requirements for admission and funding to higher education; and
- ✓ remove rigidities in the educational system that prevents educators to innovate their teaching strategies.

13.5. Directions for Future Research

The study has highlighted the severe differences in population groups in terms of the headwinds. However, the population group classifications are still generalised and could be broken down into the various language or cultural groups to better understand the unique population pyramids, educational performance, and inequalities. Such research could contribute to more complex economic strategies which acknowledges the opportunities and challenges of cultural diversity.

The COVID-19 pandemic and consequent economic shocks were investigated in the study. Nevertheless, there were little available data to investigate its impact. Future research could investigate the impact of the pandemic on the lockdown generation; the correlation between South Africa's lockdown regulations and economic growth; and the comparative severity of the economic shock relative to other developed and developing countries.

Most importantly, this dissertation identified a possible link between the differences in population pyramids and secular stagnation. It would be interesting to see whether researchers could identify such links and the implications thereof.

LIST OF REFERENCES

AARP. 2019. *The aging readiness and competitiveness report, 2018* [online]. AARP. Available at: <https://arc.aarpinternational.org/home/the-aging-readiness-competitiveness-report> [Accessed: 27 October 2020].

Abel, M. 2013. 'Unintended labour supply effects of cash transfer programmes: Evidence from South Africa's old age pension', *SALDRU Working Paper No.* 114: 1–40.

Accenture. 2018. *Creating South Africa's future workforce: Digital puts one in three jobs at risk*. Cape Town: Accenture.

Acemoglu, D., Autor, D., Dorn, D., Hanson, G. H. & Price, B (2014) 'Return of the Solow paradox? IT, productivity, and employment in US manufacturing', *NBER Working Paper*, No. 19837: 1–21.

Adefila, A. and Pillay, P. 2019. 'Collaborative learning in the Fourth Industrial Revolution: Implications for an African renaissance', *Journal of Gender, Information and development in Africa*, Special Issue (September): 151–160.

Ahmad, M. H. 2002 'The impact of the age structure of population on the household saving rate in Pakistan: A cointegration approach', *Savings and Development*, 26(3): 289–300.

Ahmed, A. 2011. 'Financial structure and economic growth link in African countries: A panel co-integration analysis', *Journal of Economic Studies*, 38(3): 331–357.

Ahmed, S. A., Cruz, M., Quillin, B. & Schellekens, P. 2016. 'Demographic change and development: Looking at challenges and opportunities through a new typology', *World Bank Policy Research Working Paper,* No. 7893: 1–40.

Akinwale, Y. O. and Grobler, W. C. 2019. 'Education, openness and economic growth in South Africa: Empirical evidence from VECM analysis', *The Journal of Developing Areas*, 53(1): 51–64.

Akoojee, S. 2016. 'Developmental TVET rhetoric in-action: The White Paper for post-school education and training in South Africa', *International Journal for Research in Vocational Education and Training*, 3(1): 1–15.

Annan, K. 2001. 'Development without borders: Globalization in the 21st century', *Harvard International Review*, 23(2): 84.

Antonio, A. and Tuffley, D. 2016. 'Bridging the age-based digital divide', *International Journal of Digital Literacy and Digital Competence*, 6(3): 1–15.

Ardington, C., Case, A. & Hosegood, V. 2009. 'Labor supply responses to large social transfers: Longitudinal evidence from South Africa', *American Economic Journal: Applied Economics*, 1(1): 22–48.

Aron, J. and Muellbauer, J. 2000. "Personal and corporate saving in South Africa," *The World Bank Economic Review*, 14(3): 509–544.

Ataguba, J. E. 2020. 'COVID-19 pandemic, a war to be won: Understanding its economic implications for Africa', *Applied Health Economics and Health Policy*, 18(3): 325–328.

Autor, D. H. 2014. 'Skills, education, and the rise of earnings inequality among the "other 99 percent"', *Science*, 344(6186): 843–851.

Baker, S. R., Meyer, S., Pagel, M. & Yenelis, C. 2020 'How does household spending respond to an epidemic? Consumption during the 2020 COVID-19 pandemic', *NBER Working Paper*, No. 26949.

Baldwin, R. and Weder di Mauro, B. 2020. *Economics in the time of COVID-19*. Edited by R. Baldwin and B. Weder di Mauro. London: Centre for Economic Policy Research (CEPR) Press.

Barro, R. J. 1991. 'Economic growth in a cross-section of countries', *Quarterly Journal of Economics*, 106(2): 407–443.

Barro, R. J. 2000. 'Inequality and growth in a panel of countries', *Journal of Economic Growth*, 5(June): 5–32.

Barro, R. J. 2008 'Inequality and growth revisited', *Asian Development Bank (ADB) Working Paper on Regional Economic Integration*, No. 11: 1–13.

Bassier, I. and Woolard, I. 2018. 'Exclusive growth: Rapidly increasing top incomes amidst low national growth in South Africa', *REDI3x3 Working Paper,* No. 47: 1–31.

Bell, K. and Gilliam, A. 2011. *Digital learning* [online]. Region 10 Website. Available at: <https://www.region10.org/programs/digital-learning/digital-fluency/ > [Accessed: 26 January 2020].

Berry, L., Biersteker, L., Dawes, A., Lake, L. & Smith, C. (eds) 2013. *South African child gauge, 2013*. Children's Institute: University of Cape Town.

Bertrand, M., Mullainathan, S. & Miller, D. 2003. 'Public policy and extended families: Evidence from pensions in South Africa', *The World Bank Economic Review*, 17(1): 27–50.

Bhorat, H., Cassim, A. & Tseng, D. 2016. 'Higher education, employment and economic growth: Exploring the interactions', *Development Southern Africa*, 33(3): 312–327.

BlockNews Africa. 2019. *South Africa blockchain ecosystem mapped for 2020* [online]. Available at: <https://blocknewsafrica.com/south-africa-blockchain/ > [Accessed: 3 August 2020].

Bloom, D., Canning, D, Chan, K. & Luca, D. L. 2014. 'Higher education and economic development in Africa', *International Journal of African Higher Education*, 1(1): 22–57.

Bloom, D. E., Chatterji, S., Kowal, P., Lloyd-sherlock, P., Mckee, M., Rechel, B., Rosenberg, L. & Smith, J. P. 2014. 'Macroeconomic implications of population ageing and selected policy responses', *The Lancet*, 385(14): 649–657.

Bloom, D. E., Canning, D. & Graham, B. 2003. 'Longevity and life-cycle savings', *Scandinavian Journal of Economics*, 105(3): 319–338.

Bloom, D. E., Canning, D. & Gunther, F. 2008. 'Population aging and economic growth', *PGDA Working Paper Series*, No. 31: 1–35.

Bonner, S. and Sarkar, D. 2018. 'The quality-quantity trade-off among Australian children', *Economic Modelling*, 70(C): 383–389.

Brodeur, A., Gray, D., Islam, A. & Bhuiyan, S. J. 2020. 'A literature review of the economics of COVID-19', *IZA - Institute of Labour Economics Discussion Paper Series*, No. 13411: 1–61.

Brückner, M. and Lederman, D. 2012. 'Trade causes growth in sub-Saharan Africa', *World Bank Policy Research Working Paper,* No. 6007: 1–36.

Brückner, M. and Lederman, D. 2015. 'Effects of income inequality on aggregate output', *World Bank Policy Research Working Paper*, No. 7317: 1–32.

Brynjolfsson, E. 1993. 'The Productivity Paradox of Information Technology', *Computing*, 36(12): 77.

Brynjolfsson, E. and McAfee, A. 2011. *Race against the machine: How the digital revolution is accelerating innovation, driving productivity, and irreversibly transforming employment and the economy*. Lexington: Digital Frontier Press.

Brynjolfsson, E. and McAfee, A. 2016. *The second machine age: Work, progress, and prosperity in a time of brilliant technologies*. New York: Norton.

Brynjolfsson, E., Rock, D. & Syverson, C. 2017. 'Artificial intelligence and the modern productivity paradox: A clash of expectations and statistics', *NBER Working Paper*, No. 24001: 1–44.

Carlsson-Szlezak, P., Reeves, M. & Swartz, P. 2020a. *Understanding the economic shock of Coronavirus* [online]. Harvard Business Review. Available at: <https://hbr.org/2020/03/understanding-the-economic-shock-of-coronavirus > [Accessed: 2 September 2020].

Carlsson-Szlezak, P., Reeves, M. & Swartz, P. 2020b. *What Coronavirus could mean for the global economy* [online]. Harvard Business Review. Available at: <https://hbr.org/2020/03/what-coronavirus-could-mean-for-the-global-economy > [Accessed: 2 September 2020].

Chatterjee, A., Czajka, L. & Gethin, A. 2020. 'Estimating the distribution of household wealth in South Africa', *WID.world Working Paper,* No. 2020/06: 1-52.

Chigona, A. 2018. 'Digital fluency: Necessary competence for teaching and learning in connected classrooms', *The African Journal of Information Systems*, 10(4): 366–379.

Clark, G. 2007. *A farewell to alms: A brief economic history of the world*. Princeton, NJ: Princeton University Press.

Cowen, T. 2010. *The great stagnation*. New York: Dutton.

Credit Suisse. 2019. *Global wealth report 2019*. Credit Suisse Research Institute.

Creswell, J. W. (2011) "Controversies in mixed methods research," in The Sage handbook of qualitative research.

DATAREPORTAL. 2019. *Digital 2019: South Africa* [online]. DATAREPORTAL. Available at: <https://datareportal.com/reports/digital-2019-global-digital-overview > [Accessed: 27 October 2020].

Deaton, A. 2005. 'Franco Modigliani and the life-cycle theory of consumption', *BNL Quarterly Review*, LVIII(233–234): 91–107.

DeCicca, P. and Krashinsky, H. 2016. 'The effect of education on overall fertility', *NBER Working Paper Series*, No. 23003: 1–44.

Demirguc-Kunt, A., Lokshin, M. & Torre, I. 2020. 'The sooner, the better: The early economic impact of non-pharmaceutical interventions during the COVID-19 pandemic', *World Bank Policy Research Working Paper*, No. 9257: 1–95.

Denzin, N. K. and Lincoln, Y. S. 2005. *The SAGE Handbook of Qualitative Research*. Thousand Oaks, CA: SAGE.

Department of Basic Education (DBE). 2019. *DBE and partners workshop coding and robotics curriculum for the GET band* [online]. Available at: <https://www.education.gov.za/CodingCurriculum010419.aspx> [Accessed: 25 January 2020].

Department of Tourism. 2020. *Tourism quarterly performance report: 1st edition: Jan-March 2020*. Pretoria.

De Vaus, D. 2012. 'Comparative and cross-national designs'. In: Alasuutari, P., Bickman, L., & Brannen, J. eds. The SAGE Handbook of Social Research Methods. London: SAGE Publications, Inc.249–264.

De Wet, C. 2016. 'The status of teaching as a profession in South Africa'. In: Education Provision for Everyone: Comparing Perspectives from Around the World. Bulgarian Comparative Education Society. 143–149.

Dwolatzky, B. and Harris, M. 2020. *The world is flat: COVID-19 becomes the driving force for 4IR* [online]. University of Witwatersrand.
Available at:
<https://www.wits.ac.za/covid19/covid19-news/latest/the-world-is-flat-covid-19-becomes-the-driving-force-for-4ir.html>
[Accessed: 23 August 2020].

Edwards, S. 2002. 'Information technology and economic growth in developing countries', *Challenge*, 45(3): 19–43.

Esser, F. and Vliegenthart, R. 2017. 'Comparative research methods'. In: Matthes, J., S, D. C., and Potter, R. F. (eds). *The International Encyclopaedia of Communication Research Methods*. John Wiley & Sons, Inc.

Esson, R. 2003. 'Savings and savers: An analysis of saving behaviour among Cape Town's poor', Social Science Working Paper No, 59, pp. 1–51.

Farid, S. 2015. 'The role of technology in the sustainable economic development - The case of Africa', *Journal of Economic Research*, 1(1): 1–11.

Fershtman, C. and Weiss, Y. 1996. 'Social status, education, and growth', *Journal of Political Economy*, 104(1): 108–132.

Fischer, S. 1993. 'The role of macroeconomic factors in growth', *Journal of Monetary Economics*, 32(3): 485–512

FRED. 2016. *The puzzle of real median household income* [online].
Available at:
<https://fredblog.stlouisfed.org/2016/12/the-puzzle-of-real-median-household-income/>
[Accessed: 21 October 2019].

FRED. 2019. *Nonfarm payrolls: Why farmers aren't included in jobs data* [online].
Available at:
<https://www.stlouisfed.org/open-vault/2019/july/nonfarm-payrolls-why-farmers-not-included>
[Accessed: 15 October 2020].

Frey, C. B. and Osborne, M. A. 2017. 'The future of employment: How susceptible are jobs to computerisation?', *Technological Forecasting and Social Change*,114: 254–280.

Galor, O. 2011. 'Inequality, human capital formation and the process of development', *NBER Working Paper,* No. 17058: 1–62.

Galor, O. and Zeira, J. 1993. 'Income distribution and macroeconomics', *The Review of Economic Studies*, 60(1): 35–52.

García, J. L., Heckman, J. J., Leaf, D. E. & Prados, M. J. 2016. 'The life-cycle benefits of an influential early childhood program', *NBER Working Paper,* No. 22993: 1–72.

Geldenhuys, J. and Marinkov, M. 2007. 'Robust estimates of Okun's coefficient for South Africa', *University of Free State Working Paper*, No. 55: 1–18.

Goodrick, W. and Pelser, A. 2014. 'The greying of a rainbow nation: Policy responses to the implications of population ageing in South Africa', *African Population Studies*, 28(1): 648–660.

Google Data Studio. 2020. *COVID-19 South Africa Google mobility index* [online]. Available at:
<https://www.covid19sa.org/mobility-index>
[Accessed: 20 August 2020].

Gordon, R. J. 2000. 'Does the "new economy" measure up to the great inventions of the past?', *Journal of Economic Perspectives*, 14(4): 49–74.

Gordon, R. J. 2010. 'Revisiting US productivity growth over the past century with a view of the future', *NBER Working Paper*, No. 15834: 1–46.

Gordon, R. J. 2013. 'Is US economic growth over? Faltering innovation confronts the six headwinds', *Voprosy Ekonomiki*, 2013(4): 49–67.

Gordon, R. J. 2014a. 'The demise of US economic growth: Restatement, rebuttal, and reflections', *NBER Working Paper,* No. 19895: 1–43.

Gordon, R. J. 2014b. 'The turtle's progress: Secular stagnation meets the headwinds'. In Baldwin, R. and Teulings, C. (eds). *Secular stagnation: Facts, causes and cures*. Centre for Economic Policy Research. 47–59.

Gouveia, M. and Masia, N. A. 1998. 'Does the median voter model explain the size of the government? Evidence from the states', *Public Choice*, 97(October): 239–248.

Gruber, J., Wise, D. A. & Milligan, K. 2009. 'Social security programs and retirement around the world: The relationship to youth employment, introduction and summary', *NBER Working Paper*, No. 14647: 1–74.

Guest, G., MacQueen, K. & Namey, E. 2012. *Applied thematic analysis*. Thousand Oaks, CA: SAGE Publications, Inc.

Hansen, A. H. 1939. 'Economic progress and declining population growth', *American Economic Review*, 29(1): 1–15.

Harford, T. 2006. *The Economics of trust* [online], Forbes.
Available at:
< https://www.forbes.com/2006/09/22/trust-economy-markets-tech_cx_th_06trust_0925harford.html?sh=7acf19e12e13>
[Accessed: 21 October 2020].

Heckman, J. 2017. *There's more to gain by taking a comprehensive approach to early childhood development* [online]. The Heckman Equation.
Available at:
<https://heckmanequation.org/assets/2017/01/F_Heckman_CBAOnePager_120516.pdf >
[Accessed: 27 October 2020].

HelpAge International. 2015. *Global age watch index, 2015* [online].
Available at:
<https://www.helpage.org/global-agewatch/population-ageing-data/compare-/countries/>
[Accessed: 21 June 2020].

Hino, Leibbrandt, Machema, Shifa & Soudien. 2018. 'Identity, inequality and social contestation in the Post-Apartheid South Africa', *SALDRU Working Paper,* No 233: 1-30.

Holmes, C. A. 2006. 'Mixed (up) methods, methodology and interpretive frameworks', Paper presented at the Mixed Methods Conference, Cambridge, UK.

Horioka, C. Y. 1997. 'A cointegration analysis of the impact of the age structure of the population on the household saving rate in Japan', *The Review of Economics and Statistics*, 79(3): 511–516.

Horioka, C. Y. and Wan, J. 2007. 'The determinants of household saving in China: A dynamic panel analysis of provincial data', *Federal Reserve Bank of San Francisco Working Paper,* No. 2007–28: 1–32.

Hundenborn, J., Leibbrandt, M. & Woolard, I. 2018. 'Drivers of inequality in South Africa', *WIDER Working Paper*, No. 2018/1: 1–21.

Husain, A. M. 1995. 'Long-run determinants of private saving behaviour in Pakistan', *The Pakistan Development Review*, 34(4): 1057–1066.

ILO. 2020. *COVID-19 and the world of work*. 4th ed. ILO Monitor.

IMF. 2020. *Six charts explain South Africa's inequality* [online]. IMF Country Focus.
Available at:
<https://www.imf.org/en/News/Articles/2020/01/29/na012820six-charts-on-south-africas-persistent-and-multi-faceted-inequality>
[Accessed: 3 June 2020].

James, R. 2019. *Eight interesting developments in IoT technology* [online]. TechRadar. Available at: <https://www.techradar.com/news/8-interesting-developments-in-iot-technology> [Accessed: 3 August 2020].

Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed methods research: A research paradigm whose time has come. Educational Researcher, 33, 14–26.

Jonck, P. 2014. 'The mitigating effect of work-integrated learning on graduate employment in South Africa', *Africa Education Review*, 11(3): 277–291.

Jordaan, N. 2019. 'More retrenchments are coming, CCMA projects [online]', *Times Live*. 15 October, 2020. Available at: <https://www.timeslive.co.za/news/south-africa/2019-10-15-more-retrenchments-are-coming-ccma-projects/?fbclid=IwAR1x0VAgSnscwGDpKMDivJviCRrqKLN2siZv5HY_3mPygST1U2BVUDQQ-vM%0D> [Accessed: 3 November 2020]

Jorgenson, D. 2001. 'Information Technology and the US Economy', *American Economic Review*, 90(1): 1–32.

Joubert, J.D. and Bradshaw, D. 2004. 'Health of older persons', *South African Health Review*, 2003/04: 147–162.

Joubert, J. and Bradshaw, D. 2006. 'Population ageing and health challenges in South Africa'. In: *Chronic diseases of lifestyle in South Africa since 1995 - 2005*. Technical report: 204–219.

Juskalian, R., Regalado, A., Orcutt, M., Piore, A., Rotman, D., Patel, N., Lichfield, G., Hao, K., Chen, A. & Temple, J. 2020. *10 breakthrough technologies* [online]. MIT Technology Review.Available at: <https://www.technologyreview.com/10-breakthrough-technologies/2020/> [Accessed: 15 August 2020].

Karr, B. J., Loh, K. & Andres, E. A. S. 2020. 'COVID-19, 4IR and the Future of Work', *APEC Policy Support Unit Policy Brief*, No. 34: 1–9.

Kavese, K. and Phiri, A. 2020. 'A provincial perspective of nonlinear Okun's law for emerging markets: The case of South Africa', *Studia Universitatis Economic Series* No. 30(3): 59–76.

Keynes, J. M. 1963. 'Economic possibilities for our grandchildren', In: Essays in Persuasion. New York: W. W. Norton & Co. 358–373.

Knoema. 2019. *Contribution of travel and tourism to GDP as a share of GDP (%)* [online], World Data Atlas.
Available at:
<https://knoema.com/atlas/topics/Tourism/Travel-and-Tourism-Total-Contribution-to-GDP/Contribution-of-travel-and-tourism-to-GDP-percent-of-GDP>
[Accessed: 27 August 2020].

Kpodar, K. and Andrianaivo, M. 2011. 'ICT, financial inclusion, and growth evidence from African countries', *IMF Working Paper,* No. 11/73: 1–45.

Lasi, H., Fettke, P., Kemper, H. G., Feld, T & Hoffmann, M. 2014. 'Industry 4.0', *Business and Information Systems Engineering*, 6(4): 239–242.

Lee, J.-Y. and Lim, J.-Y. 2017. 'The prospect of the Fourth Industrial Revolution and home healthcare in super-aged society', *Annals of Geriatric Medicine and Research*, 21(3): 95–100.

Lee, R. and Mason, A. 2006. 'What is the demographic dividend?', *Finance and Development*, 43(3): 1-9.

Lehman, T. 2015. 'Countering the modern Luddite impulse', *Independent Review*, 20(2): 265–283.

Lehohla, P. J. 2017. 'Whither a demographic dividend South Africa: The Overton window of political possibilities', STATS SA. Pretoria, (September): 1–46.

Leierson, W. M. 1916. 'The problem of unemployment today', Political Science Quarterly, 31(1): 1–24.

Leontief, W. 1983. 'National perspective: The definition of problems and opportunities'. In: The Long-term Impact of Technology on Employment and Unemployment. National Academy of Engineering: 3–7.

Liu, G. G., Yamada, T. & Yamada, T. 1996. 'Economic analysis of Chinese fertility behaviour', *Social Science and Medicine*, 42(7): 1027–1037.

Lloyd-Sherlock, P. 2019. 'Long-term care for older people in South Africa: The enduring legacies of Apartheid and HIV/AIDS', *Journal of Social Policy*, 48(1): 147–167.

Ludvigson, S. C., Ma, S. & Ng, S. 2020. 'COVID-19 and the macroeconomic effects of costly disasters', *NBER Working Paper,* No. 26987: 1689–1699.

Makgato, M. 2019. 'STEM for sustainable skills for the Fourth Industrial Revolution: Snapshot at some TVET colleges in South Africa'. In: Theorizing STEM Education in the 21st Century. IntechOpen.

Malangeni, L. and Phiri, A. 2018. 'Education and economic growth in post-Apartheid South Africa: An autoregressive distributive lag approach', *International Journal of Economics and Financial Issues*, 8(2): 101–107.

Mankiw, N., Romer, D. & Weil, D. N. 1992. 'A contribution to the empirics of economic growth', *Quarterly Journal of Economics*, 107(2): 407–437.

Maoz, Y. D. and Moav, O. 1999. 'Intergenerational mobility and the process of development', *Economic Journal*, 109(458): 677–697.

Mbarathi, N., Mthembu, M. & Diga, K. 2016. 'Early childhood development and South Africa: A literature review', *SARCHI Technical Paper,* No. 6: 1–35.

Mbeki, M., Rossouw, J., Joubert, F. & Breytenbach, A. 2018. 'South Africa's fiscal cliff barometer', *New Agenda: South African Journal of Social and Economic Policy,* 2018(70): 29–33.

McAfee, A. and Brynjolfsson, E. (2018) *Machine, Platform, Crowd*. New York: W. W. Norton & Company.

Mcdonough, C. C. 2016. 'The effect of ageism on the digital divide among older adults', *HSOA Journal of Gerontology and Geriatric Medicine*, 2(8): 1–7.

Meltzer, A. H. and Richard, S. F. 1981. 'A rational theory of the size of government', *Journal of Political Economy*, 89(5): 914–927.

Modigliani, F. and Brumberg, R. H. 1954. 'Utility analysis and the consumption function: An interpretation of cross-section data'. In: Kurih, K. K. eds. *Post Keynesian Economics.* New Brunswick: Rutgers University Press. 338–436.

Modigliani, F. and Cao, L. S. 2004. 'The Chinese saving puzzle and the life-cycle hypothesis', *Journal of Economic Literature*, XLII(March): 145–170.

Mohr, P. 2008. *Economic indicators*. 3rd ed. Pretoria: Unisa Press.

Mokyr, J., Vickers, C. & Ziebarth, N. L. 2015. 'The history of technological anxiety and the future of economic growth: Is this time different?', *Journal of Economic Perspectives*, 29(3): 31–50.

Moleko, N. and Ikhide, S. 2017. 'Pension funds evolution, reforms and trends in South Africa', *International Journal of Economics and Finance Studies*, 9(2): 134–151.

Morawczynski, O. and Porteous, D. 2019. *Africa's gig opportunity* [online]. Project Syndicate.
Available at:
<https://www.project-syndicate.org/commentary/africa-digital-platforms-portable-benefits-by-olga-morawczynski-and-david-porteous-2019-06>
[Accessed: 19 June 2019].

Morse, J. M. 2010. 'Simultaneous and sequential qualitative mixed method designs', *Qualitative Inquiry*, 16(6): 483–491.

Mosikari, T. J. and Sikwila, M. N. 2013. 'The Relationship between trade openness and GDP growth rate: The case of South Africa (1994Q1-2008Q4)', *Journal of Economic and Behavioral Studies*, 5(10): 669–677.

Myslik, W. O., Freeman, A. & Slawski, J. 1997. 'Implications of AIDS for the South African population age profile', *Southern African Journal of Gerontology*, 6(2): 3–8.

NEDLAC. 2019. *Futures of work in South Africa*. Johannesburg: NEDLAC.

National Energy Technology Laboratory (2021) Fischer-Tropsch Synthesis, US Department of Energy. Available at: <https://www.netl.doe.gov/research/coal/energysystems/gasification/gasifipedia/ftsynthesis> [Accessed: May 15, 2021].

Needham, S. 2019. 'TVET policy in South Africa: Caught between neo-liberalism and privatisation?', *Journal of Vocational, Adult and Continuing Education and Training*, 2(2): 82–101.

NICD. 2020. *COVID-19 sentinel hospital surveillance update, week 32*. Johannesburg: NICD.

Nick G. 2020. *9 new technology trends in 2020* [online]. Techjury. Available at: <https://techjury.net/blog/new-technology-trends/> [Accessed: 3 August 2020].

Nordås, H. K. 2001. 'Information technology and producer services – A source of economic development: The South African case', *TIPS Working Paper,* No. 7: 1–25.

Nordhaus, W. D. 2002. 'Productivity growth and the new economy', *Brookings Papers on Economic Activity*, 2002(2): 211–265.

Odusanya, I. A. and Akinlo, A. E. 2020. 'Growth effect of income inequality in sub-Saharan Africa: Exploring the transmission channels', *International Journal of Management and Economics*, 56(2): 176–190.

OECD. 2020a. *Labour force participation rate percentage, older than 65 years - G20 countries* [online]. OECD. Available at: <https://data.oecd.org/emp/labour-force-participation-rate.htm> [Accessed: 28 August 2020].

OECD. 2020b. *Leading indicators OECD: Reference series: Gross Domestic Product (GDP): Normalised for China* [online]. OECD. Available at: <https://fred.stlouisfed.org/series/CHNLORSGPNOSTSAM> [Accessed: 2 September 2020].

Oliner, S. D. and Sichel, D. E. 1994. 'Computers and output growth revisited: How big is the puzzle?', *Brookings Papers on Economic Activity*, 2: 273–334.

Oliner, S. D. and Sichel, D. E. 2000. 'The resurgence of growth in the late 1990s: Is information technology the story?', *Journal of Economic Perspectives*, 14(4): 3–22.

Oosthuizen, M. J. 2015. 'Bonus or mirage? South Africa's demographic dividend', *Journal of the Economics of Ageing*, 5: 14–22.

Owen, A. L. and Weill, D. N. 1998. 'Intergenerational earnings mobility, inequality and growth', *Journal of Monetary Economics*, 41(1): 71–104.

Pask, A. E. and Marx, J. 2018. 'Mitigating the South African retirement-income shortfall crisis', *Journal of Economic and Financial Sciences*, 11(1): 1–10.

Pew Research Center. 2019. *Mobile connectivity in emerging economies*. Washington, DC: Pew Research Center.

Phiri, A. 2014. 'Re-evaluating Okun's law in South Africa: A nonlinear co-integration approach', *Managing Global Transitions*, 12(2): 81–102.

Pierdzioch, C. 2009. 'Changes in the international co-movement of stock returns and asymmetric macroeconomic shocks', *International Financial Markets Institutions and Money*, 23(3): 211–226.

Pluto-men. 2020. *How augmented reality and virtual reality fit into Industry 4.0*. [online]. Available at: <https://pluto-men.com/insights/how-augmented-reality-and-virtual-reality-fit-into-industry-4-0/> [Accessed: 1 June 2020].

Population Reference Bureau (PRB). 2020. *Countries with the oldest populations in the world, Aging* [online]. Available at: <https://www.prb.org/countries-with-the-oldest-populations/> [Accessed: 22 June 2020].

PopulationPyramid.net. 2019. *Population Pyramids of the World from 1950 to 2100, South Africa*. Available at: <https://www.populationpyramid.net/south-africa/> [Accessed: 20 February 2021].

Posel, D., Fairburn, J. A. & Lund, F. 2006. 'Labour migration and households: A reconsideration of the effects of the social pension on labour supply in South Africa', *Economic Modelling*, 23(5): 836–853.

Pouris, A. 2013. 'Technology trends: A review of technologies and policies'. Pretoria: Institute for Technological Innovation, Business Enterprises at University of Pretoria (Pty) Ltd.

Priego, L. P., Switters, J. M. & Munoz, D. 2017. *Impact of EU-funded research and innovation on ICT for active and healthy Ageing - The top 25 most influential projects*. European Commission.

Psacharopoulos, G., Patrinos, H., Collis, V. & Vegas, E. 2020. *The COVID-19 cost of school closures* [online]. Education Plus Development.
Available at:
<https://www.brookings.edu/blog/education-plus-development/2020/04/29/the-covid-19-cost-of-school-closures/>
[Accessed: 6 June 2020].

Ram, R. 1982. 'Dependency rates and aggregate savings: A new international cross-section study', *The American Economic Review*, 72(3): 537–544.

Reinhard, K., Pogrzeba, A., Townsend, R. & Pop, C. A. 2016. 'A comparative study of cooperative education and work-integrated learning in Germany, South Africa, and Namibia', *Asia-Pacific Journal of Cooperative Education*, 17(3): 249–263.

Reinsfield, E. 2018. 'Integrating digital technologies into the New Zealand curriculum: Future-focused and technological ways of thinking', *Australasian Journal of Technology Education*, 5(December): 1–12.

Rifkin, J. 1995. *The end of work: The decline of the global labor force and the dawn of the post-market era*. New York: G.P. Putnam's Sons.

Rosado, J. A., Isabel, M. & Sánchez, A. 2017. 'From population age structure and savings rate to economic growth: Evidence from Ecuador', *International Journal of Economics and Financial Issues*, 7(3): 352–361.

Le Roux, D. B. 2018. 'Automation and employment: The case of South Africa', *African Journal of Science, Technology, Innovation and Development*, 10(4): 507–517

RSA. 2006. *Older Persons Act, Act 13 of 2006*. Pretoria: Government Printer.

SAIRR. 2015. 'South Africa's housing conundrum', *Liberty*, 4(6): 1–7.

SARB. 2019a. *Expenditure on GDP (current prices), 2008-2018* [online]. Quarterly Bulletin, KBP6045J.
Available at: <https://www.resbank.co.za/en/home/what-we-do/statistics >
[Accessed: 10 August 2020)].

SARB. 2019b. *GDP growth at market prices, percentage* [online]. Quarterly Bulletin, KBP6006.
Available at: <https://www.resbank.co.za/en/home/what-we-do/statistics >
[Accessed: 25 September 2020].

SARB. 2019c. *Prime overdraft rate* [online]. Quarterly Bulletin. KBP1403.
Available at: <https://www.resbank.co.za/en/home/what-we-do/statistics>
[Accessed: 16 February 2020].

SARB. 2019d. *Real GDP per capita* [online]. Quarterly Bulletin. KBP6270Y. Available at: <https://www.resbank.co.za/en/home/what-we-do/statistics> [Accessed: 17 October 2019].

SARB. 2019e. *Total remuneration per worker in the non-agricultural sector* [online]. Quarterly Bulletin. KBP7013. Available at: <https://www.resbank.co.za/en/home/what-we-do/statistics > Accessed: 16 February 2020].

SARB. 2020a. *Labour productivity in the manufacturing sector* [online]. Quarterly Bulletin. KBP7079. Available at: <https://www.resbank.co.za/en/home/what-we-do/statistics> [Accessed: 30 August 2020].

SARB. 2020b. *Labour productivity in the non-agricultural sector* [online]. Quarterly Bulletin. KBP7014. Available at: <https://www.resbank.co.za/en/home/what-we-do/statistics > [Accessed: 30 August 2020].

SARB. 2020c. *Unemployment rate, quarterly* [online]. Quarterly Bulletin. KBP7019L. Available at: <https://www.resbank.co.za/en/home/what-we-do/statistics > [Accessed: 30 August 2020].

SASI. 2008. Old age saving among low-income South Africans. Johannesburg: SASI.

SASSA. *2019. Annual Performance Report, 2018/19.* Pretoria: SASSA.

Schoeman, W., Moore, R., Seedat, Y & Chen, J. Y. 2017. *Artificial intelligence: Is South Africa ready?* Accenture Gordon Institute of Business Science (GIBS).

Schwab, K. 2016. *The Fourth Industrial Revolution: what it means and how to respond* [online]. Geneva: WEF. Available at: <https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/> [Accessed: 9 January 2019].

Schwab, K. 2017. *The Fourth Industrial Revolution*. 1st ed. Geneva: Penguin.

Schwab, K. and Davis, N. 2018. *Shaping the future of the fourth industrial revolution: A guide to building a better world*. Great Britain: Penguin.

Serajuddin, U. and Hamadeh, N. (2020) *New World Bank country classifications by income level: 2020-2021*, *World Bank*. Available at: <https://blogs.worldbank.org/opendata/new-world-bank-country-classifications-income-level-2020-2021> [Accessed: May 15, 2021].

SIFAR. 2016. *Putting older people on the agenda in South* Africa [online]. Samson Institute for Ageing Research.
Available at:
<http://www.sifar.org.za/news/201701/putting-older-people-agenda-south-africa>
[Accessed: 3 November 2020]

Sikwila, M. N., Ruvimbo, N. G. & Mosikari, T. J. 2014. 'Trade openness and GDP growth nexus in South Africa', *Global Journal of Management and Business Research*, 14(7): 1–7.

South African Government. 2019. *Health on first world middle ear transplant done at Steve Biko Academic Hospital* [online]. Media Statements, 14 March.
Available at:
<https://www.gov.za/speeches/ear-transplant-done-steve-biko-academic-hospital%C2%A0-14-mar-2019-0000>
[Accessed: 5 August 2020].

Spaull, N. 2013. *South Africa 's education crisis: The quality of education in South Africa, 1994-2011*. Johannesburg: Centre for Development & Enterprise.

Spio, K. and Groenewald, J. 1996. 'Rural household savings and the life cycle hypothesis: The case of South Africa', *South African Journal of Economics*, 64(4): 294.

STATS SA. 2011. *Labour market dynamics in South Africa*. Pretoria: STATS SA.

STATS SA. 2012a. *Census 2011: Emigration Dynamics in South Africa, Census 2011*. Pretoria: STATS SA.

STATS SA. 2012b. *Census 2011: Population dynamics in South Africa*. Pretoria: STATS SA.

STATS SA. 2016. *Early childhood development in South Africa, 2016*. Educational Series. Pretoria: STATS SA.

STATS SA. 2017a. *Education series volume III: Educational enrolment and achievement, 2016*. Pretoria: STATS SA.

STATS SA. 2017b. *Labour market dynamics in South Africa*. Pretoria: STATS SA.

STATS SA. 2018. *Mid-year Population Estimates, Statistical Release*. Pretoria: STATS SA.

STATS SA. 2019a. *Annual Financial Statistics (AFS) 2018*. Pretoria: STATS SA.

STATS SA. 2019b. *Consumer Price Index*. Pretoria: STATS SA.

STATS SA. 2019c. *General Household Survey 2018*. P0318. Pretoria: STATS SA.

STATS SA. 2019d. *Midyear population estimate, 2019*. P0302. Pretoria: STATS SA.

STATS SA. 2020a. *GDP falls by 2,0%* [online].
Available at:
<http://www.statssa.gov.za/?p=13401>
[Accessed: 30 August 2020].

STATS SA. 2020b. *Mid-year population estimates, 2020*, P0302. Pretoria: STATS SA.

STATS SA. 2020c. *Quarterly Labour Force Survey: Quarter 1: 2020*. Pretoria: STATS SA.

Stephen, G. 2012. 'Reassessing the impact of finance in growth', *Bank for International Settlements Working Paper*, No. 381.

Summers, L. 2013. *Crises Yesterday and Today* [online]. *Proceedings of the 14th Annual IMF Research Conference on 8 November*.
Available at:
<https://www.youtube.com/watch?v=KYpVzBbQIX0>
[Accessed: 15 October 2020].

Takavarasha, S., Cilliers, L. & Chinyamurindi, W. 2018. 'Navigating the unbeaten track from digital literacy to digital citizenship: A case of university students in South Africa' s Eastern Cape province', *Reading & Writing*, 9(1): 1–15.

TalkIoT. 2020. *SA's XinaBox is reinventing the way we approach IoT* [online]. AI News.
Available at:
<https://talkiot.co.za/2020/03/26/sas-xinabox-is-reinventing-the-way-we-approach-iot/>
[Accessed: 3 August 2020].

Thornton, J. 2001. 'Age structure and the personal savings rate in the United States, 1956-1995', *Southern Economic Journal*, 68(1): 166–170.

Ting, L. and Kollamparambil, U. 2015. 'Nature and determinants of household retirement savings behaviour in South Africa', *Development Southern Africa*, 32(6): 675–696.

Tondini, A., Ardington, C. & Woolard, I. 2017. 'Public pensions and elderly informal employment: Evidence from a change in retirement age in South Africa', *SALDRU Working Paper*, No. 206(1): 1–12.

US Bureau of Economic Analysis. 2019. *Corporate profits after tax with inventory valuation adjustment (IVA) and capital consumption adjustment (CCAdj) [CPATAX]* [online]. FRED.
Available at:
<https://fred.stlouisfed.org/series/CPATAX>
[Accessed: 15 July 2019].

US Bureau of Labor Statistics. 2020a. *Business - Labor Productivity (Output per Hour), percent change* [online].
Available at:
<https://data.bls.gov/cgi-bin/surveymost?bls>
Accessed: 30 August 2020].

US Bureau of Labor Statistics. 2020b. *Manufacturing - Labor Productivity (Output per Hour), percent change* [online].
Available at:
<https://data.bls.gov/cgi-bin/surveymost?bls>
[Accessed: 30 August 2020].

US Bureau of Labor Statistics. 2020c. *Nonfarm Business - Labor Productivity (Output per Hour), percent change* [online].
Available at:
<https://data.bls.gov/cgi-bin/surveymost?bls>
[Accessed: 30 August 2020].

US Census Bureau. 2020. *Growth Indices for Real Median Income and Real GDP per Capita, US, 1984-2017* [online]. FRED.
Available at:
<https://fred.stlouisfed.org/series/MEHOINUSA672N/#0>
[Accessed: 17 February 2020].

UN. 2017. *World Population Ageing 2017: Highlights*. New York: UN.

UNAIDS. 2004. *2004 report on the global AIDS epidemic*. Geneva: UNAIDS.

UNDESA. 2017. *World population prospects: The 2017 revision*. New York: UNDESA.

UNESCO. 2020a. *Education: From disruption to recovery, COVID-19*. Educational Response. Paris: UNESCO.

UNESCO. 2020b. *School life expectancy* [online]. Paris: UNESCO.
Available at:
<http://uis.unesco.org/en/glossary-term/school-life-expectancy>
[Accessed: 29 October 2020].

UNICEF. 2013. South Africa stands to benefit significantly from investing in its young [online]. New York: UNICEF.
Available at:
<https://www.unicef.org/southafrica/education_13635.html>
[Accessed: 3 November 2020]

UNICEF. 2019. *Education budget brief South Africa 2018/19*. New York: UNICEF.

UNU-WIDER. 2020. *World Income Inequality Database (WIID)* [online]. United Nations University. Helsinki: UNU-WIDER.
Available at:
<https://www.wider.unu.edu/database/wiid>
[Accessed: 20 June 2020].

Van Biljon, J., Van Dyk, T. & Gelderblom, H. 2010. 'Mobile phone adoption: Optimising value for older adults in a developing country', *in 4th IDIA Conference, 3-5 November, 2010*. IDIA.
Available at:
<http://uir.unisa.ac.za/handle/10500/5396>
[Accessed: 27 October 2020].

Van der Berg, S. and Louw, M. 2003. Changing patterns of South African income distribution: Towards time series estimates of distribution and poverty 1: *proceedings of the Economic Society of South Africa. Stellenbosch, 17-19 September.*

Vijg, J. 2011. *The American technological challenge: Stagnation and decline in the 21st century*. New York: Algora Publishing.

Wang, Q., Myers, M. & Sundaram, D. 2012. 'Digital natives and digital immigrants: Towards a model of digital fluency'. *European Conference on Information Systems (ECIS) 2012 Proceedings. 39*.

Weder di Mauro, B. 2020. 'Macroeconomics of the Flu'. In: Baldwin, R. and Weder di Mauro, B. eds*. Economics in the Time of COVID-19.* Geneva: CEPR Press. 31–35.

WEF. 2017a. *Realizing human potential in the fourth industrial revolution: An agenda for leaders to shape the future of education, gender and work*. Geneva: WEF.

WEF. 2017b. *The future of jobs and skills in Africa: Preparing the region for the fourth industrial revolution*. Geneva: WEF.

WEF. 2018a. *Global ageing is a challenge - and an opportunity* [online].
Available at:
<https://www.weforum.org/agenda/2018/11/global-ageing-challenge-opportunity-pension-retirement/>
[Accessed: 23 January 2019].

WEF. 2018b. *The future of jobs report, 2018*. Geneva: WEF.

WEF. 2019. The global competitiveness report, 2019. Geneva: WEF.

WEF. 2020. *Schools of the future: Defining new models of education for the fourth Industrial Revolution*. Geneva: WEF.

WID. 2019. *Top 1% national income share* [online].
Available at:
<https://wid.world/world/#sptinc_p99p100_z/US;ZA;BR;GR;MU;CH;NG;SG/last/eu/k/p/yearly/s/false/6.2475/40/curve/false/country>
[Accessed: 20 June 2020].

The World Bank. 2017. South Africa Economic Update [online]. Available at:
<http://www.worldbank.org/en/country/southafrica/publication/south-africa-economic-update-more-innovation-could-improve-productivity-create-jobs-and-reduce-poverty>
[Accessed: October 29, 2020].

World Bank. 2019a. *Age Dependency Ratio, Old,* [online].
Available at:
<https://data.worldbank.org/indicator/SP.POP.DPND.OL?end=2017&start=1960>
[Accessed: 21 June 2020].

World Bank. 2019b. *GDP per capita growth (annual %)* [online].
Available at: <https://data.worldbank.org/indicator/NY.GDP.PCAP.KD.ZG.>
[Accessed: 21 February 2021].

World Bank (2019c) 'Population ages 15-64 (% of population)', *World Development Indicators* [online].
Available at: <https://data.worldbank.org/indicator/SP.POP.1564.TO.ZS>

World Bank. 2020a. *Age dependency ratio, old (% of working-age population), South Africa* [online].
Available at:
<https://data.worldbank.org/indicator/SP.POP.DPND.OL?end=2019&locations=ZA&start=1960>
[Accessed: 29 August 2020].

World Bank. 2020b. *Age dependency ratio, young (% of working-age population), South Africa* [online].
Available at:
<https://data.worldbank.org/indicator/SP.POP.DPND.YG?locations=ZA>
[Accessed: 29 August 2020].

World Bank. 2020c. *Age dependency ratio, total (% of working-age population) - South Africa* [online].
Available at:
<https://data.worldbank.org/indicator/SP.POP.DPND?locations=ZA>
[Accessed: 28 August 2020].

World Bank. 2020d. *Gross domestic savings (% of GDP), South Africa* [online]. National Accounts Data.
Available at:
<https://data.worldbank.org/indicator/NY.GDS.TOTL.ZS?locations=ZA>
[Accessed: 29 August 2020].

World Bank. 2020e. *Unemployment Rate, US, 2008-2019* [online]. Available at: <https://data.worldbank.org/indicator/SL.UEM.TOTL.ZS?locations=US > [Accessed: 13 February 2020].

Xu, M., David, J. M. & Kim, S. H. 2018. 'The Fourth Industrial Revolution: Opportunities and challenges', *International Journal of Financial Research*, 9(2): 90–95.

Yoco. 2020. *Small business turnover index, by province* [online]. COVID-19 Small Business Recovery Monitor. Yoco. Available at: < https://www.yoco.co.za/blog/covid-19-recovery-monitor/> [Accessed: 21 August 2020].

Zwane, T., Greyling, L. & Maleka, M. 2016. 'The determinants of household savings in South Africa: A panel data approach', *International Business and Economics Journal*, 15(4): 209–218.

APPENDIX A

TABLE 4: QUARTILE AND DECILE PERCENTAGE INCOME SHARES, SELECTED COUNTRIES[30]

Country	Q1	Q2	Q3	Q4	Q5	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
Brazil	3	7,3	12	19	59	1	2	3	4	5	7	8,1	11	16	43
Mauritius	7	11	15	21	46	3	4	5	6	7	8	9,4	11	15	32
Nigeria	5	9,7	14	22	49	2	3	4	5	7	8	9,6	12	16	33
South Africa	2	4,8	8,2	16	68	1	2	2	3	4	5	6,5	10	18	51
Greece	7	13	17	23	40	3	5	6	7	8	9	11	12	15	25
Switzerland	8	14	17	22	39	3	5	6	7	8	9	10	12	14	24
United States	3	8,3	14	23	52	2	3	5	6	7	8	10	12	16	29

Compiled by researcher (2021)
Data from UNU-WIDER (2020)[31]

[30] Income shares represent the income of each group expressed as a percentage of total income of all groups combined.
[31] Latest available data per country is used.

TABLE 5: INCOME INEQUALITY RATIOS, SELECTED COUNTRIES

Country	GINI	Palma	Top 20%/ Bottom 20%	Bottom 40%	Bottom 5%	Top 5%	Top 1%
Brazil	54	4,06	17,76	10,6	0,46	26,6	28,3
Mauritius	38,47	1,74	6,59	18,18	-	-	13,8
Nigeria	42,97	2,17	9,12	15,08	-	-	15,3
South Africa	65,5	7,07	28,9	7,14	0,4	35,02	19,2
Greece	32,3	1,22	5,49	20,2	0,8	15,6	13,4
Switzerland	30,1	1,11	4,61	21,9	1,2	15,5	10,6
United States	48,6	1,76	16,77	11,4	0,51	23,1	20,5

Compiled by researcher (2021)
Data from WID (2019); UNU-WIDER (2020)[32]

[32] Latest available data per country is used.

APPENDIX B

TABLE 6: AGEING DATA, 2015

Country Name	Old age dependent ratio[33]	Overall Index	Capability sub-index	Health Status Sub-index	Enabling Environment Sub-Index	Income Security Sub-Index
Brazil	12,79	46,2	29,9	57,4	54,6	81,5
Mauritius	16,22	51,8	24,6	45,00	69,2	82,9
Nigeria	5,15	25,3	32,3	25,9	58,3	17,7
South Africa	8,11	35,0	25,9	37,7	55,00	79,5
Greece	33,69	34,5	16,9	70,7	49,6	76,8
Switzerland	28,02	90,1	75,0	81,3	83,7	77,3
United States	24,14	79,3	65,7	70,1	76,8	76,3

Compiled by researcher (2021)
Data from (HelpAge International, 2015; World Bank, 2020a)

[33] 2018 data

APPENDIX C

TABLE 7: LABOUR MARKET INDEX DATA, 2019[34]

	Brazil	Mauritius	Nigeria	South Africa	Greece	Switzerland	United States
Labour Market Index	**53,5**	**52,1**	**60,2**	**60,9**	**52,7**	**79,5**	**78**
Unemployment rate %	12,5	6,9	6	27	19,2	4,9	3,9
Flexibility 0-100	48,4	52,1	62,4	52,1	47	76,8	73,7
Redundancy costs	76	0	100	89	75,2	87,3	100
Hiring and firing practices	29,3	59,8	60,6	31,3	46	80,4	71,8
Cooperation in labour-employer relations	44,1	62,5	50,3	36,4	50,3	85,2	70,6
Flexibility of wage determination	54,8	62,4	77,2	41,1	55,8	79	77,9
Active labour market policies	27,4	45,4	18,5	24,9	32,4	79,2	65,7
Workers' rights	62	74	65	86	10	89	69
Ease of hiring foreign labour	43,9	55,9	58,8	40,6	57,3	57,4	59,4
Internal labour mobility	49,9	56,7	68,9	67,6	48,7	57,1	75
Meritocracy and Incentivisation 0-100	58,5	66	58	69,8	58,5	82,1	82,3
Reliance on professional management	58,6	55	58,7	59,3	49,2	81,2	78,9
Pay and productivity	40,4	50	45,2	46	41,4	74,6	71,1
Ratio of wage and salaried female workers to male workers	78,6	59,1	35,9	73,8	71,7	86,2	81,6
Labour tax rate	56,4	99,9	92,4	100	71,8	86,5	97,5

Compiled by researcher (2021)
Data from WEF (2019); UNU-WIDER (2020)

[34] For detailed methodologies, primary data sources and definitions, visit http://gcr.weforum.org/.

APPENDIX D

TABLE 8: SKILLS INDEX DATA, 2019[35]

	Brazil	Mauritius	Nigeria	South Africa	Greece	Switzerland	US
Skills Index	**56,4**	**60,6**	**40,1**	**58,1**	**70,5**	**86,7**	**82,5**
Current workforce	**44,9**	**49,6**	**42,4**	**56,8**	**59**	**85,3**	**80,5**
Mean years of schooling	50,5	45,3	46	67,6	68,4	92,4	89,4
Skills of current workforce	**39,4**	**53,9**	**38,8**	**46,1**	**49,6**	**78,2**	**71,7**
Extent of staff training	47,1	56,8	44,1	58	43,3	79	72,3
Quality of Vocational training	38,6	54,6	30,5	41	42,4	90,8	70,7
Skillset of graduates	36,7	51,7	29,8	44,5	55,8	81,4	71,2
Digital skills among active population	34,8	55,7	40,4	37,9	51,8	74,4	72,2
Ease of finding skilled employees	39,7	50,6	49,1	49	54,5	65,4	72,1
Future workforce	**67,9**	**71,7**	**37,8**	**59,3**	**82**	**88,2**	**84,4**
School life expectancy	84,9	83,2	48,2	75,9	99,5	90	90,4
Skills of future workforce	**50,9**	**60,2**	**27,4**	**42,7**	**64,5**	**86,3**	**78,4**
Critical thinking in teaching	27,6	40,1	23,7	36,2	29	72,9	67,9
Pupil-to-teacher ratio in primary education	74,2	80,2	31,1	49,2	100	99,7	88,9

Compiled by researcher (2021)
Sourced from WEF (2019)

[35] For detailed methodologies, primary data sources and definitions, visit http://gcr.weforum.org/.

ETHICAL CLEARANCE CERTIFICATE

UNISA university of south africa

UNISA ECONOMICS ETHICS REVIEW COMMITTEE

Date 16/09/2020

Dear Linda Stone

Decision: Ethics Approval from 2020 to 2023 (specify the time period relevant to the approval)

NHREC Registration # : (if applicable)

ERC Reference # : 2019_DE_07(SD)_L Stone

Name : Linda Stone

Student #: 46174079

Staff #: N/A

Researcher(s): Name Linda Stone
Linda_stroebel@yahoo.com
084 020 8894

Supervisor (s): Mrs Storme Kennedy-Palmer
kennes@unisa.ac.za
012 433 4666

Working title of research:

SOUTH AFRICA'S HEADWINDS GOING INTO THE FOURTH INDUSTRIAL REVOLUTION

Qualification: MCom Economics

Thank you for the application for research ethics clearance by the Unisa Economics Ethics Review Committee for the above-mentioned research. Ethics approval is granted for 3 years.

*The **low risk application** was **expedited** by a Sub-committee of URERC on 16/09/2020 in compliance with the Unisa Policy on Research Ethics and the Standard Operating Procedure on Research Ethics Risk Assessment. The decision was approved on 16/09/2020.*

The proposed research may now commence with the provisions that:

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1. The researcher will ensure that the research project adheres to the relevant guidelines set out in the Unisa Covid-19 position statement on research ethics attached.
2. The researcher(s) will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.
3. Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study should be communicated in writing to the Economics Committee.
4. The researcher(s) will conduct the study according to the methods and procedures set out in the approved application.
5. Any changes that can affect the study-related risks for the research participants, particularly in terms of assurances made with regards to the protection of participants' privacy and the confidentiality of the data, should be reported to the Committee in writing, accompanied by a progress report.
6. The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study. Adherence to the following South African legislation is important, if applicable: Protection of Personal Information Act, no 4 of 2013; Children's act no 38 of 2005 and the National Health Act, no 61 of 2003.
7. Only de-identified research data may be used for secondary research purposes in future on condition that the research objectives are similar to those of the original research. Secondary use of identifiable human research data require additional ethics clearance.
8. No field work activities may continue after the expiry date (xxx). Submission of a completed research ethics progress report will constitute an application for renewal of Ethics Research Committee approval.

Note:

*The reference number **2019_DE_07(SD)_L Stone** should be clearly indicated on all forms of communication with the intended research participants, as well as with the Committee.*

Yours sincerely,

Signature

Chair of Economics ERC

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