TECHNIUM
SOCIAL SCIENCES JOURNAL

Vol. 26, 2021

A new decade for social changes

www.techniumscience.com

ISSN 2668-7798
9 772668 779000

TECHNIUM SOCIAL SCIENCES JOURNAL

Technium Social Sciences Journal
Vol. 26, 488-501, December, 2021
ISSN: 2668-7798
www.techniumscience.com

Infrastructure development and economic complexity in South Africa. Running title: Can infrastructure development influence economic complexity?

Richard Chauke, Thobeka Ncanywa

School of Economics and Management, University of Limpopo, South Africa

richard.chauke@ul.ac.za

Abstract. South African economy comprises of a narrow range of exports and an over-dependence on the primary production. These challenges hindered the growth and development of the country as well as the continent. One of the ways to enhance growth and development is through the improvement of economic complexity which measures productive capabilities of sophisticated products that countries export. The study seeks to find the role of investing in infrastructure development has on economic complexity using South African data. The autoregressive distributive lag approach was employed using yearly data spanning from 1960 to 2018. Results indicate that investing in government economic infrastructure has a negative and robust impact on economic complexity. Investment on government social infrastructure and public corporations' infrastructure can positively influence economic complexity. It can be recommended that there should be policies to support industrial development that targeted incentivising economic infrastructure development. The development should prioritize specific geographical areas such as special economic zones to improve the lives of citizens, boost the economy, attract foreign direct investment and create jobs.

Keywords. Economic complexity; government economic infrastructure; government social-economic infrastructure; public corporations' infrastructure; special economic zones

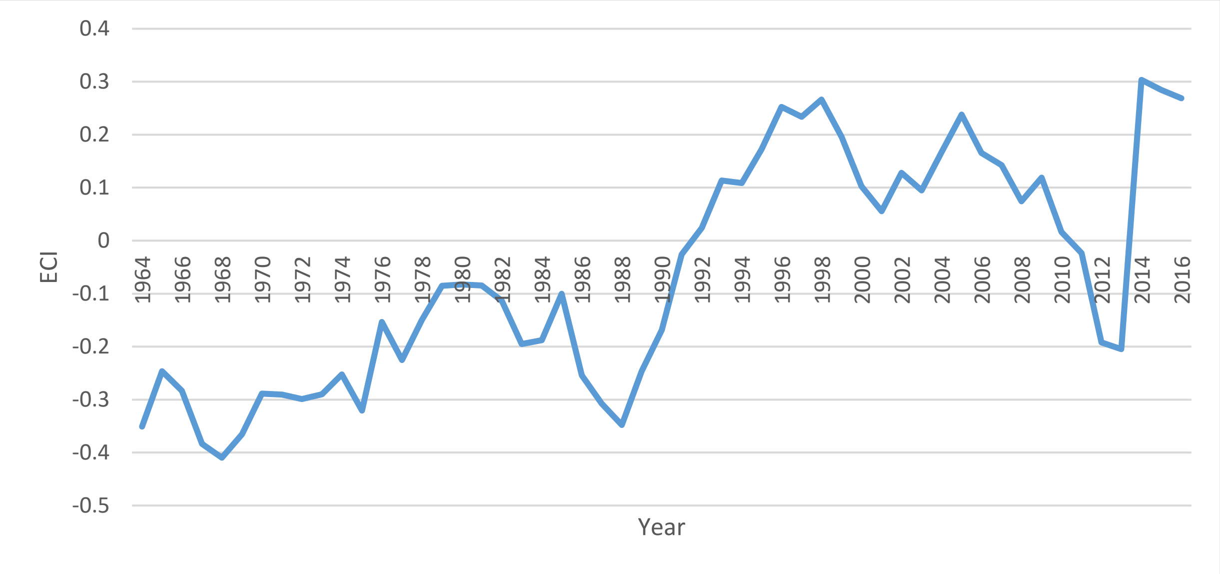
1. Introduction

In the increasingly volatile global political environment, the mobilising of the financial resources for use in the infrastructural projects is a complex and challenging exercise (Tyson, 2018). African challenges of the high unemployment which are exacerbated by slow economic growth among others have generated insights on global trade networks into new patterns of economic development (Mealy, Farmer & Teytelboym, 2018). The African governments have become innovative and also entrepreneurial, on the back of the political will, and accountability from their governments. This is backed by sound public-private-partnerships that are premised on the interest of their citizens (PricewaterhouseCoopers (PwC), 2014; National Development Plan (NDP), 2015). This brought attention to the emerging concepts of economic complexity that deals with goods and services that an economy produces and export (Hidalgo & Hausmann, 2009).

Economic complexity as an economic development tool measuring what refined productive capabilities a country can export and is reported as economic complexity index

(Hidalgo & Hausmann, 2009; Bhorat et al, 2019). According to Simoes and Hidalgo (2011), the economic complexity index is designed to measure diversity and ubiquity of products in the export basket. In Hausmann et al (2005), it is argued that the production capabilities refers to all the inputs, technologies and the ideas that when combined, can determine the frontiers of what an economy can be able to produce. It is further argued that the production capabilities can be enhanced by many things including infrastructure, the land usage, the laws, advanced machinery, and also including the people and collective knowledge (Hausmann et al, 2005). Figure 1 indicates that the South African economic complexity has been struggling over the years as it has been revolving around zero and reached the positive side beyond 1995. Economic complexity dropped drastically in 2014 (figure 1).

Figure 1: Economic complexity index of South Africa, 1965-2018



Source: Own compilation from SARB data **Note:** ECI represent economic complexity index

In the economic complexity index, South Africa's economic complexity was ranked on average around the '50s, improved and reached position 43 between 1993 and1998, moved back to the '50s from 1998 to 2012, remained at position 47 between 2013 and 2017 (Simoes, 2012). This was because, in 2017, South Africa exported $108B and imported $81.9B, resulting in a positive trade balance of $26.4B (World Bank, 2019). The country exported more on gold, diamonds, platinum, cars and coal briquettes; and imported crude petroleum, refined petroleum, cars, gold and broadcasting equipment. The major trading partners are China, the United States, India, the United Kingdom, Germany and Saudi Arabia (Hausmann, et al. 2014). In this study, it was imperative to investigate if investing in infrastructure development can boost economic complexity to create jobs and increase economic activities in communities.

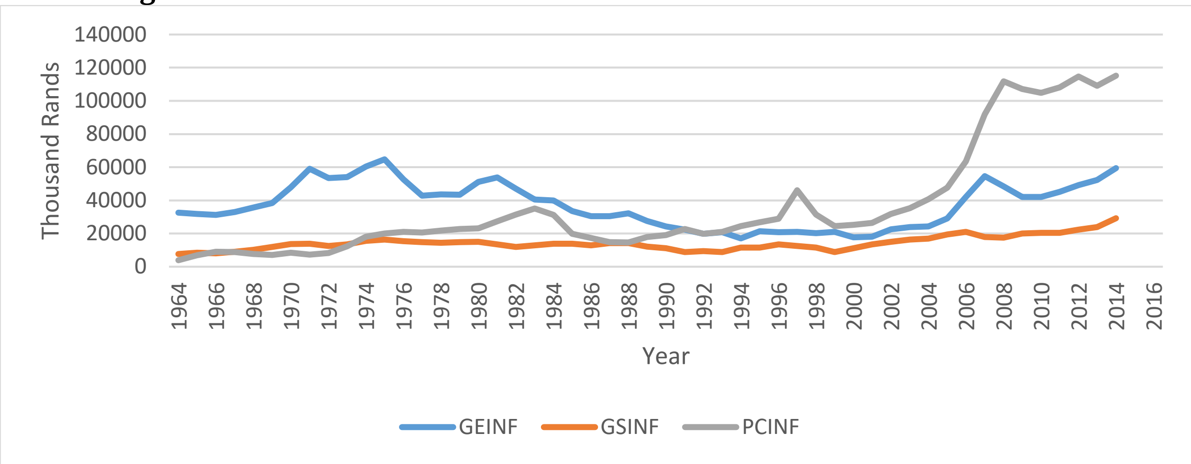
The African continent accounts for at least 12percent of the world's population, but it generates a mere 1percent of global GDP, and in the world trade is only 2percent. The dire situation, happen even though six of the world's ten most rapidly expanding economies being located in sub- Saharan Africa. In the South African context, figures that were released by Statistic South Africa in 2019 revealed that the South African economy had contracted by 3.2percent in the first quarter of 2019. In addition, same relative period in the first quarter of 2018, wherein the agriculture, the mining and the manufacturing industries showed the most significant decline. The 3.2percent decline was the largest drop in the economic activity since the first quarter of 2009 wherein there was a contraction of 6.1percent recorded. This was at the time when the economies of the world including South Africa were still feeling the effects of the global financial crisis. This is when comparing industry growth of the first quarter of 2019 and the fourth quarter of 2018 (Statistics (Stats) SA, 2019).

Infrastructure has become an investment and industrial hubs for the developing countries that are seeking economic growth and development (Chinguno, 2011). Investment in infrastructure development bears benefits for the country's economy and thus, generates meaningful and tangible social returns (National Treasury, 2019). Infrastructure investment can facilitate economic transformation and lead to new structural reform. According to Lakshmanan (1989), through investing in infrastructural development economies can engage in the technical process of production, distribution and communication networks of information flows. In the developing countries, infrastructure development aimed at attracting investment in the diversified industrial activities. They are therefore expected to provide customs, fiscal and regulatory benefits to all the businesses in more substantial and the integrated industrial areas. All the productive economies have secure infrastructure networks at their disposal (National Treasury, 2019). The infrastructure can connect the cities and the countries, and this is done through the transport system, which is the backbone of such endeavours. These include reliable healthcare systems, which is supported by technology and the supportive schools' system (National Treasury, 2019).

In South Africa, investment in infrastructure development is measured by the gross fixed capital formation in infrastructure. There are three forms of this investment, namely general government economic infrastructure, general government social infrastructure and public corporations' economic infrastructure (South African Reserve Bank, 2020). Economic infrastructure, both government and public corporations promote business activities, and examples include systems in communication, transportation and distribution networks, among others (Business Dictionary, 2018). Government social infrastructure support social services that ultimately influence economic activity. Examples of government social infrastructure are schools, parks, hospitals, sports grounds, among others.

Figure 2 indicates that investment in public corporations is higher than the others beyond the year 1992 followed by investment in economic infrastructure. Furthermore, figure 2 shows that investment in infrastructure development in South Africa generally improved in the democratic era beyond 1994, when the country was freed from sanctions and engaged in an open economy. The largest infrastructure development South Africa invested in for trade operations is called special economic zones (SEZ) (Farole, 2011; Farole & Sharp, 2017). The terminology that is used across countries varies wildly, with the most common terms used being the free zones, special economic zones, free trade zones, export processing zones, free economic zones, and open ports.

Figure 2: Trends of different infrastructure investment in South Africa



Source: Own compilation from SARB data
Notes: GEINF- government economic infrastructure ; GSINF- government social infrastructure ; PCINF- public corporations' economic infrastructure

The pace at which the infrastructure development is pursued and the magnitude thereof are the critical contributors to the country's economic development prospects. The infrastructure can be used as an umbrella for many activities; hence, it was imperative to find out if it can enhance economic complexity (PWC, 2014; National Treasury, 2019). This can be attributed to the fact that the development of the country's infrastructure is vital to the growth of the various sectors and by extension to the economy as a whole (National Treasury, 2019). What is critical in assisting the continent in achieving and realising its economic potential is to ensure that there is a careful construction of the sustainable infrastructure that can assist in turning the continent for the best (Jouanjean, Gachassin & te Velde, 2015).

2. **Materials and Methodology**

2.1 **Literature review**

The theoretical approach followed in this article combines the neo-Schumpeterian theory with a legal, regulatory framework perspective. The neo-Schumpeterian theory relate to competitive equilibrium specifically to knowledge and innovation (Hanusch & Pyka, 2005). In this theory, the focus is on innovation-driven industry dynamics, innovation determined growth and international competitiveness. According to Robert and Yoguel (2016), the theory involves competition in complex systems that include change, transformation and development. There are heterogeneity and divergence among productive systems, and this is relevant to relationships between economic complexity and infrastructure development. Complexity issues accommodate very different positions in the economy, and it has been seen as a unifying approach for neo-Schumpeterian streams.

The legal, regulatory framework refer mainly on industrialisation as the preferred route to sustainable economic development (Gebrewolde, 2019). The South Africa industrial development plan is informed by the realisation that industrial development offers the most viable path towards the economic prosperity and success of the country (Tang, 2008; Farole & Sharp, 2017; Gebrewolde, 2019). This position is clearly articulated and spelt out in the National Industrial Policy Framework (NIPF), the Industrial Policy Action Plan (IPAP) and the National Development Plan (NDP). These important policy and strategy documents outline several challenges that are confronting the country's economy, the goals and key drivers, the

Technium Social Sciences Journal
Vol. 26, 488-501, December, 2021
ISSN: 2668-7798
www.techniumscience.com

cross-cutting measures as well as sector-specific measures that are critical in driving country's industrial and the economic agenda. Concerning the implementation of the country's industrial development plan, they will require adaptation, effective and efficient instruments that will be responsive to the strategic needs of the host region, the investors and other vital stakeholders. To this end, the government has developed the infrastructure policy as one of the critical instruments that will be sued to accelerate the implementation of the envisaged industrialisation agenda (DTI, 2014; 2017; 2018).

Countries that portray a disconnected productive structure contribute to low levels of economic complexity (Bhorat et al, 2019; Cherednichenko et al, 2018). In building economic complexity, there a requirement that there should be diversification and an increase in complex products (Cherednichenko, et al, 2018; Bhorat, et al, 2019). The infrastructure development will trigger and stimulate economic complexity, as was found that it is associated with the process of transformation and could ultimately shift from low productivity to high productivity (Bhorat, et al, 2019).

There are limited studies on economic complexity and those that are found are focusing on its relationship with other economic indicators such as economic growth, unemployment, and inequality. For instance, Hartman et al (2017) found that economic complexity can reduce inequality, especially in the post-colonial states. Yalta and Yalta (n.d) when employing a panel analysis discovered that human capital plays a significant role in boosting economic complexity. In Bhorat et al (2019), the manufacturing sector can boost the economic complexity of a country. The novelty of this paper is to provide insights into South Africa's development placing evolution on infrastructure investment, and this relationship will add to literature as there are limited studies on the concept of economic complexity.

There are cross-country levels of the economic complexity, and as a result, thereof the product knowledge, are positively correlated with economic development (Cherednichenko, et al, 2018 Bhorat, et al, 2019). The potential to shifts to higher levels of economic development happens through the process of the structural transformation (Bhorat, et al, 2019). Therefore, the building of the economic complexity, or the accumulating productive knowledge, is mainly link or associated with the process of the structural transformation because it has the propensity to shift productivity from low-level to a higher level. This is similar to the shift from less complicated products toward more sophisticated products when considering the link between the economic complexity of an economy and its ability to produce a diverse range of manufacturing products when the product is diversified into the frontier products that will enable the country to build economic complexity (Bhorat, et al, 2019).

Investing in SEZ are instrumental on investment in industrial infrastructure, and a service provider to attract and facilitate foreign investment, integrate local firms into global chains, promote export growth and generate employment (Tang, 2008). SEZs have been widely used phenomenon used internationally to attract foreign direct investment (FDI), reduce large-scale unemployment that exists in countries, development and diversification of exports, and experiment the new policies (Lawler, 2003; Tang, 2008; Farole & Sharp, 2017). SEZ need to pursue business activities in a more socially and environmentally responsible manner that advances sustainable development goals (Tao, Yuan & Li, 2016).

Universal industrial parks, which can be found in almost all urban agglomerations, especially in developed economies, have a demarcated area and may even provide some publicly funded necessary infrastructure. Still, they do not offer a particular regulatory regime or incentives. In the United Kingdom, the enterprise zones that are promoted by the local governments provide discounts on the local property taxes but not on the corporate income taxes, which is mostly the norm in most SEZs (Dorfling, 1999). These SEZs mainly focus on supporting small and medium-sized enterprises (SMEs) and are not part of active clustering efforts or national industrial policies.

An economy of a country can be diverse and increase its economic complexity through macroeconomic stability, access to credit, good infrastructure, a conducive regulatory environment, a skilled workforce, and income equality. It was confirmed by Erkan and Yilirimci (2015) in Turkey that economic complexity comes from diverse production and competitive exportation, which can have visible effects on the country's growth and development. Ferraz, Moralles, Campoli, Oliveira and Rebelatto (2018) found a positive relationship between economic complexity and social variables in a study in Latin America and Asia. In the case of efficient Asian countries, it was noted that governments had developed public policies that encourage export of high technology products, mechanization of agriculture, reallocation of workers in technologically sectors, such as Industry, and productivity increase. It was also noted that structural changes were accompanied by an increase of individual's capabilities, increase of the human capital and improvement in the infrastructure (Ferraz et al, 2018).

There is a negative relationship between product ubiquity and diversity of the product and this lead to more complex products. It could be confirmed that the less product ubiquity a country has, the more sophisticated and diverse products that the country will produce (Gala, Rocha and Magacho, 2018). Therefore, a country needs to produce less ubiquitous products and more diverse products with high technological content and those that are highly scarce. The production of, for instance, aeroplanes, are classified as having a high technological content, while those that are naturally non-ambiguous include diamonds, a highly scare in nature commodity. For example, it has been found that sectors which heavily rely on raw materials such as energy, horticulture and metals are less in complexity. In contrast, those sectors which are based on a high level of technology and advanced skills and infrastructures, such as high tech, life sciences and chemicals, have a high average complexity (Zaccaria, Cristelli, Kupers, Tacchella & Pietronero, 2016).

Concerning the infrastructure regulations in the context of South Africa, they do not deviate from the social, labour and environmental rules which are in force throughout the rest of the country (DTI, 2018). International experience with infrastructure development commands that there is a need for them to be globally competitive to create significant benefits to the country (DTI, 2018). Successful infrastructure types are those that use public-private partnerships, which means that these institutions require political commitment from the government and must offer solutions that are tailored to deal with local businesses and particular industries (Dorfling, 1999; Gebrewolde, 2019).

Special economic zones geographically (SEZs) delimited areas within which governments facilitate industrial activity through fiscal and regulatory incentives and infrastructure support, and they are widely used across most of the developing and developed economies (Chinguno, 2011). Additionally, the relief from customs duties and tariffs, most zones offer fiscal incentives; business-friendly regulations concerning land access, permits and licenses, or employment rules; and administrative streamlining and facilitation. Infrastructure support is another essential feature, especially in developing countries where the necessary infrastructure for business outside these zones can be miserable (Cizkowicz, Cizcowicz-Pekela, Pekala, & Rzonca, 2015). As a result of the concessions concerning the customs, fiscal regulatory, business support measures, investment in infrastructure, the government expects that the participants in the SEZs, will create the necessary jobs, increase the exports and ensure that the economy is diversified and the requisite production capacity build. Nevertheless, developing countries that have made progress towards more attractive investment climates also continue to rely on the SEZs. When such development fails to deliver better levels of competitiveness rankings or expected foreign investment, SEZs may still be viewed as a necessary complement to the investment promotion package and as a signal of the country's progress in building a climate which is attractive for investment.

The global business and investment climate, the strategic focus, the regulatory and governance models, and the incentives package offered to remain the key ingredients of a successful SEZ policy framework (Gebrewolde, 2019). The policymakers face emerging challenges that are the result of the sustainable development imperative, the new industrial revolution and the changing patterns of international production. The global sustainable development agenda that is embodied in the United Nations Sustainable Development Goals is also affecting the strategic decisions and operations of businesses around the world (Tang, 2008). The efficiency and the cost savings that might be associated with the lower social and environmental standards are no longer considered a viable competitive advantage, especially in industries that have incurred or are at high risk of reputational damage—as such, offering laxer social and environmental rules or controls is no longer a competitive advantage to attract the investment in SEZs (Tang, 2008).

The economies that have most successfully achieved rapid industrial development through the use of SEZs underscore that the zones are not only an investment promotion tool but first and foremost an industrial policy tool. There is also an opportunity to follow a multi-activity approach with no active efforts to promote specialisation or clustering, reducing the zones to mere investment promotion tools – virtually incentives available in limited geographic areas. The Special Economic Zones Programme, as used in many countries, is increasingly becoming the primary attractor of foreign direct investment in South Africa (Chinguno, 2011; Farole & Sharp, 2017).

2.2 Methodology

The study employed an econometric analysis called autoregressive distributive lag (ARDL) to find the role of investing in infrastructure development on economic complexity. Yearly data in the period 1960- 2018 was obtained from the South African Reserve Bank for infrastructure variables and Atlas of economic complexity for economic complexity. The study formulated a model where investment in government economic infrastructure, government social infrastructure and public corporations infrastructure are regressed against economic complexity to achieve the set aim. Based on the non-Schumpeterian theory discussed in the previous section and some reviewed literature (Dorfling, 1999; Gala et al, 2018; Ferraz et al, 2018), the following log-linear model was estimated:

$$ECI_t = \alpha + \beta_1 LogGEINF_t + \beta_2 LogGSINF_t + \beta_3 LogPCINF_t + \varepsilon_t \quad (1)$$

The variables under investigation are; ECI represents economic complexity index; $LogGEINF$ logged government investment in economic infrastructure; $LogGSINF$ logged government investment in social infrastructure; $LogPCINF$ logged public corporations investment in economic infrastructure. Data has been transformed and standardized by introducing logarithms to the variables.

Time series data is characterised mainly by stationarity and therefore need to be checked as pre-requisite (Glyn, 2007). To test for stationarity issues the Augmented Dickey-Fuller (ADF) and Phillip-Perron (PP) were used, as found reliable and sufficient in econometric literature when compared to others (Brooks, 2008; Nkoro & Uko, 2019). The order of integration found in stationary tests would inform the methodology to be used for the analysis. In cases where variables are integrated at the level I (0), first-order I (1) or combination of the two, the autoregressive distributive lag (ARDL) could give robust results (Nkoro & Uko, 2019).

Technium Social Sciences Journal
Vol. 26, 488-501, December, 2021
ISSN: 2668-7798
www.techniumscience.com

The stationarity tests were also used to detect if there is no second-order integration as the adoption of ARDL would explode in its presence (Nkoro & Uko, 2016).

This study adopted the ARDL approach that was developed by Pesaran, Shin and Smith (1999) and later extended by Pesaran et al. (2001). To find the role played by investment in infrastructure development on economic complexity, a long-run relationship and short-run error correction term were determined in the time series data and can be modelled as follows:

$$Y_t = \sigma + \chi Y_{t-1} + \beta_0 X_t + \beta_1 X_{t-1} + \varepsilon_t \quad (2)$$

Where Y_{t-1} denotes the dependent variables lagged by one year; X_{t-1} denotes independent variables lagged by one year, and ε represent the error term. The long-run relationship was tested with the use of the ARDL bounds test, which is a cointegration relationship. Comparing the F statistics with lower and upper bounds, the test estimated the existence of cointegration in the model. Therefore, to determine the long run, the short-run dynamics and error correction model, equation 2 can be transformed into:

$$\Delta ECI = \alpha + \sum_{i=1}^{k} \beta_1 \Delta ECI_{t-1} + \sum_{i=1}^{k} \beta_2 \Delta LGEINF_{t-1} + \sum_{i=1}^{k} \beta_3 \Delta LGSINF_{t-1} + \sum_{i=1}^{k} \beta_4 \Delta LPCINF_{t-1} + \delta_1 ECI_{t-1} + \delta_2 LGEINF_{t-1} + \delta_3 LGSINF_{t-1} + \delta_4 LPCINF_{t-1} + \varphi EC_{t-1} + \varepsilon_t \quad (3)$$

Where variables are as explained in equation 1, EC represents the error correction term which represents the speed of adjustment of the system towards equilibrium. The test was chosen due to the estimated stationarity tests where variables showed different orders of integration; and also because of the small size sample (Nkoro & Uko, 2016). Furthermore, Pesaran et al (2001) authenticated the use of the ARDL model in cases where a few variables are employed. ARDL is also advantageous as it can simultaneously estimate the dynamic long-run, short-run and error correction term. Narayan (2004) confirmed that the ARDL approach avoids problems of serial correlation and of endogeneity that may be found in other cointegration techniques (Verma, 2007).

3. Results and discussions

To find the role of investing in infrastructure development on economic complexity, this section presents the findings as estimated using the e-views software. Table 1 indicates the unit root test results conducted using both the Augmented Dickey Fuller (ADF) and Phillips-Perron (PP)

Table 1: Unit Root Tests Results, 1960-2018

	ADF None	ADF Intercept	ADF Trend	PP None	PP Intercept	PP Trend	ORDER OF INTEGRATION
ECI	0.0908	0.5307	0.1696	0.0899	0.1696	0.5318	I(0); I(1)
DECI	-	0.0000	0.0000	-	0.0000	0.0000	
LGEINF	0.8911	0.6441	0.9495	0.8720	0.6487	0.9168	I(1)
DLGEINF	0.0000	0.0000	0.0003	0.0000	0.0003	0.0000	
LGSINF	0.9823	0.4505	0.5885	0.9793	0.3979	0.4786	I(1)
DLGSINF	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
LPCINF	0.9514	0.5795	0.1560	0.9965	0.3455	0.1881	I(1)
DLPCINF	0.0000	0.0002	0.0019	0.0000	0.0004	0.0032	

TECHNIUM SOCIAL SCIENCES JOURNAL

Technium Social Sciences Journal
Vol. 26, 488-501, December, 2021
ISSN: 2668-7798
www.techniumscience.com

Source: Own compilation from SARB data **Notes:** probabilities are reported; ADF Augmented Dickey Fuller; PP Phillips Perron; ECI economic complexity index; DECI differenced ECI; LGEINF logged government investment in economic infrastructure; DLGEINF differenced LGEINF; LGSINF logged government investment in social infrastructure; DLGSINF differenced LGSINF; LPCINF logged public corporations' investment in economic infrastructure; DLPCINF differenced LPCINF.

In table 1, probabilities of stationary tests are reported, where insignificant probabilities indicate non-stationary. Table 1 indicate different orders of integration, meaning that some variables are stationary after first differencing I (1) and others at levels I (0). Also, in table 1, there is no evidence of variables integrated at I (2). According to Nkoro and Uko (2016), the autoregressive distributive lag (ARDL) is the best approach to analyses this series in the presence of I (0) and I (1). This approach works well with small samples as robust results are obtained and are advantageous because it can estimate both the short and long-run parameters simultaneously (Nkoro & Uko, 2016). Therefore, the study employed the ARDL bounds test developed by Pesaran et al (2001) to find out if there is a long-run relationship in the series. Results are presented in table 2.

Table 2: ARDL Bounds test (cointegration test)

Test statistics	**Value**	**k**
F-statistic	5.94	4
Critical value bounds		
Significance	**I0 Bound**	**I1 Bound**
10%	2.2	3.09
5%	2.56	3.49
2.5%	2.88	3.87
1%	3.29	4.37

Source: Own compilation from SARB data

Table 2 presented the ARDL bounds test for cointegration. It can be shown that the F-statistics of 5.9 is greater than both the lower and upper bound at all significant levels (see table 2). For instance, at 1percent significance, the lower bound is 3.29, and the upper bound is 4.37; therefore, F-statistics of 5.9 is greater than both. This denotes that there is a cointegrating relationship and thus a long-run relationship in the investment of infrastructure and economic complexity series (Brooks, 2008). Table 3 presents estimates of the long-run relationship between explanatory variables against economic complexity as a depended variable.

Table 3: Long run estimates and error correction term

Model: Depended variable is economic complexity	**ECT(-1)**	**LGEINF**	**LGSINF**	**LPCINF**
1.ECI-LGEINF-LGSINF	-0.274***	-1.075***	1.50***	N/A
2.ECI-LGEINF-LPCINF	-0.400***	-0.641***	N/A	0.41***
3.ECI-LGSINF-LPCINF	-0.181**	N/A	0.004	0.42
4.ECI-LGEINF-LGSINF-LPCINF	-0.38***	-0.768**	0.592	0.27
5.ECI-LGEINF-LGSINF-LPCINF-no constant	-0.39***	-0.769**	0.518	0.29**

Source: Own compilation from SARB data **Notes:** *, **, *** indicate significance at 10%, 5percent & 1% respectively; ECT (-1) indicate error correction model; ECI economic complexity index; LGEINF logged government investment in economic infrastructure; LGSINF logged government investment in social infrastructure; LPCINF logged public corporations investment in economic infrastructure;

In table 3, different models were estimated to find the role that investing in infrastructure have on economic complexity. It can be seen that in all models that estimated government economic infrastructure against economic complexity, negative and significant results were obtained. This can be aligned with challenges on the building of the critical infrastructure by government, the institutional development and the capacity building of the municipalities and the provinces, planning and designation of new industrial zones, stakeholder mobilisation and management as well as continuous improvements of policies and strategies are critical to the success of infrastructure development (Chinguno, 2011; Farole & Sharp, 2017). Moreover, some industry players warn they are not a panacea to re-establish manufacturing to its rightful place in the economy (Farole & Sharp, 2017). Issues that remain stumbling blocks for the success of government economic infrastructure development include legislation, consistency and alignment with other policy decisions and state incentives (Chinguno, 2011). International experience shows that, at SA's stage of economic development, manufacturing should contribute close to 30percent of GDP. In the early 1980s, manufacturing contributed 24percent to GDP.

It can be noted in table 3 that five models have been regressed. In the models in table 3 that were used to estimate the role that government social infrastructure (GSINF) can play on economic complexity, a positive relationship existed. In model 1 of Table 3, the relationship was positive and significant. This is in line with the findings of Ferraz et al (2018), Yalta and Yalta (n.d); Erkan and Yilirimci (2015) who found a positive link between economic complexity and social variables. These results support the notion that governments need to develop public policies that encourage export of high technology products, mechanization of agriculture, and reallocation of workers in technological sectors. Therefore, economic complexity in society can increase an individual's capabilities, increase human capital and improvement in infrastructure development (Zaccaria et al, 2016).

Table 3 illustrated that investment in public corporation infrastructure could yield a positive and significant (model 2 and 5) role in economic complexity as it was explained in the background section that public corporations promote business activities. Examples include systems in communication, transportation and distribution networks, among others. This positive role would mean that there should be reinforcement in investing in public corporation infrastructure development (Zaccaria et al, 2016). There are five issues that can be reduced from the positive relationship. Firstly, this indicates that public corporations' infrastructure can be a tool to attract both foreign and domestic direct investments. Secondly, expanding the manufacturing sector can be a critical foundation that might grow both the primary and secondary economic activities in the economy. Thirdly, it can grow and diversify value-added exports activities. Fourthly, can create sustainable and decent jobs in those regions where they are hosted. Lastly, it can enhance innovation, attraction, development and retention of talent and knowledge.

Key dimensions that will drive infrastructure success should include amongst others the strategic focus; regulatory framework and governance; and the value proposition for the investors; the sustainable development imperative; the new industrial revolution and digital economy; changing patterns of international production (Cizkowicz et al, 2015; Zaccaria et al, 2016). There should be the building of the required industrial infrastructure; promoting coordinated planning among key government agencies and the private sector, and guiding the deployment of other necessary development tools.

Technium Social Sciences Journal
Vol. 26, 488-501, December, 2021
ISSN: 2668-7798
www.techniumscience.com

In all the estimated models, the coefficient of the indicate error correction model (ECT) was negative and significant and was around 20percent to 40percent (see table 3). The ECT indicates that, for instance, a 1percent increase in random shocks to equilibrium will lead to 20percent amendment in the equilibrium. Since there is a cointegration relationship in the series, this implies that any change in the current equilibrium level of the economy is a temporary phenomenon and will come to the long-run path in future. The long-run relationship is an indicator that there can be long-run change, transformation and development in the economy as alluded in Robert & Yoguel (2016). Based on the outcome of this result, it means that any deviation of the equilibrium will be corrected at the speed of 20percent from the short run to the long run. The models with the highest speed of adjustment are the one that includes public corporation infrastructure, highest at 40percent. This support public corporations as the most attractive investment activity for South Africa.

4. Conclusion

The study aimed to investigate the role of investing in infrastructure development on economic complexity in South Africa. To achieve the set aim, the autoregressive distributive lag (ARDL) approach was employed on a yearly data spanning from 1960 to 2018. Data used was obtained from the South African Reserve Bank and Atlas of economic complexity.

The stationary tests results indicated that there were different orders of integration which gave way to the use of ARDL. There existed a long-run relationship in the series of investing in infrastructure development and economic complexity. Government economic infrastructure had a negative and significant role in economic complexity. This adheres to poor government policies and regulations to this infrastructure. There was a positive and strong role played by both the government social and public corporation infrastructure on economic complexity. The speed of adjustment into equilibrium was established with the error correction model in all models and was found to be negative and significant.

These long-run positive estimates are an indicator of the need for the country to invest more in the development of this infrastructure, especially on public corporations. These investments have proved to attract both foreign and domestic direct investments; expand the manufacturing sector; grow and diversify value-added exports activities; create sustainable and decent jobs; and enhance innovation, attraction, development and retention of talent and knowledge.

References

[1] Bhorat, Haroon, Ravi Kanbur, Christopher Rooney, and Francois Steenkamp. 2017. “Sub-Saharan Africa's Manufacturing Sector: Building complexity.” Development Policy Research Unit, University of Cape Town, South Africa.
[2] Bhorat, Haroon, Arabo Ewinyu, Kezia Lilenstein, Christopher Rooney, Francois Steenkamp and Amy Thornton. 2019. “Economic Complexity and Employment Expansion: the case of South Africa.” Development Policy Research Unit, University of Cape Town, South Africa.
[3] Brooks, Chris. 2008. "Introductory Econometrics for Finance. Cambridge University Press, 2a upplagan." ISBN-13 (2008): 978-0.
[4] Business Dictionary.com, 2018. “What is the economic infrastructure? Definition and meaning.”
[5] Cherednichenko, L. Gennadievna, Mayya V. Dubovik, Sergei A Ermolaev and Aleksandr Z. Seleznev, 2018. “Economic Complexity and Inclusive Growth in a Climate of outside s Sanctions.” Espacios, *39*(18), 8.

[6] Chinguno, Crispen. 2011 "South Africa's Experience with Special Economic Zones." Report Commissioned.
[7] Cizkowicz, Piotr, Magda Cizcowicz-Pekala, Piotr Pekala and Andrzej Rzonca, A. 2015. "The Effects of Special Economic Zones on Employment and Investment: Spatial Panel Modelling Perspective." NBP Working Paper No.208. Economic Institute.
[8] Crane, Bret, Chad Albrecht, Kristopher M. Duffin and Conan Albrecht. 2018. "China's Special Economic Zones: An Analysis of Policy to Reduce Regional Disparities." Regional Studies, Regional Science, 5:1, 98-107.
[9] Department of Trade and Industry (DTI). 2014. SEZ Performance Analysis Bulletin. Report No 1. Pretoria. South Africa.
[10] Department of Trade and Industry (DTI). 2017. Industrial Policy Action Plan 2018 - 2019. Part 2. Pretoria. South Africa.
[11] Department of Trade and Industry (DTI). 2018. Industrial Policy Action Plan 2018/2019 – 2020/2021. Part 1. Pretoria. South Africa.
[12] Department of Trade and Industry.2018. Special Economic Zones. Industrial Park Symposium DBSA Midrand 13 November 2018. Pretoria. South Africa.
[13] Dorfling, Tamzyn. 1999. "Is Industrial Development an Effective Local Economic Development Strategy? The Case of Port Elizabeth-Uitenhage." Friedrich Ebert Stiftung.
[14] Erkan, Birol and Elif Yildirimci. 2015. "Economic Complexity and Export Competitiveness: The Case of Turkey." Procedia - Social and Behavioral Sciences Elsevier, 195, 524–533.
[15] Farole, Thomas. 2011. "Special Economic Zones in Africa: Comparing Performance and learning from Global experience." Washington DC, World Bank.

[16] Farole, Thomas and Mark Sharp. 2017 "Spatial industrial policy, special economic zones and cities in South Africa." Unpublished manuscript. Washington: World Bank (2017).
[17] Ferraz, Diogo, Herick F. Moralles, Jessica S. Campoli, Fabiola C. Oliveira and Daisy A. Rebelatto. 2018. "Economic Complexity and Human Development: DEA performance measurement in Asia and Latin America." Gestão & Produção. 25 (4), 839-853.
[18] Gala, Paulo, Igor Rocha and Guilherme Magacho, G. 2018**. "**The Structuralist Revenge: Economic Complexity as an Important Dimension to Evaluate Growth and Development**."** Brazilian Journal of Political Economy, 38 (2). 219-236.
[19] Gebrewolde, T.M. 2019. "Special Economic Zones: Evidence and Prerequisite for Success." Policy Brief. International Growth Centre.
[20] Glyn, Andrew. 2007. "Capitalism Unleashed: Finance, Globalization, and Welfare." Oxford University Press.
[21] Hartmann, Dominik, Miguel R. Guevara, Chrstian Jara-Figueroa, Manuel Aristarán and César A. Hidalgo, C.A., 2017. "Linking Economic Complexity, Institutions, and Income Inequality." World Development, 93, 75-93.
[22] Hanusch, Horst, and Andreas Pyka. 2005. "Principles of neo-Schumpeterian economics. No. 278." Volkswirtschaftliche Diskussionsreihe/Institut für Volkswirtschaftslehre der Universität Augsburg.
[23] Hausmann, Ricardo, César A. Hidalgo, Sebastián Bustos, Michele Coscia, and Alexander Simoes. 2014. "The Atlas of Economic Complexity: Mapping Paths to Prosperity." Mit Press.

Technium Social Sciences Journal
Vol. 26, 488-501, December, 2021
ISSN: 2668-7798
www.techniumscience.com

[24] Hidalgo, César A., and Ricardo Hausmann. 2009. "The building blocks of economic complexity." Proceedings of the national academy of sciences 106(2), 10570-10575.
[25] Jouanjean, Marie-Agnès, Marie Gachassin, and Dirk Willem te Velde. 2016 "Regional Infrastructure for Trade Facilitation–impact on Growth and Poverty Reduction." Overseas Development Institute and Ukaid Report. ODI, London.
[26] Lakshmanan, T. R. 1989. “Infrastructure and Economic Transformation.” Advances in Spatial Theory and Dynamics, Amsterdam, North-Holland, 241-261.
[27] Lawler, Brigitte. 2003. “The South African Government’s Initiative to Optimistimise the Economy through the Industrial Development Zones.” PhD Dissertation. Graduate School of Business. University of Natal, Durban. South Africa.
[28] National Treasury. 2019. “Economic Transformation, Inclusive Growth, and Competitiveness.” Economic Policy. National Treasury. South Africa.
[29] Narayan, P. Kumar. 2004. “The Economic Impact of Tourism on Fiji's Economy: Empirical Evidence from The Computable General Equilibrium Model.” Tourism Economics, 10(4), 419-433.
[30] Nkoro, Emeka and Aham K. Uko. 2016 "Autoregressive Distributed Lag (ARDL) Cointegration Technique: Application and Interpretation." Journal of Statistical and Econometric Methods 5(4), 63-91.
[31] Nkoro, Emeka, & Aham K. Uko. 2019. “Financial Structure and Economic Growth: The Nigerian Experience, 1980-2017.” American Economic & Social Review, 5(1), 33-48.
[32] Okorie, I.E., Akpanta, A.C., Ohakwe, J., Chikezie, D.C., Onyemachi, C.U. and Ugwu, M.C. 2019. “Modelling the Relationships across Nigeria Inflation, Exchange Rate, and Stock Market Returns and Further Analysis.” Annals of Data Science, Springer Berlin Heidelberg, 1–35.
[33] Pesaran, M. Hashem, Yongcheol Shin, and Ron P. Smith. 1999. "Pooled Mean Group Estimation of Dynamic Heterogeneous Panels." Journal of the American statistical Association 94 (446), 621-634.
[34] Pesaran, M. Hashem, Yongcheol Shin, and Richard J. Smith. 2001. "Bounds Testing Approaches to the Analysis of Level Relationships." Journal Of Applied Econometrics 16 (3), 289-326.
[35] Mealy, Penny, J. Doyne Farmer, and Alexander Teytelboym. 2018. "A New Interpretation of the Economic Complexity Index." Alexander, A New Interpretation of the Economic Complexity Index (February 4, 2018).
[36] Robert, Verónica, and Gabriel Yoguel. 2016. "Complexity paths in neo-Schumpeterian evolutionary economics, structural change and development policies." Structural Change and Economic Dynamics 38, 3-14.
[37] PricewaterhouseCoopers (PwC). 2014. “The African Government and Public Services”. Insight Journal. Botswana.
[38] Simoes, A. Gaspar. 2012. "The Observatory: Designing Data-Driven Decision Making Tools." PhD dissertation, School of Architecture and Planning Lab. Massachusetts Institute of Technology.
[39] Simoes, A. Gaspar, and César A. Hidalgo. 2011 "The Economic Complexity Observatory: An Analytical Tool For Understanding The Dynamics Of Economic Development." In Workshops at the twenty-fifth AAAI conference on artificial intelligence.
[40] South African Reserve Bank, 2020. http://www.sarb.co.za [accessed 02 April 2020].

[41] Statistics South Africa (StatsSA). 2019. Economy Stumbles in the First Quarter – published on 4 June 2019. Source: http://www.statssa.gov.za/ [accessed 21 July 2020].
[42] Tang, Vanessa. 2008. "Zoning in on South Africa's Industrial Development Zones." TIPS Annual Forum in October 2008. School of Economics and Finance. The University of Kwazulu-Natal. Durban.
[43] Tao, Y., Yuan, Y and Li, M. 2016. "Chinese Special Economic Zones: Lessons for Africa Economic Brief." African Development Bank Group. AEB, 7 (6), 1-16.
[44] Tyson, E. Judith. 2018. "Private Infrastructure Financing in Developing Countries: Five Challenges, Five Solutions." Working paper 536. Overseas Development Institute.
[45] Verma, Reetu. 2007. "Savings, Investment and Growth in India: An Application of the ARDL Bounds Testing Approach. South Asia Economic Journal, *8*(1), 87-98.
[46] Wang, Jin. 2010 "The Economic Impact of Special Economic Zones: Evidence from Chinese Municipalities." Journal of development economics 101, 133-147.
[47] World Bank, 2019. www.worldbank.co.za.
[48] Yalta, A. Yasemin, and A. Talha Yalta. N.d "Determinants of Economic Complexity in MENA Countries."
[49] Zaccaria, Andrea, Matthieu Cristelli, Roland Kupers, Andrea Tacchella, and Luciano Pietronero. 2016. "A Case Study for a New Metrics for Economic Complexity: The Netherlands." Journal of Economic Interaction and Coordination 11 (1), 151-169.