The impact of transport infrastructure investment on the output growth of rural nodal district municipalities in South Africa.

By

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Abstract

Transport infrastructure is an integral part of economic and social development in many countries, including South Africa, and it is pivotal in transportation systems. According to economic growth theories and empirical literature, a good transportation system not only ensures lower transportation costs but enhances accessibility and output in general. Despite this, rural South Africa continues to have widespread poverty, poor infrastructure, and restricted access to essential services. This research interrogates why this phenomenon occurs by using secondary data from the National Treasury on Local Government, Statistics SA (South Africa), and the Department of Cooperative Governance and Traditional Affairs. To date there is little literature that examines the effect of transport infrastructure investment on output growth in South Africa. Most of this literature has not assessed the underdevelopment of transport infrastructure in rural areas. In addition, no empirical studies have examined the impact of investment in transport infrastructure on output growth in rural nodal district municipalities within South Africa.

This dissertation investigates how transportation infrastructure investment affects the output growth of rural nodal district municipalities in South Africa. This is accomplished by 1) investigating the relationship between transport infrastructure investment and output growth in rural nodal district municipalities, and 2) understanding the causal relationship between transportation infrastructure investment and output growth in rural nodal district municipalities. This analysis makes use of panel data from 2012 to 2019. Furthermore, Fisher-type (ADF and PP) panel unit root tests (Maddala and Wu, 1999) were used to determine whether the variables used were stationary. Moreover, the Pedroni tests (1999) were used to determine the presence of cointegration among the variables. Once the existence of cointegration was confirmed, this study employed the panel VECM. A Panel Granger-Causality test was employed to check and examine the direction of causality between transportation infrastructure investment and output growth. The study recommends that the government should improve investments in transport to improve the output of rural nodal districts.

Keywords: Transport infrastructure investment, output growth, rural nodal district municipalities.

Abbreviations

ADF- Augmented Dicky- Fuller

COGTA- Cooperative Governance and Traditional Affairs

DoT- Department of Transport

GDP- Gross Domestic Product

HDM- Harrod-Domar Model

ISRDS- Integrated Sustainable Rural Development Strategy

PP- Phillips-Perron

Stats SA - Statistics South Africa

VAR-Vector Autoregressive Model

VECM- Vector Error Correction Model

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CHAPTER ONE

Introduction

It has been over two decades since South Africa ushered in a new era defined by a common vision of a non-discriminatory and equal society (DPME, 2019). These years are not very long regarding the transformation agenda of the country; however, they are an excellent guide to account for policy research on rural transport (Chakwizira and Mashiri, 2015). The government has worked to provide all citizens with basic services, social support, education, and health care. Moreover, they have sought to build an inclusive economy in pursuit of a new equal society. Thus, it is appropriate to take stock of the progress of the previous years in overcoming the apartheid legacy (DPME, 2019).

The government has invested massive resources in designing progressive policies aimed at building inclusive and shared socio-economic growth (Chakwizira and Mashiri,2015). Regarding rural transport, the objective has been to achieve several outcomes such as: (i) improving rural transport infrastructure, (ii) improving levels of rural transport passenger services and reliability, (iii) improving the security and safety of rural transport and lastly, (iv) ensuring that interventions and innovations of rural transport are implemented without damaging the environment (Chakwizira and Mashiri, 2015).

Rural areas in South Africa are sparsely populated and the manufacturing base is weak. This is because of poor infrastructure and as a result the agriculture sector is dominant and provides the base for many livelihoods (Kaiser and Barstow,2022). There are numerous reasons for the current state of rural areas; for example, past policies of the apartheid government. Further, rural areas lack a foundation that enables their economy to grow and create job opportunities (Mahanjan,2014). Therefore, it can be argued that the current rural poverty would not be as challenging if the economy had followed a different path of development(JICA,2022).

This chapter introduces the dissertation. Section 1.1 provides the background on the impact of transport infrastructure investment on output growth in rural nodal district municipalities within South Africa. Section 1.2 discusses the research problem. Section 1.3 outlines the overall objective and aim. Section 1.4 provides a brief overview of the research methodology employed in this study. Section 1.5 examines the significance of the study. Section 1.6 concludes the chapter by providing a structure of the dissertation.

1.1 Background and Context

Infrastructure consists of factors that provide key public or private physical services for a society; i.e. transport, water and sanitation, electricity, and military(Mehmood et al.,2020). Doyle and Havlick (2009) argued that infrastructure is a stimulus for economic development and growth and this implies that infrastructure is a crucial tool for a country to advance and grow. Infrastructure plays an essential role in output growth; hence it has emerged as a base for developed economies. Population growth has seen many countries expand their economies; therefore, the quantity and infrastructure scale have increased significantly (Doyle and Havlick, 2009). Infrastructure is pivotal for the movement of people and goods which is why in South Africa, it has mostly been developmental and economic (Shoba,2018).

Government spending plays a fundamental role in enhancing economic growth and the alleviation of poverty (Dissou and Didic, 2013). Empirical studies(Hooper et al .,2017; Olufemi et al., 2013; and Garcia- Escribano et al.,2015) demonstrate that infrastructure under-investment hinders output growth. Simultaneously, other studies(Cervero, 2013 and Jouanjean et al.,2015; noted that infrastructure investment can be an effective tool in blocking poverty. In this regard, infrastructure financing has been essential in output growth and reducing poverty in developing countries (Dissou and Didic,2013). Further numerous developing countries have started implementing policies that emphasise infrastructure scaling.

Transport infrastructure plays a crucial role in a nation's transport system and transport is a significant driver of economic and social development (Okechukwu et al., 2020). Economically, transport is a measure and reflection of economic production. Over the years, the economic impact of transportation infrastructure has been given attention. Around the globe, governments rank infrastructure among their greatest concerns (DBSA, 2012). Moreover, the modernisation of infrastructure is crucial to future economic competitiveness and pivotal in serving the growing urban populations (DBSA, 2012).

Infrastructure is one of the main barriers to progress, and South Africa is no different.The public sector invested more than R2.7 trillion in infrastructure between 1998/9 and 2016/17. In addition, infrastructure spending climbed by 5.2% from R48 billion in 1998/1999 to R249.9 billion in 2016/2017. (National Treasury, 2018). R288 billion intransportation and logistics costs represent 34.5% of all public sector spending during this time. These investments were made to strengthen the transportation system, increase people's and goods' mobility, lower transportation costs, and promote regional trade (National Treasury, 2018).

The Group Areas Act, No. 36 of 1966, was one of many legislations enforced by the government in apartheid South Africa. This law spatially excluded rural areas from economic and infrastructural development, and it disadvantaged the rural population in terms of economic opportunities, quality education, and basic services. After democracy was established in 1994, South Africa needed to undergo economic, social, and physical restructuring (Stats SA, 2014).

In an effort to address the challenges of infrastructure development, economic opportunities, quality education, and basic services, the government designed "The Integrated Sustainable Rural Development Strategy" (ISRDS) in 2000. This strategy was to realise a vision that would "attain socially cohesive and stable rural communities with viable institutions, sustainable economies and universal access to social amenities, able to attract and retain skilled and knowledgeable people, who are equipped to contribute to growth and development" (South Africa: The Presidency, 2000:5). To achieve this vision, the ISRDS suggests that the government takes a lead in consolidating, formulating, implementing, monitoring and evaluating well-coordinated programmes that enable participation of all government spheres and civil society (South Africa: The Presidency, 2000).

Globally, in developing countries the widespread poverty and poor basic service delivery in rural areas continue to constrain developmental efforts (Banjo et al., 2012). Governments, civil society organisations, and developmental agencies face major challenges because of the prevalence of rural poverty (Hossaian and Oosterom, 2021). Over the last thirty years, many rural development projects have failed and according to the government, the key issues are poor local capacity and decision-making centralisation (Merrel, 2022).

The common characteristics of global rural areas are:(i) populations are dispersed; (ii) agricultural dominance and (iii) resource mobilisation constraints. The spatial dispensation of the rural population increases transportation costs and limits the efficiency of goods and services provision. The economic climate in rural areas results in fewer opportunities compared to non-rural areas (South Africa: The Presidency, 2000).

In 2001, as part of the ISRDS, the government designated 13 specific rural areas for accelerated development (Stats SA, 2011). These rural areas have extreme poverty, inadequate facilities, and a lack of services. From the original 13 to the current 18 rural nodes, the number has grown over time. The original node's shape, size, and administrative alignment have significantly changed due to the geopolitical demarcation of administrative boundaries over time (Stats SA,2011). At least one local municipality has been lost or gained by some original nodes. Since each node is a district municipality, those who were located on cross-borders in 2001 are currently under the control of a single provincial government. (Stats SA, 2011).

In 2001 Rural nodes had limited to no access to electricity, clean water, and adequate sanitation in 2001. The government has shown a particular interest in the poverty levels in these nodes. (Stats SA,2011). The government has implemented several programmes targeting rural nodes and funding since 2001. This indicates that the state is interested in what has occurred in nodal areas over the years and whether the standard of living has changed for the nodal population (Stats SA, 2011).

Rural nodes are primarily occupied by Black Africans and have little to no infrastructure, inadequate communication tools, restricted access to services, inferior living conditions, high unemployment rates, and a lack of facilities (Stats SA,2011). In 2001, nodal areas were only found between eight provinces excluding Gauteng asshown in the table below:

Table 1.1: Rural Nodes per Province in 2001

Province	District Municipality
Eastern Cape	Chris Hani, Ukhahlamba, OR Tambo, Alfred Nzo
Free State	Thabo Mofutsanyane
KwaZulu-Natal	Ugu, uMzinyathi, Zululand, uMkhanyakude
Limpopo/ Mpumalanga	Sekhukhune, Bohlabela
Northern Cape/ North West	Kgalagadi Cross Boundary
Western Cape	Central Karoo

Source: *ISRDP and URP Guidelines for Political Championship guide, Western Cape Government (2003).*

As shown in **Table 1.1**, only thirteen rural nodes were designated for accelerated development in 2011. Eastern Cape and KwaZulu-Natal had the highest number of nodes with four respectively, followed by Limpopo/Mpumalanga with two each. Free State, Northern Cape/North West, and Western Cape with one, respectively. In 2011, more areas were designated; therefore, the number of nodes grew from thirteen to eighteen. Furthermore, the number of provinces hosting rural nodes decreased from eight to seven thus, excluding North West along with Gauteng province.

Table 1.2: Nodal Areas per Province in 2011.

Province	Nodal area	Old Names
Western Cape	Central Karoo	
Northern Cape	John Taolo Gaetsewe	Kgalagadi
Eastern Cape	OR Tambo, Alfred Nzo, Joe Gqabi, Chris Hani, Amathole	Ukhahlamba
Free State	Thabo Mofutsanyane	
KwaZulu-Natal	uMkhanyakude, Zululand uThukela, uMzinyathi uMgungundlovu, Sisonke, Ugu	
Mpumalanga	Ehlanzeni	
Limpopo	Mopani,Greater Sekhukhune	

Source: *The nodal report, Statistics South Africa (2011).*

Table 1.2 shows nodal areas after they were increased from 13 to 18 in 2011. KwaZulu-Natal has the highest number of rural nodes, (an increase from four in 2001 to seven in 2011) , this implies that three more nodal areas were designated for development in the province. While KwaZulu-Natal and the Eastern Cape had nodal equivalents of four each in 2001, the Eastern Cape currently ranks second with five, indicating that one more area was identified. The Limpopo/Mpumalanga region was separated into two independent provinces. Mpumalanga had one node in 2011, while Limpopo had two. The Northern Cape/North West region excluded the North West, leaving Northern Cape with the Kgalagadi Cross Boundary (now known as the John Taolo Gaetsewe District Municipality). From 2011, Gauteng and the North West province had no rural node. The Western Cape still has one rural node, Central Karoo.

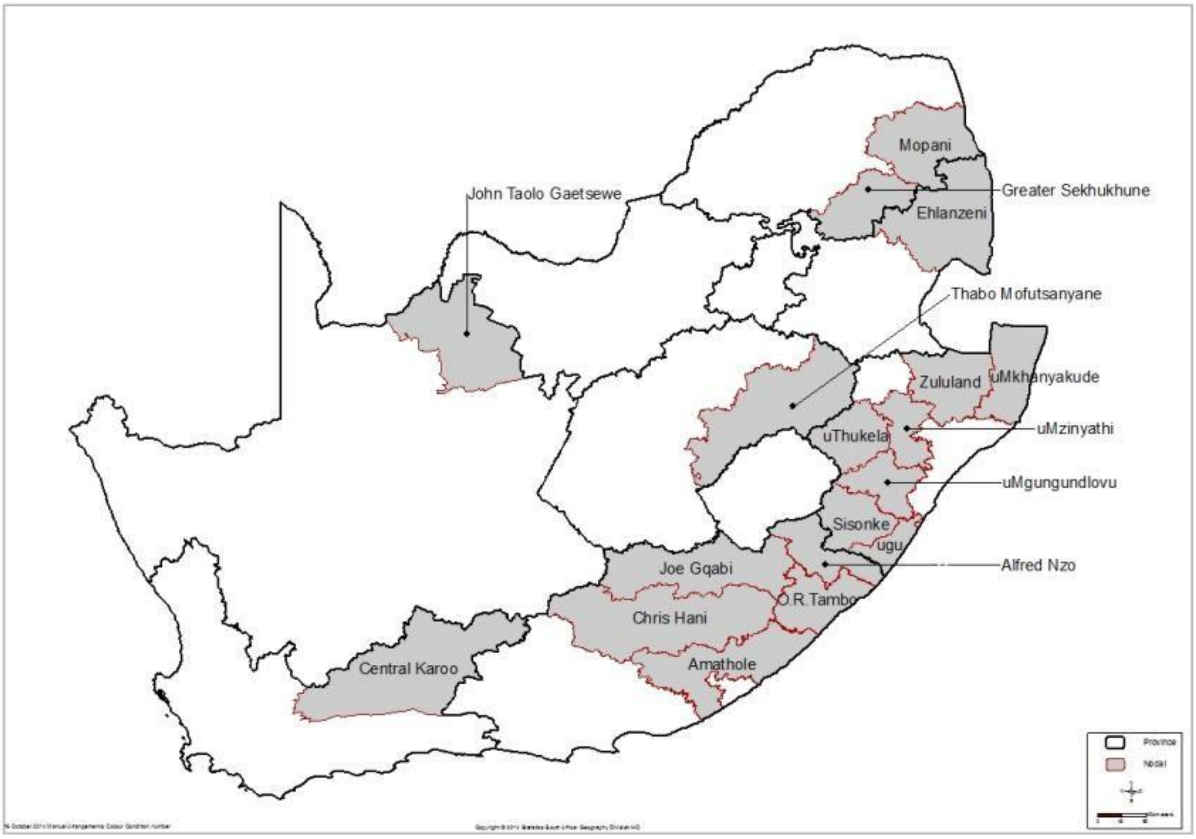


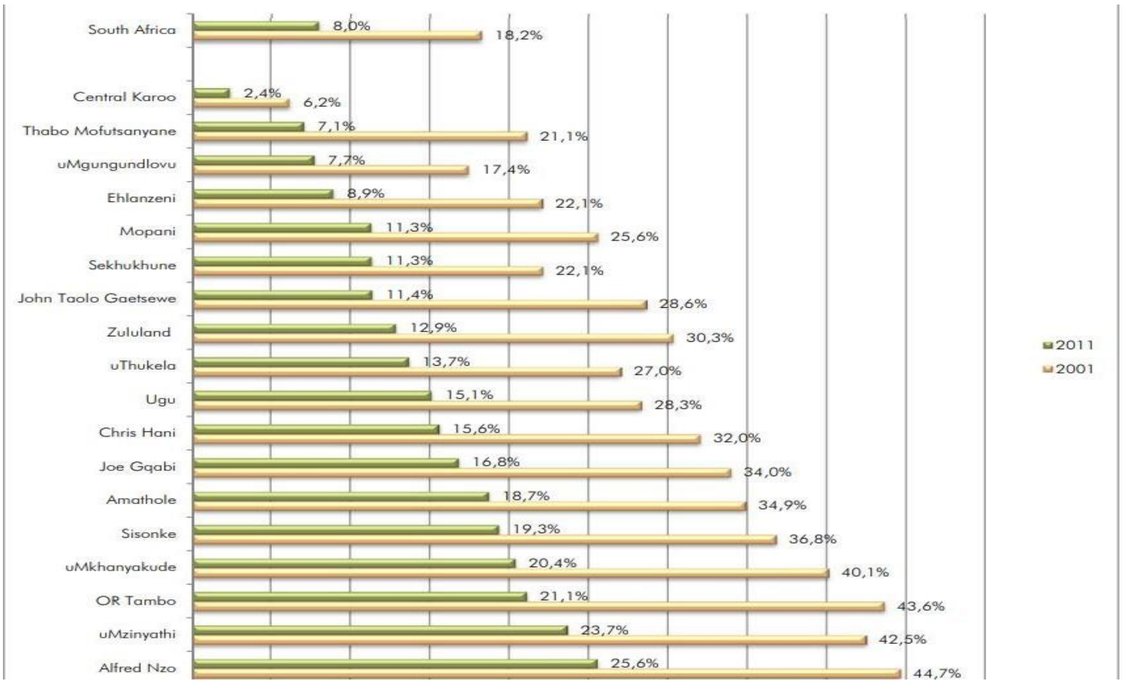
Figure 1.1: The geographical location of each rural node in the country.(*Source: The nodal report, Statistics South Africa (2011)).*

The map above demonstrates, the names and locations of each along with the nodal and province boundaries according to 2011 geography. Furthermore, the names, tags, and colour coding serve to increase contrast for identification. (Stats SA, 2011).

In 2001, the total nodal population was 13.2 million, representing 29.6% of the South African population of 44.8 million. Further, in 2011, the nodal population grew to 13.7 million; therefore, representing 26.9% of the total population of 51.7 million. This implies that while the South African population over the past ten years grew by 15.5 %; and only 4.88% of the nodal area's population increased. Elements like migration and variations in population structures can help explain why the nodal areas population growth is unevenly lower than that of the South African population (Stats SA, 2011).

According to the Community Survey (CS), (2016), Gauteng and the Western Cape provinces received the greatest proportion of migrants. The Eastern Cape and Limpopo provinces received the greatest number of out-migrants. There is a long history of underlying changes in population structures however, this is beyond the scope of this study. Nonetheless, understanding demographics is critical because it is a decisive factor in shaping current socioeconomic realities. Demographics are essential for government, civil society organisations, and development agencies(Stats SA, 2016).

Figure 1.2: Multidimensional headcount in rural nodes between 2001 and



2011.(*Source: The nodal report, Statistics South Africa (2011)).*

The number of people living in poverty has decreased significantly across all nodal districts. In 2011, the Central Karoo, Thabo Mofutsanyane, and uMgungundlovu district municipalities were estimated to have poverty rates lower than South Africa's 8%; each rural node accounted for 2.4%, 7.1%, and 7.7%, respectively. Notwithstanding, truly little has changed in some nodes regarding the headcount for poverty ranking over the last ten years. Since 2001 the same five rural nodal areas: Alfred Nzo, uMzinyathi, OR Tambo, uMkhanyakude, and Sisonke continue to be the poorest, with an estimated poverty headcount twice the national figure of 18,2%, accounting for 44,7%, 42,5%, 43,6%, 40,1%, and 36,8%, respectively (Stats SA,2011).

The Western Cape and Gauteng have always been the wealthiest provinces (ECSECC,2017). The Eastern Cape, Limpopo, and KwaZulu-Natal have moreover been among the poorest provinces since 2001. Following the 2001 and 2011 censuses, the Eastern Cape Province is the most impoverished in South Africa (ECSECC, 2017).

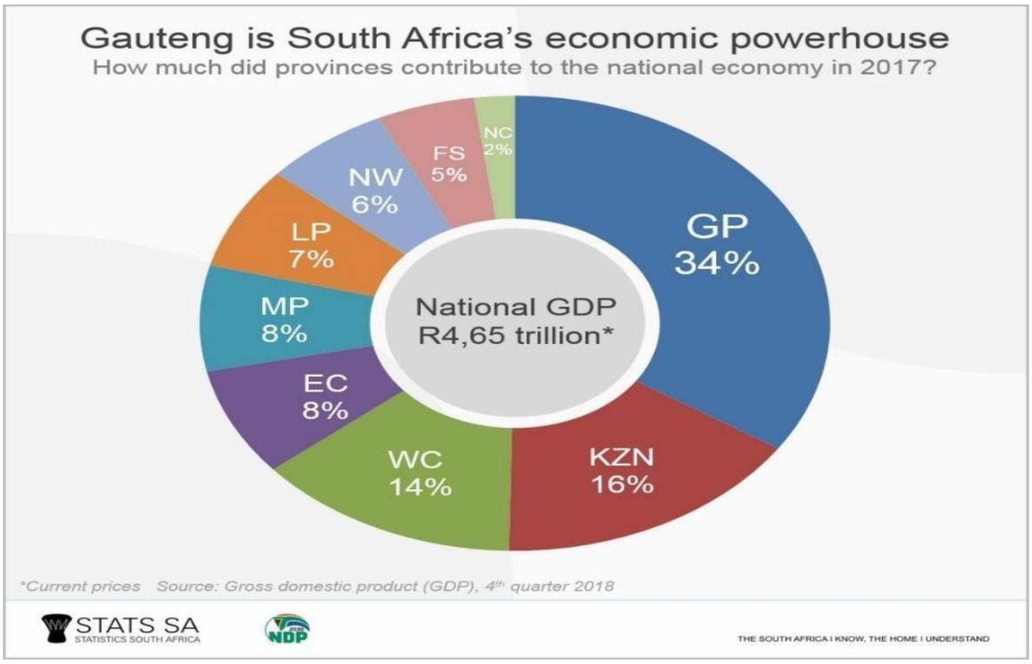


Figure 1.3: Gross Domestic Product (GDP) 4th Quarter (*Source: Gross Domestic Product (GDP) 4th quarter, Statistics South Africa (2018)*)

According to Stats SA (2018) GDP Q4:2018, as illustrated in **Figure 1.3**, Gauteng province was the largest contributor to the national GDP in 2017, accounting for just over a third (34%) of the total GDP. KwaZulu-Natal was the second largest contributor, accounting for 16%, followed by the Western Cape and Eastern Cape provinces, which contributed 14% and 8%, respectively. The Northern Cape province contributed the least to the national GDP at 2%.

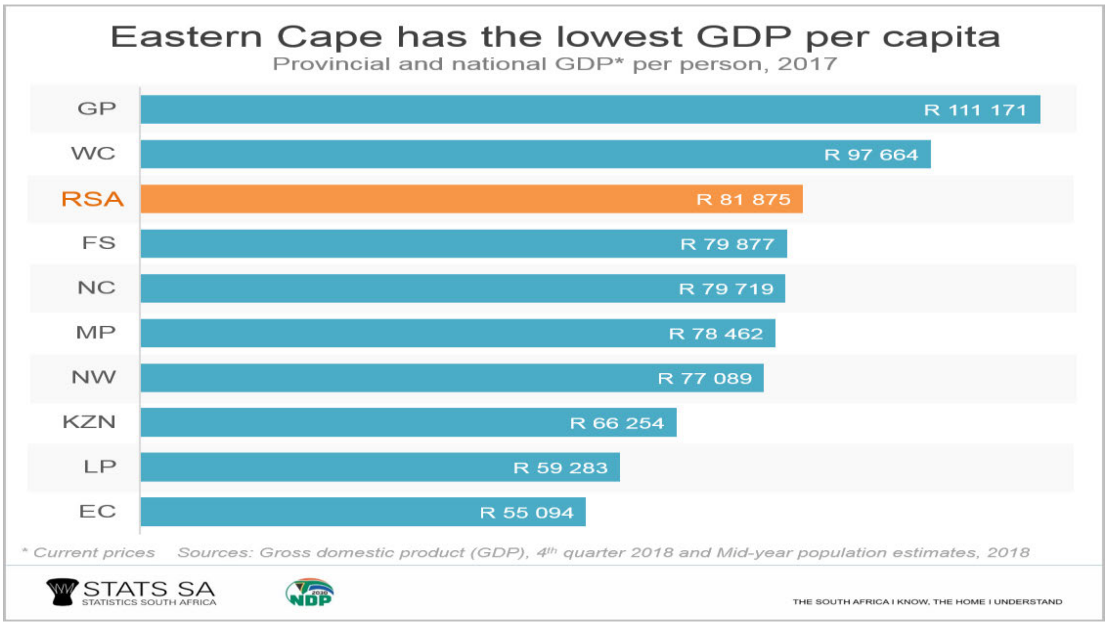


Figure 1.4: Provincial and national GDP* per person, 2017 (Source: Gross Domestic Product (GDP) 4th quarter and Mid-year population estimates, Statistics South Africa (2018)).

The GDP per capita of Gauteng was twice that of the Eastern Cape. The Gauteng province was not only the largest generator of the national GDP, but it was the most populous, housing 14,3 million persons as per data from the Mid-year population estimates report. The GDP per capita is R111 171 in Gauteng, which translates to R 1, 5 trillion to the national GDP of R 4, 65 trillion. The Western Cape had the second highest GDP per capita with R97 664, both provinces were above the national GDP per capita of R81 875. The Free State province was third highest with R79 877 GDP per capita. The Eastern Cape, Limpopo and KwaZulu- Natal provinces were the three lowest GDP per capita. KwaZulu-Natal is the second most populous province, housing 11, 4 million as per data from the Mid-year population estimates report, Stats SA (2018). The GDP per capita is R66 254 in KwaZulu-Natal. The Eastern Cape generated the lowest GDP per capita of R55 094.

Investment in transportation is essential for growth(Rodrigue and Nottebom, 2017). According to Prus and Sikora(2021:1), investment is “an element that guarantees regional growth development in terms of movement of people and goods”. This implies that the contribution of transport investment to regional growth depends on how it is used to enhance transport infrastructure in that region. Further, Tsikai(2016) noted that the transport sector is an essential component of a nation’s economy and a tool for development. Furthermore, the author added that, the level of economic growth is always influenced by the size and quality of transportation infrastructure.

Transportation provides mobility at the macroeconomic level by being linked to the level of output, employment, and the national economy (Tsikai,2016).The transportation sector accounts for 12% of the GDP in the majority of developing countries. While there are links to the producer, consumer, and production costs at the microeconomic level (Tsikai, 2016).

The benefits of infrastructure for regional growth and development are widely acknowledged (Polyzos and Tsiotas, 2020). Reduced transport costs contribute to expanding the business market and yielding more specialised productivity (Polyzos, 2019). Increasing accessibility of regions improves access to markets and boosts productivity, the benefits of transportation development are favourable for inter-regional economies' productivity and competitiveness (Polyzos,2019).

In 1996, the Department of Transport (DoT) introduced a National Transport Policy White Paper. The goal was for transport to be “the efficient interaction that enables society and the economy to assume their preferred form” (DoT, 1996:1). For this goal to be achieved, policies in the transport sector must be outward and designed by societal needs, transport users, and the transport economy. Transport can be an engine for addressing spatial distortions and economic development (DoT, 1996). Moreover, transport provision priorities should be aligned with those set for the country.

The vision of the South African transport sector is to “provide safe, reliable, effective and fully integrated transport operations and infrastructure which will best meet the needs of freight and passenger customers at improving service levels and cost in a manner which supports government strategies for economic and social development while being environmentally and economically sustainable” (DoT, 1996:1). This vision is shared by role players and is supported by coordinated, integrated planning, and decision making. Therefore, a formulation of broad goals translated into more specific attainable objectives of transport modes is needed (DoT: 1996).

In rural and developing urban environments, the transport system is inadequate for mobility needs; i.e. to travel to and from work, education, and health facilities. Subsistence and small-scale farmers face challenges to move their products to and from the market in rural areas. The DoT noted that among their key focus areas is “to invest in infrastructure in ways that satisfy social, economic or strategic investment criteria” (DoT, 1996:1). This implies that infrastructure investment must boost both social development and output growth.

Given the long-term and indivisible nature of the investment, South Africa must build a strong financial base for creating, maintaining, and upgrading transportation infrastructure (DoT, 1996). Further, the DoT noted that targeted investment will be available to build and serve societal and economical needs. Nonetheless, there is a conflict between the provision of efficient services and minimised high-level infrastructure required for economic functioning and social development infrastructure. This dichotomy is causing a trade-off because it is not possible tomeet both demands (DoT, 1996).

Rural areas in South Africa were spatially excluded from economic and infrastructural development and people residing in rural areas still have inferior access to basic social services and economic activities (DoT, 2007). Over the years, the government has tried to address challenges of rural development, with transport being a key challenge. Therefore, in 2007, the Department of Transport developed the Rural Transport Strategy (RTS). The objective of this strategy was to guide all government spheres, in an integrated manner, to continuously address mobility challenges faced by rural communities. Transport plays a catalytic role in tackling poverty; thus, implementation plans must respond to the needs of district municipalities and provinces (DoT, 2007).

To ensure the equitable distribution of resources, the government is working together with civil society and developmental agencies to mitigate the economic and social crisis facing rural areas (DoT, 2007). Key tools such as, The National Spatial Development Perspective (NSDP), the Integrated Sustainable Rural Development Programme (ISRDP), Integrated Development Plans (IDP), and land use and transport plans were developed to support rural nodal and linkage development (DoT,2007).

The Rural Transport Strategy is directed at designing sustainable rural transport systems by supporting local infrastructure. The key focus was to improve access roads and address neglected infrastructure and corridors that are linked to social services and markets (DoT, 2007). Rural areas are agricultural, which is crucial for their economic development. Nonetheless, agriculture needs to be strengthened by the provision of freight logistical support to enhance productivity.

In 2006, the Department of Transport piloted the strategy under the Integrated Rural Mobility and Access (IRMA) project. Phase 1 of DoT's Public Transport Action Plan (2007-2010) identified six rural nodal district municipalities. In terms of the NSDP, they were grouped as areas with a high social need index but were close to economic opportunities. The six identified areas were Greater Sekhukhune; uMkhanyakude; O.R Tambo; Ehlanzeni; Thabo Mofutsanyane and Kgalagadi District Municipalities (DoT, 2007). Geographical locations are illustrated in **Figure 1.1**.

The action plan focused on three intervention areas associated with road transport; (i)the development of appropriate rural public transport subsidy options; (ii) transport brokering and special needs contracting services; and (iii) the promotion of combined passenger and freight services. Furthermore, these interventions were assumed tobe identified through Municipal Integrated Transport Plans (ITPs).

Intervention 1 was to propose projects such as assessing grants and loans to provide for rural transport operators, the introduction of appropriate technologies (adapted rural vehicles), and assessing the pattern and beneficiaries of subsidised transport operations within deep rural areas (DoT, 2007). The intervention sought to emphasise the "peri-urban" bias of the public transport subsidy system and promote capital and user-side subsidies. These subsidies were to address the usual rural conditions. Finally, a new subsidy system that was aimed at providing funds for the development of appropriate transport means was investigated. In conclusion, other sectors benefited through improved education, health access, and economic opportunities (DoT, 2007).

Intervention 2 proposed projects such as piloting numerous rural transport brokering services to provide an interlinked transport service for passenger transport needs. The plan was also to develop single district hubs for brokering services, e.g. toll-free call centres. There was also a call to establish a forum for special needs transport and to design appropriate vehicle specifications for special needs and ill people (DoT,2007). Furthermore, transport services for agriculture, access to health care, and Thusong Centres (which brought government-relevant information and services closer to people to promote access to opportunities; therefore, improving livelihoods) were among the benefits (DoT, 2007).

Intervention 3 proposed projects such as investigating and addressing issues relating to safety and regulations and introducing adapted vehicles for the Taxi Recapitalisation Programme. Finally, the intervention included preparing relevant document specifications on pilot projects on adapted vehicles on a tender bias (DoT,2007).

In 2009, the National Land Transport Act 5 of 2009 (NLTA) was developed. The purpose of the Act was to “further the process of transformation and restructuring the national land transport system as initiated by the Transition Act” (The Presidency, 2009:9). The National Land Transport Strategic Framework (NLTSF) is a legal framework in terms of NLTA. Every five years the NLTA empowers the government to prepare an NLTSF. Further, it carries the national five-year (2017-2022) land transport strategy; thus, guiding transport planning and delivery by the spheres of government for the relevant period (South African Government,2009).

The NLTSF established priorities for linking transportation planning to economic, social, health, and objectives (DoT, 2017). The identified priorities and objectives connected the framework to all government levels for effective transportation planning. The NLTSF was not a transportation plan or strategy; rather, it established comprehensive goals, vision, and objectives for each element of transportation systems, as reflected in the Provincial Land Transport Frameworks (PLTFs) and ITPs.

The overall vision of NLTSF was to “create an integrated and efficient transport system supporting a thriving economy that promotes sustainable economic growth, provides safe and accessible mobility options, socially includes all communities, and preserves the environment" (DoT, 2017:55). This implies that a sustainable transportation system is crucial for economic growth, wealth creation, and to address social challenges. Furthermore, rural transport was among the functional areas covered by NLTSF and applied to local needs. The government committed to increasing transport infrastructure expenditure in the thirteen priority rural nodes. The progress was a 15% growth to 6.7 billion in allocation to Provincial Road Maintenance Grant 2008/09-2011/12 (DoT Plan 2011) and the completion of the development of the RTS (DoT, 2017).

The NLTSF noted that an assessment and review of the relevance of the ISRDS was required. Furthermore, it needed to be based on the progress made with the identified rural nodes in the strategy and the success of any interventions (DoT, 2017). Moreover, the rural access index of rural communities needed to be reviewed and updated to develop a rural transport network plan with clear budget needs for transport network infrastructure upgrades and maintenance. In conclusion, improving rural access is key to poverty alleviation, so the intervention sought to increase access to education and improve health (DoT, 2017).

The National Development Plan 2030 provides a long-term perspective and aims to reduce poverty and inequality by 2030 (South African Government, 2012). Furthermore, the plan aims to create an inclusive and integrated rural economy by enabling rural areas to participate more in the economic and social sphere of South Africa. Additionally, the idea is that everyone should have access to education, health care, and transport of decent quality (South African Government, 2012). The plan aimed to improve infrastructure as it is essential not only for economic growth however, it also promoted inclusivity thus enabling citizens to improve their lives and boost their incomes (South African Government, 2012). Overall, the strategies mentioned in this dissertation illustrate that the government has attempted to address challenges regarding transport infrastructure in rural nodes. They also note the importance of transport infrastructure and how it yields economic growth if promoted and implemented in a precise and constructive manner.

1.2 Research Problem

Infrastructure investment is a major interest area in the field of macroeconomics. Many empirical studies (Gnade et al., (2017), Fedderke and Garlick (2008), Kumo(2012),and Sharma and Tenyane (2021),have found an association between investment in infrastructure and economic growth. Transport infrastructure plays a vital role in output growth and poverty reduction. Therefore, investment in transport infrastructure improves accessibility, causes a redistribution and more advantages to the accessible parts of the country (Banister and Berechman,2001). The current literature fails to identify the impact of rural transport infrastructure investment on economic growth. Research is limited to national analyses that have been conducted regarding the relationship between the two variables. In South Africa, published empirical studies include, but are not limited to Hlotywa and Ndaguba (2017), Selamolela (2018), Mayekiso (2015), and lastly, Hanyurwumutima and Gumede (2021). This rationale is comparable in the same way, these empirical studies have overlooked the underdevelopment of transport in rural areas. Chibba (2014) ascertained that the underdevelopment of transport infrastructure affects a nation negatively. Following the background of this study, rural nodal areas have limited infrastructure and extreme poverty levels. Given this context, it is apparent that the delivery of rural transport investment could be a stimulus for output growth.

1.3 Overall Objective and Aims

This study's primary goal is to examine how investment in transport infrastructure affects the output growth of rural nodal district municipalities in South Africa. This study looks at the impact of transport infrastructure investment on rural output growth in South Africa from 2012 to 2019. The specific sub-objectives that were formulated are listed below:

1. To examine the relationship between transport infrastructure investment and output growth in rural nodal district municipalities; and
2. To understand the causality between transport infrastructure investment and output growth of rural nodal district municipalities.

This dissertation addresses the impact of transport infrastructure investment by focusing on the critical questions listed below in order of importance:

- ❖ Firstly, what is the link between transport infrastructure investment and output growth in rural nodal district municipalities?
- ❖ Secondly, what is the direction of ~~the~~ causality between transport infrastructure investment and output growth in rural district municipalities?

South Africa continues to face challenges in improving long-term economic growth; thus, making policy development critical (Kumo, 2012). The relationship between infrastructure and economic growth is becoming increasingly important in economics, academia, and policy circles (Fedderke and Garlick, 2008). Nonetheless, few studies have examined the impact of transportation infrastructure and output growth on long-run growth. Therefore, this study investigates the following hypotheses:

- H0: A positive relationship does not exist between investment in transportation infrastructure and output growth in rural nodal district municipalities.
- H1: A positive relationship exists between investment in transportation infrastructure and output growth in rural nodal district municipalities
- H0: A causal relationship does not exist between investment in transportation infrastructure and output growth in rural nodal district municipalities.
- H1: A causal relationship exists between investment in transportation infrastructure and output growth in rural nodal district municipalities.

1.4 Research Methodology

This study employs the quantitative research method. According to Creswell (2012), this research methodology quantifies data using statistical techniques. Further, descriptive statistics is employed to test the relationship between transport infrastructure investment and output growth in rural nodal district municipalities. Furthermore, secondary yearly data from COGTA and National Treasury on Local Government and Statistics South Africa (2012-2019) is used. For output growth, the GDP of each rural nodal district municipality was collected. For transport infrastructure investment, transport expenditure was employed as a proxy variable and education and health expenditures along with the gross value added (GVA) by business activities across economic sectors: primary, secondary, and tertiary were employed by the total rural nodal district municipality for social investment expenditure. In addition, this data was sought from the medium-term expenditure framework (MTEF) for 2012/13; 2013/14; 2014/15; 2015/16; 2016/17; 2017/18;2018/19; 2019/20 fiscal years from the Estimates of Provincial Revenue and Expenditure along with Integrated Development Plans (IDPS) by rural nodal district municipalities. Additionally, for labour, the total labour employment by the rural nodal municipality was collected. This study considers panel data analysis.

Baltagi (2008) argued that panel data is the accumulation of observations on a sample of households, countries, firms, and so on over time. This data analysis is most suitable for this study as it allows control for individual heterogeneity acrossrural nodal district municipalities. Additionally, Fisher-type (ADF and PP) panel unit root tests (Maddala and

Wu, 1999) were employed to check for stationarity among variables. To check for cointegration between transport infrastructure investment and output growth, Pedroni tests (1999) were conducted. After confirming the existence or non-existence of cointegration, this study employed a panel VECM, (Watson, 1993). Lastly, a Panel Granger-Causality test is used to check for the direction of causality between transport infrastructure investment and output growth in rural nodal district municipalities was conducted. These tests are conducted using the STATA 17 and EViews 10 statistical programs.

1.5 Significance of The Study

This study generated improved insights because it is the first to examine the relationship between transport infrastructure investment and output growth within rural nodal district municipalities in South Africa. Evidence illustrates that over the years, the government has tried to address challenges in rural transport. Hence, various policies such as the National Land Transport Strategic Framework (NLTSF) which is a legal requirement of the National Land Transport Act 5 of 2009 (NLTA), the Integrated and Sustainable Rural Development Strategy (ISRDS), the White Paper on National Transport Policy (1996, 2017), Rural Transport Strategy for South Africa (2007), Road Infrastructure Framework as well as the Provincial Land Transport Frameworks have been and are currently being developed in all provinces.

Further, these strategies aim to develop balanced and sustainable rural transport systems by supporting local infrastructure and services. The emphasis has been put on improving access roads, developing passable roads, and addressing neglected infrastructure along with corridors connected to markets and social services.

The quality of transport systems in rural nodal district municipalities relies on facilities which are not well integrated to function to be sustainable and equitable. Considering the current state of transport systems in rural nodal areas in South Africa, this study contributes to transport literature by using recent data to offer new evidence. From a methodological perspective, this dissertation improves previous work(Moketsi(2017) Selomolelo(2018), and Hanyurwumutima and Gumede (2021) by employing a Panel Vector Error Correction Model (VECM). From the researcher's knowledge, this study is the first to explore the impact of investment in transport infrastructure on output growth using a Panel VECM in rural nodal district municipalities within South Africa. Therefore, it is important because it highlights the direction of the relationship between the variables and whether transport infrastructure investment contributes to the output growth of rural nodes.

1.6 Structure of Dissertation

Chapter Two presents the conceptual framework followed by a theoretical and empirical literature review on transport infrastructure investment and growth. The conceptual framework supporting this dissertation discusses transport infrastructure, rural transport infrastructure and transport infrastructure investment. The theoretical study also discusses economic growth and development growth theories; namely Harrod-Domar, neoclassical and lastly the endogenous growth model. Empirical literature is grouped into two themes namely; infrastructure investment and economic growth, and transport infrastructure investment and economic growth. Additionally, both international and domestic published studies are presented, and research gaps are identified

Chapter Three outlines the research methodology of this dissertation. This chapter discusses and justifies the research methodology, the research approach, data and variables, model specification and estimation, panel unit root test, the panel cointegration test and lastly, the panel Granger-Causality test.

Chapter Four includes a report on the analysis of test results and the research findings. In conclusion the study gives recommendations and highlights the need for further research.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Transport investment should be integral to transport policies. Further, the development of transport infrastructure should be regulated by responding to the needs of people (Negota, 2001). In South Africa, it is evident that rural areas face the challenges of an inefficient infrastructure network, long travelling time, dispersed and fragmented settlement patterns, and low population densities (Chakwizira and Mashiri, 2018). In addition, low population densities create spatial and economic investment inefficiencies regarding the provision of transport infrastructure. Moreover, when looking to connect with surrounding economic hubs, rural areas face mobility challenges which have resulted in constrained socioeconomic development and growth (Chakwizira and Mashiri, 2015). The DoT(2007) noted that challenges faced by rural transport concern the need to transform the pattern of rural transport infrastructure investment. Hence, many rural communities still face challenges from under-investment in the maintenance of roads and transport services. It is essential to increase the overall level of investment in rural transport infrastructure given the backlog and current needs.

This chapter gathers literature and provides conceptual, theoretical, and empirical frameworks. The conceptual framework discusses transport infrastructure, rural areas, rural transport infrastructure, and lastly, transport infrastructure investment. Furthermore, the theoretical review provides economic growth and development theories consisting of the Harrod-Domar, neoclassical and endogenous growth models. In terms of this study the endogenous growth model is employed. Finally, empirical published studies both on international and domestic literature are discussed. This section is divided into two themes: infrastructure investment & economic growth and transport infrastructure investment & economic growth.

2.2 Conceptual Framework

Svinicki (2010) noted that a conceptual framework is an interrelated group of theories regarding a certain phenomenon. While Bowen (2008) stated that concepts lay out the analytical frame, which is a point of reference and guides data analysis with the corresponding theory. For this study, the conceptual framework includes; transport infrastructure, rural areas, rural transport infrastructure and lastly, transportinfrastructure investment.

2.2.1 Transport Infrastructure

According to ITF (2013), transport infrastructure is an integral part of a country's growth and development; thus, quality transport infrastructure is fundamental. Transport infrastructure refers to the structure that supports the overall transport infrastructure that consists of roads, railways, airways, and waterways (Chandra Das, 2013). In addition, the South African transport network includes transport by road, rail, air, and sea. Furthermore, this transport network plays a pivotal role in the economy by moving people and goods (Western Cape Government, 2022).

The DoT refers to transport as the "heartbeat of economic growth and social development" (2022:1). This implies that transportation plays an essential role in enhancing output growth and socioeconomic development. Similarly, ITF (2013) argued that transport infrastructure is a capital input in the production process that enables the market exchange of goods and broader welfare benefits. Further, the significant role played by transport infrastructure makes it the backbone of the economy. The National Treasury (2015) noted that transport systems connect people to education, healthcare, and work facilities. This implies that transport is pivotal to sustaining development and growth in a country. Similarly, Chaithoo and Venkatesh, (2010) noted that transport is significant in reducing poverty. However, they argue that if designed inappropriately, transport strategies result in networks and services that increase the conditions of the poor, damage the environment, and lastly, neglect the ever-changing needs of users (Chaithoo and Venkatesh, 2010).

2.2.2 Rural Areas

Jean Vasile et al., (2019: 1) defined a rural area as an "area out of urban town and city areas". Further, these places are dispensed compared to congested urban areas. There are various definitions of rural areas that are similar. For instance, Statistics Canada referred to rural areas as, "towns and municipalities outside the commuting zone of urban areas" (2001:6) and the Spanish Ministry of Agriculture referred to them as," a place where the main activity is farming" (Statistics Canada, 2001:7). The Danish Government asserted that it is "houses through the countryside with a large distance to the urban city area"(Cullinane and Stokes, 1998:1). Similarly, the National Treasury defined rural areas as "sparsely populated areas where people farm or depend on natural resources, it consists of villages and small towns that are dispersed through the areas" (2011:192). These definitions are consistent with the characteristics of rural areas as provided in section 1.2 of this dissertation.The Palmer Development Group categorised municipalities into classifications for analysis in South Africa. **Table 2.1** below illustrates those findings (National Treasury,2011).

Table 2.1: Classification of Municipalities into Categories.

Class	Characteristics	Number
Metros	Category A municipalities.	6
Secondary Cities(B1)	All local municipalities cited as secondary cities.	21
Large towns(B2)	Every local municipality has an urban core. There is a significant urban residing population.	29
Small towns (B3)	There is a small population. The local economy is agricultural dominant ; therefore,rural areas have commercial farms.	111
Mostly rural(B4)	There is at most one or two small towns. These municipalities are communal land tenure and villages. These are usually located inpreviously homelands.	70
Districts (C1)	These district municipalities do not provide water services.	25
Districts (C2)	These district municipalities do provide water services.	21

Source: *LGBER, National Treasury (2011).*

As shown in **Table 2.1**, rural areas fall under small towns (B3) and mostly rural (B4) categories. The location of both the B3 and B4 categories is in line with the definitions of rural areas provided above. B4 areas are mostly in the Eastern Cape, KwaZulu-Natal, Limpopo, and Northern Cape provinces. B3 is hosted among Mpumalanga, North West, and Western Cape provinces.

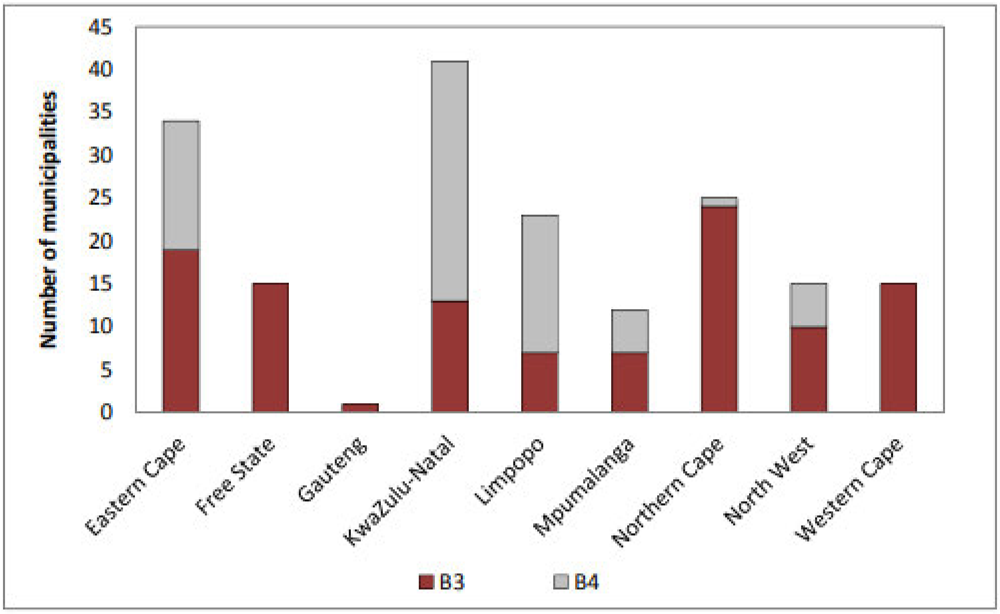


Figure 2.1: The Distribution of Rural Municipalities Among Provinces (Source: LGBER, National Treasury (2011)).

As illustrated in Figure 2.1, KwaZulu-Natal has the highest number of B4 areas followed by Eastern Cape and Limpopo, respectively. Northern Cape has the least number of B4 areas, while Gauteng has no B4 areas at all and hosts a small portion of B3 areas. The findings shown are consistent with the background provided in Section 1.1, where the highest top three provinces have the most rural nodal district municipalities. As reported in Chapter One, KwaZulu-Natal has the highest number of nodal areas; seven, followed by Eastern Cape with five then Limpopo with two.

Extreme poverty levels are among the challenges faced by rural areas. Starkey (2002) noted that poverty alleviation requires less isolation, increased mobility, and increased access through complementary transportation infrastructure. Further, improved rural mobility is required to provide citizens with easy access to basic needs, markets, and participation in both economic and social activities. Furthermore the lack of mobility limits income generation and economic demand (Starkey,2002). Finally, efficient rural transportation entails complementary large and small-scale transport modes that operate within villages and from village to market (Starkey, 2002).

2.2.3 Rural Transport Infrastructure

Bryceson and Howe(1993:1719) defined rural transport as the "movement of people or goods for any conceivable purpose (including the collection of water or firewood) by any conceivable means (including walking or head loading) on different types of infrastructure (including unproclaimed roads, tracks or footpaths)". On the other hand, Robison, and

Banjo (1990) noted that rural transport plays a primary role in the economic development of any country. Further, many people and a heavy weight of goods are moved by road and industries such as agriculture depend on road transport for both inputs and outputs. Moreover, production heavily depends on effective and efficient transport activities.

The majority of developing countries have poor quality rural transportation networks (Lebo and Schelling, 2010). Rural areas lack access to a reliable, safe, and efficient transport system; thus, endure high transport costs. This causes strain on economic development in these areas (ECSECC, 2003). Similarly, Chaithoo and Venkatesh (2010) contended that adequate road networks and robust rural transportation are the primary causes of the lack of access in rural areas. Improved rural transportation is required to alleviate poverty, improve livelihoods, boost economic growth, and improve access to health, education, and other essential services.

In South Africa, access and district roads, public transport interchanges, tracks, and non-motorised transport infrastructure (NMT) are provided by provincial and municipal governments, and other relevant bodies. These bodies include the Department of Transport, the Department of Public Works (DPW), and the South African National Roads Agency Limited (SANRAL), all of which involve communities directly and indirectly; and create local construction-related jobs, ultimately increasing output growth (DoT,2007).

2.2.4 Transport Infrastructure Investment

The performance of the economy serves as a stimulus to investment in transport infrastructure. Negota (2001) noted that sustainable economic growth and strong mobility increase the demand for public transport and transport infrastructure. Further, transportation investment can be linked to overall economic investment and can be viewed as a kind of response to economic growth (Negota,2001). Moreover, transport infrastructure facilitates import and export demand. Therefore, infrastructure development should be prioritised in order to ensure that goods are delivered on time (Negota, 2001).

The most significant impact of transportation infrastructure investment is the effect it has on the price levels of accessibility to different locations. Price changes also reflect changes in the relative advantage of geographically located activities and economic opportunities, both for the producer and the consumer (Negota, 2001).Accessibility to resources and institutions is impacted by transportation investment because it moves the sources of supply closer to the sources of consumption, which has an impact on labour prices, travel time, and other associated issues (Negota, 2001). A regional transportation development strategy is; therefore, required to encourage investment in transportation infrastructure (Negota, 2001).

2.3 Theoretical Review

Salkind (2012) ascertained that theories are formed to explain, predict, and understand phenomena. Further, in many events, theories challenge and expand existing knowledge. Therefore, a theoretical framework is a structure that holds a theory of a study by introducing and describing support for the research problem (Salkind,2012).

Global governments continuously focus on improved strategies to increase their economic capacity (Dissou and Didic,2013). In recent years, advanced models for analysing the economic impacts of various supply-side policies to enhance output have been developed. Modelling with factors of production such as physical capital and labour, in particular. These models attempt to capture the simultaneous usage of other inputs, such as public infrastructure and education, as significant contributors to output growth (Dissou and Didic,2013).

This section shows an understanding of the theories and concepts relevant to the study and considers broader areas of knowledge. Further, economic growth theories such as the Harrod-Domar, neoclassical and endogenous growth models are compared in terms of transport infrastructure.

2.3. 1 Harrod-Domar model (HDM)

Two authors with similar models of economic growth, Harrod and Domar expanded the short-run Keynesian framework to analyse the growth process. Both authors emphasised investment as the prime mover of the economy and the dual role it plays by creating demand and capacity (Ghatak, 1995). The Harrod-Domar model criticised the basic Keynesian theory of short-run determination for ignoring the role investment plays in increasing output capacity (Singh and Pant, 2010). Keynes observed that in a closed economy, plans to invest are equal to plans to save at income and output equilibrium levels (Clunies-Ross et al., 2009). As a result, Harrod- Domar assumed that new investment, represented by capital stock, can influence GDP growth (Todaro and Smith, 2012). Therefore, this model suggested that the national savings rate and the capital-output ratio jointly determine the rate of economic growth and as a result, it illustrates that investment directly drives output growth.The Harrod-Domar model used broad aggregate, for instance, investment, capital, and output. Further, this model assumed that there is a fixed- relationship between capital invested and output produced using that capital, thus, the capital- output ratio is constant (Clunies-Ross et al., 2009). According to the Harrod-Domar model, capital accumulation is essential for output growth. Harrod (1948) and Domar (1957) suggested that, at full employment equilibrium income level, the spending volume generated by investment must be sufficient to hold increased output to maintain the equilibrium. Likewise, capital accumulation increases the productive capacity of the economy. However, capital accumulation and income growth must be in equilibrium. For instance, investment in transport infrastructure indirectly supports production; therefore, enabling the growth of output (Harrod, 1948; Domar, 1957).

A higher marginal propensity to save increases capital accumulation and national income. Nonetheless, capital accumulation must go along with an increase in income to not remain untitled. Replacing old capital deprives the latter of its labour, therefore, an increase in capital unaccompanied by income increase leads to both factors of production being unemployed (Harrod,1948; Domar 1957).

The shortcomings of the Harrod-Domar model have been discussed for some time now. Firstly, the underlying assumption of a fixed capital-labour ratio is the main source of the criticism (Sato, 1964). Further, this model did not highlight structural and regional problems. Moreover, in developing countries estimating capital is complicated. Ghatak (1995) noted that the assumption that investment funds will be retained on a plan is invalid as priorities change thus resulting in other uses for funds. Correspondingly, the Harrod-Domar model ignored the role of technology and the quality of labour and did not analyse the relationships between the variables and growth (Gürak, 2015). Taking all of these assumptions into account, an alternative model was developed in which factor proportions are flexible and all rigidities are assumed away (Sato, 1964). This model is known as the "neoclassical model", and it demonstrates why the Harrod-Domar model was not a good place to start.

2.3.2 Neoclassical model

Solow (1987) replaced the rigid-technology assumption that was primary to the Harrod-Domar model embodied in a fixed capital-output ratio, with his flexible assumption. The primary underlying assumption of the neoclassical model was that different technologies (i.e. alternative types of machinery with a different degree of capital intensity) are available to choose from when production is scheduled. In addition, Clunies-Ross et al., (2009)noted that firms will have different options for technologies at a disposable, which allows capital-labour and capital-output ratios to vary.

Further, the neoclassical model emphasised that the relationship between capital accumulation and savings decisions (Solow, 1956). In addition, a foundation of three main propositions was presented to better understand the model. In a long-run steady state, output growth is regulated by the growth rate of labour in efficiency units, which is independent of the investment-to-GDP and savings ratios. Furthermore, per capita income is directly correlated to the savings-investment ratio and negatively associated to the rate of population growth. Assuming equal preferences, the capital-labor ratio and capital productivity are inversely related(Solow, 1956).

According to Moeketsi (2017), the neoclassical model suggested that infrastructure capital has diminishing returns to scale over time. Further the author states that many countries share similar elements in their efforts to expand and improve their infrastructure. They have stable governments, for example, that uphold prudent economic policies, offer basic infrastructure and services, and, a long-term economic outlook. Moeketsi (2017) argues that in the neoclassical model, infrastructure accumulation is influenced by short-term growth rates of saving and depreciation. In the long run; however, it is determined by the rate of population growth.

The neoclassical model became theoretically unsatisfactory to explore long-run growth determinants in the 1980s. Authorsuch as Clunies-Ross et al., (2009) noted the exogenous status of technical progress and consequently, concluded that assessing and implementing technical progress is normally difficult for developing countries. Further, the authors argued that technical progress is assumed to happen but there is no explanation of why it happens or the contributing factors of what leads to it being pursued. Another criticism of the neoclassical model is the low marginal productivity of investment in developing countries where it is assumed to be particularly high which is not feasible. Additionally, Romer (1986) argued that increased savings and investment can increase the long-run growth rate. Hence, the endogenous growth model emerged as an alternative model to the neoclassical model.

2.3. 3 Endogenous growth model

The endogenous growth model sometimes referred to as the “new growth theory” emerged in the 1980s as a response to the shortfalls of the neoclassical model. The papers of Romer (1986) and Barro (1990) laid the groundwork for Endogenous Growth Models that look to endogenize human capital and infrastructure accumulations as the primary arguments of the aggregate production function (Dissou and Didic,2013). Further this theory forms the precursor of the model specification in this study.

Barro (1990) argued that the underlying dependence of output growth on endogenous forces rather than external factors is the major driver of the endogenous growth model. Furthermore, Clunies-Ross et al., (2009) ascertained that the endogenous growth model hypotheses spending on human capital and concludes that such investment directly increases productivity and output growth.

Rodriguez-Pose and Crescenzi (2008) argued that investment in research and development (R&D) increases inventions that enhance growth in the production chain. Moreover, innovation places investment in R&D on technological progress and economic growth. For instance, research into rural transportation infrastructure will result in innovation, which will advance technology and subsequently increase output. In a similar vein, Barro (1990) asserted that human capital growth does not diminish as economies develop. Further, the author argued that knowledge spillovers among producers and human capital benefit are part of the process since they avoid diminishing returns to capital accumulation.

Romer (1986) removed the tendency for diminishing returns to the capital with the assumption that knowledge is part of the investment. The author argued that when a firm increases physical capital, it also learns to produce more efficiently. For instance, when investment in rural transport infrastructure increases, it will concurrently drive productivity which will yield output growth. Additionally, Barro and Sala-i-Martin, (2004) referred to the positive impact on productivity as “learning by investing”. This implies that output growth is a result of investment in transport infrastructure. Therefore, the greater the investment, the greater the productivity, and thus output growth, *ceteris paribus*.

Romer (1993) based the endogenous growth theory on three premises. Firstly, technological change is at the heart of economic growth, secondly the model is of endogenous technological change because of investment from firms, and lastly, modern technology can be used continuously at no additional cost. For instance, transport infrastructure is central to output growth and once developed and maintained it can be used continuously at no additional cost.

In the long run, output growth and development are dependent on infrastructure services (Barro and Sala-i-Martin 2004). The government must regulate and resolve cases of market failure that are associated with various investment types. Investments are critical for output growth and development; however, transportation investment creates more opportunities and jobs in a country (Barro and Sala-i-Martin,2004).

2.3. 4 Conclusion

The assumptions of the endogenous growth model prove it to be the most relevant for this study. Firstly, the Harrod-Domar model assumed fixed proportions in the combination of capital and output and fixed savings-income ratios in the long run. This is unlikely to be attainable in a developing country such as South Africa because as with fellow developing countries, they find it difficult to increase marginal propensity to save. In addition, the Harrod-Domar model ignored the role of modern technology and the quality of labour, so it neglected the role of technical progress in yielding output growth. Evidence shows that technological progress changes the production function, hence countries that have increased their technology experience growth. It is therefore unrealistic to neglect its role or assume it will be fixed in the long-run growth. Capital accumulation increases if there is economic growth and capital increase is not a precondition for output growth. When a country's economy grows, so too do income and savings, which eventually increases demand and therefore capital investment spending.

Alternative to the Harrod-Domar model is the neoclassical mode which also lacks relevance for this study. This model did not explore long-run growth. As a result, it assumed infrastructure capital is subject to diminishing returns to scale in long-run growth, which is unlikely given that countries grow and develop their infrastructure with a long-term economic perspective (Moeketsi, 2017). In contrast to the Harrod- Domar model and neoclassical model growth theories, the endogenous growth model proves to be relevant to this study. Firstly, this theory emphasised the role of human capital investment, which eventually promotes growth. For instance, the research undertaken for this study will lead to improvement and innovation in policy framework and will contribute towards output growth. This implies that knowledge is an investment and therefore, has a positive impact on productivity. Further, the theory argues that a physical capital increase simultaneously drives production and therefore output growth. The endogenous growth theory ascertains that infrastructure services are crucial for both output growth and development. This implies that infrastructure is pivotal for economic growth thus development which is consistent with existing literature that has tackled infrastructure expenditure on growth globally.

2.4 Empirical Framework

This section provides a structured literature review and analyses previously published studies to address the research problem. This framework relies on observations and measurements to draw up a conclusion. For this study, the empirical framework is divided into two sections. The first is infrastructure investment and economic growth, and the second is transport infrastructure investment and economic growth. Both international and domestic literature are considered.

2.4.1 Infrastructure Investment and Economic Growth

Numerous macroeconomic studies link infrastructure investment to economic growth. Aschauer (1989) noted that in the 1970s, production levels in the U.S slowed down due to the lack of investment in infrastructure. Further, the author argued that an increase in public stocks relative to private capital has a positive but diminishing effect on the marginal product of factor inputs such as capital and labour. As a result, factor input prices fall while private production levels rise.

Démurger (2001) conducted a panel empirical study on infrastructure development and economic growth in twenty-four Chinese provinces from 1985 to 1988. The role of transportation infrastructure as a differentiating factor in explaining the growth gap was central to the findings. Démurger (2001) noted that telecommunications facilities account for a massive portion of provincial growth performance. In the same vein, Calderón and Servén (2004) conducted an empirical analysis of the impact of infrastructure development on economic growth and income distribution as measured by infrastructure stocks and improved service quality. Further, the authors concluded that infrastructure investment might be essential for eliminating poverty since it enhances growth and reduces income inequality.

Agenor and Moreno-Dodson (2006) identified two channels through which infrastructure can influence growth. Complementarity and crowding-out effects are two of these channels. The first channel promotes growth by encouraging the formation of private capital. Further, the authors argued that public infrastructure raises the marginal productivity of private inputs, increasing the rate of return on private capital and private sector demand for physical capital. The second channel asserts that an increase in public sector capital stocks may crowd out private investment in the short term. Furthermore, if the decline in private capital formation persists, the negative effect of crowding out infrastructure may have long-term consequences.

Herranz-Loncan (2007), analysed the impact of investment in infrastructure on economic growth, in Spain from 1850 to 1935. This study employed Engle-Granger and Johansen tests for cointegration and a VAR technique to test the relationship between the two variables. In addition, the paper illustrated that local-scope infrastructure investment has a positive effect on the economy. While wider networks had no significance on productivity growth. The author noted that the second result is surprising as transport cost-saving effects of Spanish railroads occurred in the late 19th and early 20th-century market integration.

Jan et al., (2012), examined the interplay between physical infrastructure and development in Pakistan using time-series analysis. The study employed a composite index of infrastructure using principal component analysis (PCA). This was done by considering three different angles of infrastructure. The three angles are transportation, energy, and telecommunications infrastructures. The PCA combined and transformed these three indicators of physical infrastructure. Therefore, the results of this analysis indicated a long–term relationship between the variables of interest. These findings confirm the importance of physical infrastructure for the growth and development of Pakistan.

In a similar study, Younis (2014) investigated the effect of infrastructure investment on the economy in Pakistan as using a time series analysis. This study adapted Barro's (1990) model of government spending to evaluate the significance between social and economic infrastructure in output growth. The results demonstrated that social infrastructure and growth have a positive relationship, while economic infrastructure and growth have an inverse relationship. The theory suggested that the inverse relationship is a result of economic infrastructure exceeding the threshold therefore its effect becomes negative. Younis (2014) suggest that more research should be conducted to investigate the cause of this negative relationship between the variables.

Using panel data from 1985 to 2008, German-Soto and Barajas Bustillos (2014) investigated the relationship between infrastructure investment and economic growth in Mexican cities. As expected, the findings revealed a positive relationship between the variables of interest. Nonetheless, the impact is intended to restore economic growth. The authors supported this notion and argue that any investment takes time after being implemented to create jobs, and increase productivity and economic growth. Nonetheless, economic, and social opportunities are generated in the meantime.

Unnikrishnan and Kattookaran (2020), investigated how public and private infrastructure investment impact the economic growth of India. The VECM technique was used to measure the effect of investment in public and private infrastructure on output growth. The results demonstrated that both infrastructure investments affect growth significantly. Further, the relative contributions of both investments were measured in this study and the conclusion was that private investment stimulates growth more than public. Consequently, private investments must be promoted for growth and development.

Seidu et al., (2020), examined how infrastructure investment affects economic growth in the United Kingdom. They argued that despite infrastructure investment being an economic accelerator the United Kingdom still ranks poorly internationally. This rating is regarding infrastructure investment and growth among comparative countries. Interviews with individuals in different infrastructure sectors were conducted for this study and the findings confirmed that infrastructure investment is crucial in the United Kingdom. It is crucial because it is a stimulus for growth through job creation resulting from factor productivity. This study added that investment must be within opportunity areas in the region and have the potential to create and increase output growth. Further, it must a maximise returns and stimulate more growth for other regions to benefit.

From a South African perspective, Perkins et al., (2005) analysed economic infrastructure investment. A database covering transport and telecommunications was designed and F-tests were conducted to check the directions of association between the two variables. The results indicated a long-run forcing relationship that passes both directions between economic infrastructure and economic growth. This implies that infrastructure investment must increase as it promotes output growth opportunities. The authors added that, there is always a need to invest, thus infrastructure maintenance and expansion is important for economic growth stimulus.

Kularathe (2006) examined social and economic infrastructure on economic growth . This study employed a Johansen test for cointegration and a Vector Error Correction Model (VECM) to check whether a long-run relationship exists between the variables. Further,a Pesaran, Shin and Smith (PSS) F-test was conducted to check the direction of the association between the social and economic infrastructure on output growth. The results indicated a positive association between the variables of interest and that social and economic infrastructure have a significant effect on gross value added (GVA). This implies that spending on health and education increases the economic growth rate by creating a healthy and educated population, which eventually increases factor productivity and social welfare benefits (Kularathe, 2006).

Fedderke and Garlick (2008) argued that investment in economic infrastructure drives economic growth. The authors stated that economic theory identifies five channels through which infrastructure can positively impact economic growth: (i) as a factor of production, (ii) as a complement to other inputs in the production process, in the sense that it may lower or increase production costs, (iii) as a motivating factor for human capital development ,(iv) increasing aggregate demand during construction and maintenance periods and(v) serving as a tool to guide industrial policy.

Kumo (2012) conducted a Granger-Causality analysis between investment in infrastructure and economic growth. The empirical findings revealed a strong inverse relationship between economic infrastructure investment and output growth. These findings suggested that long-run growth is driven by investment, while growth stimulates infrastructure investments. Further, the author accessed the causality results for cointegration using autoregressive distributed lag (ARDL) to see if there were any short-run or long-run relationships between the variables of interest (Kumo, 2012). The results showed that economic infrastructure investment and growth have a long-run steady-state equilibrium relationship. This is similar to the neoclassical model, which also notes steady-state long-run equilibrium but contends that output growth is determined by labour growth rather than investment to GDP.

Sharma and Tenyane (2019) used data from the South African Reserve Bank (SARB)from 1960 through 2017 to measure infrastructure investment from a public sector perspective. The endogenous growth model was used to capture how thegovernment affects output per capita in the economy endogenously. Further, a Granger-Causality test was conducted to determine whether infrastructure investment Granger causes economic growth in South Africa, as well as the direction of the causal relationship. The results revealed a unidirectional relationship between the variables of interest. Furthermore the causal relationship runs from public infrastructure investment to per capita growth. Infrastructure investment was found to be significant in the regression, implying that it has an effect on output growth. Regarding the structural break in 1994, the researchers included dummy variables in the regression to see if it affected the interpretation of the results. Nonetheless, no significant differences in the results of the two variables were observed. According to Sharma and Tenyane (2019), their paper can be used to measure economic infrastructure investment, particularly in developing countries.

Gnade et al., (2017) used panel data from 1996 to 2012 to examine the effect of infrastructure (basic and social) on economic growth and development in urban and rural municipalities. For regression estimates, a synthetic index of both basic and social infrastructures was created using principal component analysis (PCA). The authors used estimation methods for economic and social development functions as they were limited to Least Square Dummy Variables (LSDV). Further, the empirical results on elasticities were employed to test the statistical significance of the differences between urban and rural municipalities. As a result, the findings revealed that the elasticities of infrastructure investment are more visible for output growth in rural areas than in urban municipalities. In conclusion, the authors stated that their findings could help in the development of a policy framework regarding infrastructure investment in rural municipalities in order to increase economic growth and development in these areas, thereby decreasing spatial inequalities in South Africa.

2.4.2 Conclusion

The studies discussed above, from both an international and domestic perspective, conclude that there is a positive association between infrastructure investment and economic growth. This implies that infrastructure is pivotal for growth in countries. Different empirical theories and econometric models were employed in the analysis of these studies. However, since this study focuses on the relationship between transport infrastructure and economic growth the research gaps between the empirical studies discussed above will not be reviewed thoroughly. In the next section, this study discusses empirical literature on the interplay between transport infrastructure investment and economic growth looking at both international and domestic perspectives while identifying the research gap.

2.3.4 Transport Infrastructure Investment and Economic Growth

The relationship between transport infrastructure and economic growth is a growing phenomenon. Globally, several papers have investigated the association between the variables. For instance, Lebo and Shelling (2001) argued that rural transport infrastructure is important but insufficient for development. Therefore, it should exist with additional building blocks of rural development such as water and energy, production activities, and socioeconomic services. Further, a holistic understanding of rural and access mobility is required. Furthermore, specific rural transport policies are required to effectively use and target resources.

Fan and Chan-Kang (2005) investigated the contribution of public infrastructure to growth and poverty reduction in China, focusing on roads. One of the key findings was that low-quality rural roads have benefit/cost ratios that are four times higher than high-quality roads in terms of national GDP. In terms of urban GDP, low-quality roads have a much higher benefit/cost ratio than high-quality roads. Furthermore, high-quality roads have no statistically significant effect on agricultural GDP, whereas low-quality roads produce 1.57 yuan of GDP for every yuan invested. The authors added that investment in low-quality roads generates high returns in rural non farm GDP. Nonetheless, rural roads have received less attention than urban roads, despite the fact that their marginal returns are greater than those of high- quality urban roads.

Badalyan et al. (2014) used cross-country panel data from Armenia, Georgia, and Turkey from 1982 to 2010 to examine the relationship between transportation infrastructure (rail and road) and economic growth. To investigate the impact of transportation infrastructure on output growth, panel cointegration and panel causality analysis were used. The results showed that the model has more than one cointegrating vector, implying that it is stationary in more than one direction. Further, there is bidirectional causality between the variables. The authors argued that infrastructure investment can benefit countries significantly, implying that in order to achieve sustainable growth and development, an emphasis on infrastructure quality is required.

Ng et al. (2018) investigated the economic impact of road infrastructure development from 1980 to 2010 using a fixed effects panel linear regression. The authors argued that road infrastructure alone is insufficient to achieve long-term growth. As a result, this study examined the impact of infrastructure and other socioeconomic factors that contribute to output growth, such as exports, education, capital stock, and urbanisation. The findings demonstrated that improvements in road infrastructure, exports, education, and capital stock have a significant impact on output growth. However, urbanisation and infrastructure development have an inverted U-shape relationship in which increased urbanisation reduces growth and decreased urbanisation leads to sustainable growth. This implies that, in order to sustain higher economic growth, road infrastructure and social development policies should be implemented concurrently.

In contrast to the findings presented above, Kayode et al., (2013) conducted an empirical analysis of transport infrastructure investment and economic growth in Nigeria using a time series analysis from 1977 to 2009. The paper examined transportation investment from the perspective of public sector growth. The study's model was based on Endogenous Growth Theory. Further, an Ordinary Least Squares (OLS) estimation was used. According to the study's findings, transportation plays a minor role in determining Nigeria's output growth. However, because of the positive relationship between transportation and economic growth, more investment is recommended. In conclusion the study added that these investments would improve the transportation system and thus its role in the economic growth process.

From a South African perspective, Cheteni (2013) examined how investment in transportation infrastructure and transportation sector productivity affect economic growth using a time series analysis from 1975 to 2011. As empirical tools, the study used a Vector Error Correction Model (VECM) and a Bayesian Vector Autoregressive (BVAR) Model. Endogenous variables in this study include Gross Domestic Product (Y), Multifactor Productivity (MFP), Real Effective Exchange Rate (REER), Inflation (INF), and Real Domestic Transport Fixed Investments (RGDI), which were calculated using the Vector Autoregressive (VAR) model. The VECM results showed INF,RDGI, and REER output growth. However, the BVAR results illustrated that growth in the second period is influenced by INF, RGDI, MFP, REER, and Y. In conclusion, the author argued that the government should increase investment while keeping inflation low in order to stimulate growth and productivity through infrastructure investments. This implies that while investment is important for growth, it must be implemented well so that the inflation rate does not spike, which consequently is not good for growth.

Mayekiso (2015) used a time series analysis from 1982 to 2012 to examine the impact of transportation infrastructure investment on unemployment Unemployment (Ue) was used as a dependent variable explained by movements in transport infrastructure investment (Tii), real gross domestic product (RGDP), the real exchange rate (RExch), real interest rate (Ri), openness (OPEN) and total infrastructure minus transport infrastructure investment (TT-Tii). Further both the VAR and VECM were employed after checking the stationarity of the series to separate the short and long-run effects. According to the study's findings, Tii and Ue have an inverse relationship, which implies that when one increases, the other decreases. Furthermore, the author added that investment in transportation infrastructure is a valuable tool for growth, and; thus, the government should increase infrastructure spending in order to reduce unemployment in South Africa.

Moeketsi (2017) used a time series analysis from 1960 to 2013 to examine the relationship between road infrastructure investment and economic growth, along with ICT investments and labour inputs. The VAR model was used to interpret andforecast series data, as well as for dynamic shocks in variables. The empirical model was developed from the Cobb-Douglas production function. The findings revealed that the variables of interest have a positive relationship with growth, implying that more investment in road infrastructure, ICT, and labour inputs are required to boost economic growth in South Africa.

In a similar study, Hlotywa and Ndaguba (2017) used a time series analysis to investigate the relationship between road infrastructure investment and economic development from 1990 to 2014. The endogenous growth theory was used to develop the empirical model for this study, in which road infrastructure investment was incorporated into the production process. Furthermore, economic development (ED) was used as a dependent variable explained by movements in road infrastructure investment (ROTI), government expenditure on road transport (GENOT) and Income (I). Before performing cointegration tests, stationarity tests were performed at all levels for the variables under consideration. After stationarity was confirmed the Johansen (1988) cointegration test was conducted to check for cointegration among variables. Once cointegration was confirmed, a VECM was employed to analyse short-run and long-run interactions between the variables. In closing, the authors add that a link exists between ROTI and ED thus, implying that road transport investment is pivotal to economic development in South Africa.

Ross and Townshend (2018) examined the significance of a road investment policy. The authors argued that road infrastructure spending contributes to economic growth as a factor of production. Further, investment in road infrastructure improves road service reliability, reducing the need for users to invest in substitutes due to road interruptions. Inadequate investment, on the other hand, may push private investment, resulting in higher operational costs and crowding out of private sector capital. This paper used an economic growth theory function to investigate the role of road infrastructure investment in the growth process. Furthermore, to emphasize the importance of a sound road policy, national development policies, South Africa's geographic structure, distance to basic services, and, finally, rural-urban migration were all considered.

In addition, authors argued that investing in road infrastructure reduces access constraints and increases output through a more skilled and healthier workforce. According to Ross and Townshend (2018), citizens migrate from rural areas due to insufficient income, job opportunities, and connectivity. Further, the authors added that the extent to which road infrastructure investment positively impacts output growth is determined by the investment's efficiency. Moreover, road sector policies should be linked to addressing the fundamental rights of citizens, which promotes human development and economic growth. Finally, road infrastructure is critical for addressing structural changes that have contributed to South Africa's underdevelopment.

From a slightly unique perspective, Selamolela (2018) used a time-series analysis from 1970 to 2015 to examine the effect of transportation infrastructure on economic growth. This study's empirical model was influenced by neoclassical growth theory. This model's dependent variable is South Africa's GDP growth (GDPGSA). This is defined by gross domestic fixed capital formation in South Africa (GDFCFSA), which is used as a proxy for investment, transport infrastructure in South Africa (TINFSA), which includes railways, roads, airways, and ports, and finally, transport infrastructure performance (PFTISA) (% of commercial services). A Granger- Causality test based on a VAR model was applied, and a VECM was to detect the short and long-run equilibrium relationships between variables. The findings revealed that GDP growth was the underlying cause of GDFC. This result is consistent with previous research on GDP and GDFC.However, unlike other studies, this study showed a unidirectional causality between the variables.

Matsolo (2021) used a time-series analysis from 2001 to 2019 to investigate how transport infrastructure investment influences economic growth. A general econometric model was used, with real gross domestic product (RGDP) as a dependent variable explained by changes in employment (EMPL), openness to trade (OPENT), real exchange rate (RExch), capital expenditure (CE), and transport infrastructure investment (TII). For the series that was not in % form, a natural log was used. Further, for testing stationarity, the Augmented Dickey-Fuller unit root test (ADF), Phillips-Perron (PP), DF-GLS, and KPSS tests were performed. Furthermore, the autoregressive distributed lag model (ARDL) was used to test the relationship between variables. According to the findings, transportation infrastructure investment has a positive impact on economic growth. In conclusion the author argued that transportation infrastructure coverage is still a major concern in South Africa. As a result, the government must address coverage issues in order to boost economic growth and living standards by increasing transportation infrastructure funding.

Hanyurwumutima and Gumede (2021) used panel data analysis to examine the impact of public transportation investment on the economic growth of metropolitan cities from 2003 to 2017.This study adopted a neoclassical growth model to define the econometric model. Output growth(Y) for each metro was employed as the dependent variable explained by a movement in public transport expenditure (PTE), social infrastructure expenditure (S), the interaction between S* PTE, capital (K), labour (L), and inflation rate (INF). These variables were presented in logarithmic form. Further, the one-way error component model was used as the study disaggregated data. This panel regression model followed the individual effect of cross-units. Further, a time series analysis ADRL was employed for each metro. The results indicated that in metros with huge populations, public transport expenditure did not affect growth significantly. However, if combined with social infrastructure expenditure it affects growth remarkably. Nonetheless, in small metros both public transport expenditure and social infrastructure impacted growthsignificantly whether combined or not.

2.4.4 Research Gap

The studies reviewed above, both from an international and domestic perspective, conclude that transport infrastructure has a positive and significant effect on growth in a country. Various theories were employed to build econometric models and different methodologies were applied. Despite the variety in the literature, however, from a South African perspective, no assessment has been conducted on transport infrastructure underdevelopment in rural areas.

Internationally Fan and Chang (2005) conducted a study on how public infrastructure affects growth and reduces poverty in China. This study concluded that rural roads have a higher benefits/costs ratio in terms of GDP when compared to urban roads. Moreover, rural road investment has greater returns. However, these areas have been neglected. The findings were consistent with the idea that investment in rural roads alleviates poverty. Further, this is similar with the aim of this study which is to examine the relationship between transport infrastructure and output growth within rural nodal district municipalities in South Africa. Studies by Cheteni (2013), Mayekiso (2015), Hlotywa and Ndaguba (2017), Ross and Townshend (2018),Selamolela (2018) and Matsolo (2021) were limited in the sense that they have only conducted national analysis on their studies. This might not apply to all areas most especially in rural areas where there is still limited infrastructure, access to basic services (education and health), and economic hubs. The problem of whether transport infrastructure investment impacts output growth in rural nodal district municipalities exists. Empirical studies by Ng et al. (2018), along with Hanyurwumutima and Gumede (2021), illustrated that transport infrastructure alone does not affect growth significantly however, it must be combined with socioeconomic factors to have a great impact.

2.5 Conclusion

This chapter began by discussing the conceptual and theoretical frameworks of the study. It highlighted transport infrastructure, rural areas, rural transport infrastructure, and transport infrastructure investment. Further, the theoretical review discussed three economic growth and economic development theories such as the Harrod-Domar, neoclassical Model and the endogenous growth theory.

The empirical framework section was divided into two sections: the relationship between infrastructure investment and economic growth at then, and the relationship between transportation infrastructure investment and economic growth.

For the first subsection, studies from both an international and domestic perspective were discussed. Further, these studies concluded that there is a positive relationship between investment in infrastructure and growth. Furthermore, the relationship between transport infrastructure investment and economic growth was discussed. Similarly, studies from both an international and domestic perspective were examined. Most of these studies concluded that there is a positive association between transport infrastructure investment and output growth, implying. that the other has a significant impact on the other; i.e. investment in transport infrastructure causing growth. Kayode et al. (2013) concluded that transportation has a minimal effect on output growth. Moreover, Ng et al. (2018) and Hanyurwumutima and Gumede (2021) discovered that transportation infrastructure alone does not produce growth. As a result, it must be combined with socioeconomic factors to have a significant positive impact on economic growth. The following chapter discusses the methodology that is employed in this study.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

The methodology used to investigate the relationship between transportation infrastructure investment and output growth within rural nodal district municipalities in South Africa is presented in this chapter. Wilkinson (2000) ascertained that research methodology is the distinct technique employed to find, choose, process, and analyse data on a subject. This section enables the reader to critically evaluate a study's overall validity and reliability. Furthermore, the methodology section tackles the collection and generation of data as well as the analysis.

Section 3.2 of this chapter discusses the research approach, followed by section 3.3 which examines panel data analysis which is considered in this study. Section 3.4 explores the model specification applied in this dissertation and section 3.5 examines the variables employed in this study. Section 3.6 discusses the data analysis technique used and section 3.7 examines the model estimation methods employed which comprises of Panel Unit root tests: Fisher-type: ADF and PP tests, Panel Cointegration: Pedroni tests (1999), Panel VAR and Panel VECM and lastly the Panel Granger-Causality test.

3.2 Research Approach

This study employs a quantitative research method. to Creswell (2012) ascertained that quantitative methods consist of the collection, analysis, and interpretation of a study's results. This research method also observes and quantifies data using statistical techniques. According to Grover (2015), quantitative research is a technique for testing objective theories by examining the relationships between variables. Further, because these variables are typically instrumental, numbered data can be analysed using statistical techniques. Bhattacharjee (2012) asserted that quantitative research can be analysed using a tool called descriptive statistics and variable constructs can be described, aggregated, and presented statistically with this tool. Hence, the relationship between transportation infrastructure investment and output growth in rural nodal district municipalities is tested by employing this tool and the test is conducted using STATA 17.

3.3 Panel Data Analysis

Baltagi (2013) argued that panel data is the accumulation of observations on a sample of households, countries, firms, and so on, over time. Hsiao (2003) ascertained that in panel data households, countries, and firms are different. This suggests that in panel analysis there is a time series for each cross-sectional unit in the data (Wooldridge,2012). The author added that panel data has two types of variation, which are between and within the cross-sectional units. Therefore, this indicates that individuals, firms, and countries have distinctive characteristics and behave differently. Further, the within variation implies that the same cross- sectional units may change their characteristics and behave differently over time.

Panel data analysis has several advantages, including the ability to control individual heterogeneity (Baltagi, 2013). Moreover, Baltagi (2013) ascertained that both time- series and cross-sectional data do not account for this type of heterogeneity, thus, they risk producing biased results. Additionally, the Baltagi (2013) argued that panelsprovide:

- More informative data.
- More significant variability.
- Less collinearity among variables.
- Greater degrees of freedom.
- Greater efficiency.

Similarly, Hsiao (2014) ascertained that panel data analysis has different major advantages over time-series and cross-sectional unit analysis. Further, the author noted that economic behaviour is naturally dynamic due to institutional and technology rigidities however, panel data uncovers dynamic relationships. Whereas, in a cross-sectional data set micro dynamic and macro-dynamic impacts cannot be estimated (Hsiao,2014). Similarly, in a single time-series dataset, good estimates of dynamic coefficients cannot be provided either (Hsiao,2003). In addition, panel datasets control the impact of omitted variables and are better suited for identifying and measuring effects that cannot be captured in pure time series or cross-sectional data (Hsiao, 2003). Furthermore, panel data models enable the development and testing of more complex behavioural models than pure cross-sectional or time–series data. As a result, this dissertation considers panel data analysis. This data analysis most suitable for this study as it allows control for heterogeneity across rural nodal district municipalities.

3.4 Model Specification

An econometric technique is used in this study to investigate the relationship between transport infrastructure investment and output growth. Based on the theoretical framework discussed earlier, this model considers an Endogenous Growth Theory hence it is specified as follows

$\Delta Y = \theta X \Delta\, k/k + (1-\theta) X \Delta\, A/A$ (3.1). (Dornbusch et al., 2011)

. $\Delta Y = Output\ growth$

$\theta X \Delta\, k/k = capital\ growth.$

$(1-\theta) X \Delta\, A/A = techology\ growth$

To test for elasticity and to reduce variance and fluctuations in the data, Equation 3.1 is transformed into a logarithmic form. As a result, the econometric model can be applied as follows:

$$ln\Delta Y_{it} = \beta_0 + \beta_1 lnTE_{it} + \beta_2 lnSIE_{it} + \beta_3 lnTE_{it} * lnSIE_{it} + \beta_4 lnL_{it} + \beta_5 lnY_{t-1} + \varepsilon_{it}$$

(3.2.)

$ln\Delta Y_{it}$= Output growth by each rural nodal district municipality.

$lnTE_{it}$= transport expenditure in each rural nodal district municipality.

$lnTE_{it}$= social investment expenditure in each rural nodal district municipality.

$lnTE_{it} * lnSIE_{it} ==$ the interaction of transport expenditure and social investment expenditure in each rural nodal district municipality.

lnL_{it}= labour employed in each rural nodal district municipality.

lnY_{t-1}= lagged value of dependent variable.

3.5 Data and Variables

The variables used in this study are described in this section. All data and variables are obtained from secondary data sources and are publicly available from the Department of Cooperative Governance and Traditional Affairs, National Treasury on Local Government, and Statistics SA (Stats SA), for the period 2012-2019. Moreover, the data derived is annual during the sample period which is large enough to get accurate results. Additionally, seven rural nodes including John Taolo Gaetsewe, Alfred Nzo, Joe Gqabi, Zululand, Ehlanzeni, Greater Sekhukhune, and Mopani were excluded due to missing data. **Table 3.1** provides a description of the variables.

Table 3.1: Description of The Study Variables

Variable	Code	Description	Measurement	Data Source
Log of output growth in rural nodal district municipalities (i in period (t).	$ln\Delta Y_{it}$	The gross domestic product (GDP) contribution of each rural nodal district municipality to the national GDP. This is the dependent variable of the regression model.	In million Rands.	Department of Cooperative Governance and Traditional Affairs.
Log of transport expenditure in rural nodal district municipalities (i in period (t).	$lnTE_{it}$	This variable was employed as a proxy variable for transportation infrastructure investment. It is the transport expenditure of each rural nodal district municipality on infrastructure. This was also used in Hanyurwumutima and Gumede (2021).	In thousand Rands.	National Treasury on Local Government.
Log of social investment expenditure in rural nodal district municipalities (i in period (t).	$lnSIE_{it}$	Jimenez (1995) ascertains that, any infrastructure does not exist for its own sake however to support different economic activities such as: education, health, and business activities which are significant in shifting output growth. Thus, this variable capture expenditure on socio-	In thousand Rands.	National Treasury on Local Government and Department of Cooperative Governance and Traditional Affairs.

		economic factors such as education, health and gross value added (GVA) by business activities across economic sectors: primary, secondary, and tertiary by rural nodal district municipality.		
Log of the interactions of transport expenditure and social investment expenditure in rural nodal district municipalities (i in period (t).	$lnTE_{it} * lnSIE_{it}$	This variable is created to check whether an additional combination of these two variables will add significantly on output growth. Morgenroth (2014) argues that transportation infrastructure alone is not enough to impact growth, therefore socioeconomic factors must be added. In conclusion, it is noted that it is not transport infrastructure solely that yields growth however its usage as it enables improved and efficient access.	In thousand Rands.	National Treasury on Local Government and Department of Cooperative Governance and Traditional Affairs.
Log of labour in rural nodal district municipalities (i in period (t).	lnL_{it}	Labour is one of the important shifters of output growth. Therefore, this variable captures the total labour employed in each rural nodal district municipality.	In thousand Rands.	Statistics South Africa.

Source: Author's compilation.

The total observations employed for this panel regression is 88. Additionally, the data in each rural nodal district municipality has eight years of observations. The data collected was extracted and converted into Excel formation and then imported into the STATA 17 and EViews 10 programs.

3.6 Data Analysis

This study examines how investment in transportation infrastructure affects the output growth of rural nodal district municipalities in South Africa. Numerous studies have tackled this association both globally and domestically, which has seen varied methods explored. These methods include double-log functional forms for all equations (Fan and Chang-Kan,2004), OLS estimation technique (Kayode et al., 2013), Granger-Causality with dynamic ECM (Mohmand,2016), VECM (Hlotywa and Ndaguba, 2017), Granger-Causality with VAR (Selomolela,2018), VECM and BAR(Cheteni,2013), VAR and VECM (Mayekiso,2015), ARDL (Matsolo,2021), one- way error component (Hanyurwumutima and Gumede,2021) and lastly, VAR (Moeketsi,2017). All these methods have their positives and shortfalls which is why this dissertation explores the Granger-Causality test with a Panel VECM to examine the dynamic impact between the variables of interest. The primary difference is that the analysis will be conducted across rural nodal district municipalities rather than pooling the data.

3.7 Model Estimation

3.7.1 Panel Unit Root

Unit root tests must be performed to ensure the validity of VAR modelling. The Dickey-Fuller (DF), Augmented Dickey-Fuller (ADF) (Dickey and Fuller, 1981), and Phillips-Perron (PP) (1998) are three commonly used unit root tests. Nonetheless, these unit root tests are affected by whether deterministic characteristics are present in the regression equation (Barbieri, 2006). Further, in small sample sizes, these tests have little power to distinguish the unit root from a single time series with extremely persistent deviations from the equilibrium unit root-based tests. The different null hypothesis tested in this case could explain why standard unit roots performed poorly in the panel framework (Barbieri,2006). Thus, the following simplified model is considered:

$\Delta y_{it} = \rho_i y_{it-1} + \mu_{it} i = 1,2 \ldots\ldots Nt = 1,2, \ldots\ldots T$ (3.3)In this equation: H_0:ρ_i=0

H_A:ρ_i < 0 (3.4)

However, in the panel data analysis the hypothesis of interest is:

H_0:ρ_i =0

H_A:$\rho_i < 0$ for $i = 1,2 \ldots\ldots N$ (3.5).

According to Baltagi and Kao (2000:1), in a large panel framework, “non-stationary panel data econometrics hopes to combine both methods of dealing with non-stationarity from time series and increased data and power from the cross section”. Further, the Baltagi and Kao (2000) added, unlike time series unit root testing, which is widely used and essential in econometrics, panel unit root testing is new. Atmadja (2005) ascertained that the objective of unit root tests is to examine whethera panel contains a unit root. Moreover, if a panel contains a unit root, it implies that the panel is non-stationary. If not, the panel will be stationary. Stock and Watson (1989) argued that many economic variables are non-stationary. This implies that the properties of the mentioned variables change over time.

Panel unit root testing has evolved through two generations. The first generation of these tests include: Levin, Lin, and Chu (2002), Im Pesaran and Shin (2003) and Fisher-type tests (ADF and PP) suggested by Maddala and Wu (1999). These unit root tests assume that data is independent and distributed identically (Barbieri, 2006). In addition, these tests are based on the following univariate regression:

Where:

$\Delta y_{it} = \rho_i y_{it-1} + \zeta_{it}{}'\gamma + \mu_{it}$

(3.6)

$i = 1,2 \ldots\ldots N$ is the individual who for each.

$t = 1,2, \ldots\ldots T$ time series observations available.

$\zeta_{it}{}'$= the deterministic component.

μ_{it}=stationary process.

For this study, Fisher-ADF and Fisher-PP (Maddala and Wu, 1999) are considered. The IPS test assumes is constant for all , while the Fisher-ADF test does not need a balanced panel. Further, unlike both IPS and LLC which are primarily based on the ADF, the Fisher type tests can accommodate various unit root tests. In addition, these tests can accommodate heterogeneity across cross-sections-different ’s. Furthermore, Fisher type tests can be adapted for less restrictive assumptions about cross-correlations but they require Monte Carlo simulation based -values.

Therefore, the null hypothesis and alternative hypotheses are defined similarly to IPS:

H_0: ρ_i =0 $\forall_i$ each series in the panel has a unit root.

H_A: ρ_i< 0 some but not all individual series have a unit root. (3.7).

Maddala and Wu (1999) suggested a Fisher (1932) based test combining information on the ρ-values unit root test. Therefore, this test is built around repeated observations on ρ-values .

$$P = -2\sum_{i=1}^{N} lnp_i \, \chi^2_{2N}$$

(3.8)

p_i = ρ-value for the unit root test performed on.

One of the advantages of this test is that it is independent of asymptotics for distributions. Nonetheless, given -ρ values, the test is simple, however finding - ρvalues may be difficult as they require stimulation after testing. Regarding $\longrightarrow \infty$ for small N, test statistic P is distributedχ^2_{2N}, thus rejecting the null of non-stationarity

if$P$ >P_{crit}, or $< 0.0.5$.

Further, the number of observations in a series can vary because regressions are run separately for each series and their -values are combined in the test statistics. For χ^{22} distribution the assumption of cross-sectional independence is crucial. (Brooks, 2019).

3.7.2 Panel Cointegration

Following panel unit-root testing confirmation, the next step is to determine whether the two variables have a long-term equilibrium relationship. According to Hlotywa and Ndaguba (2017:4), "cointegration provides a formal framework for testing and estimating short-run and long-run equilibrium relationships between economic variables". This implies that cointegrated variables move together over time, allowing short-run disturbances to be corrected in the long run. In contrast, the absence of cointegration indicates that the variables have no long-run relationship (Hlotywa and Ndaguba, 2017).

Pedroni (1997) argued that it is crucial to check to allow for much heterogeneity across individuals members in the series to ensure the application of any cointegration testing. Therefore, for this study the Pedroni (1999) tests are employed. These tests are most appropriate as they are not based on an assumption of homogeneity of cointegrating vectors among panel individual members (Pedroni, 1999).

3.7.2.1 Pedroni Tests

Pedroni's (1999) framework allows for separate intercepts and deterministic trends for each group of potentially cointegrating variables. For a given t and „t that are individually integrated of order one and thought to be integrated (Brooks, 2019). The following model is considered:

$$y_{it} = \alpha_i + \delta_{it} + \beta_{1i}x_{1i,t} + \beta_{2i}x_{2i,t} + \dots \beta_{Mi}x_{Mi,t} + \mu_{i,t}$$
(3.9)

Where: $m = 1, \dots, M$ = the explanatory variables.

$t = 1, \dots, T \dots, N.$

$\mu_{i,t}$=residuals.

Pedroni also created tests for the null of no cointegration in dynamic panels with multiple regressors (1999). These tests allow for panel heterogeneity in the short and long run dynamics, as well as in the long-run scope and intercept coefficients. Unlike time series analysis, the Pedroni tests do not consider the exact number of cointegration relationships.

Therefore, the following test is considered:

H_0: Each member in the panel, the variables of interest are not cointegrated.

H_A: A single cointegrating vector exists, although it does not need to be the same for each member.

Pedroni tests use a variety of methods; however, only three are used in this dissertation: the modified Phillips-Perron t, the Phillips-Perron, and the Augmented Dickey-Fuller t. These tests are more concerned with calculating approximate critical values for tests where they are interested in the simple null hypothesis of no cointegration vs cointegration rather than issues concerning the number of cointegrating relationships (Pedroni, 1999).

Further, under the alternative hypothesis, the Pedroni (1999) tests allow for significant heterogeneity in the long-run cointegrating vectors and the dynamics associated with deviations from these cointegrating vectors. This is regarded as an important aspect of the test. Because cointegrating vectors are unlikely to be purely homogeneous in panels, falsely imposing homogeneity of the cointegrating vectors in the regression would imply that the null hypothesis would not be rejected even if variables were cointegrated (Pedroni, 1999).

3.7.3 Panel VAR

Ampountolas (2019) argued that the VAR is a dynamic system of equations whereupon each variable is dependent on its past movements and that of all other variables in the system. This implies that in the VAR model, a variable's lagged values and lagged values of other variables included in the model along with the error term form part of the equation. Ampountolas (2019) stated that the basic VAR model with k lags is specified as follows:

$y_t = (y_{1t}, \ldots y_{kt}, \ldots y_{Kt})$ for k =1, ... K (3.10)

The VAR(p) process is then defined as:

$y_t = A1y_{t-1} + \cdots + A_P y_{t-p} + \mu_t$ for k =1... K (3.11)

Where :

A_i= (K XK)Coefficient matrices to be predicted for $= 1,\ldots$

p = lag length

u_t= the white noise error term.

Holtz-Eakin et al., (1988) formulated a set of procedures for estimating and testing Vector Autoregressive (VAR) with panel data. Further, panel VARs (Vector Autoregressive) are built similarly to standard VARs however incorporate a cross- sectional aspect. These features make them a powerful technique that is of interest in tackling policy questions (Canova and Ciccarelli,2013). $y_t$is a stacked version of Ty_{it} $i = 1$. This index$i$ is general and could indicate municipalities. Therefore, a panel VAR is:

y_{it}=$A_{i1}y_{1,t-1} + \cdots + A_{ii}y_{i,t-1} + \cdots + A \quad y_{N,t-1} + \mu_{it}$ (3.12)

In addition, instead of having two variables, a panel VAR can be expanded to include other variables (Brooks, 2019). This model can be extended to a case where it includes first differences and cointegrating relationships, i.e. the vector error correction model (VECM).

3.7.4 Panel VECM

If cointegration exists among panel variables the VAR form is not convenient thereby parameterisations supporting the analysis of a cointegrated structure must be applied (Suharson et al., (2007). Further, the authors added that a panel VECM is a restricted panel VAR imposed when there is the existence of cointegrated non- stationary data forms. Similarly, Warsono et al., (2020) argued that a panel VECM forms part of the panel VAR model which is designed for non-stationary panel data with cointegrating relations among variables. Jalil and Ma (2008) argued that a panel VECM integrates short-run changes with the long-run equilibrium without data loss. In a similar vein, Ang and McKibbin (2007) added that a panel VECM is constructed to present information lost during differencing. This enables short-rundynamics and long-run equilibrium relationships.

Further, Warsono et al., (2020)argued that a panel VECM describes the relationship between exogenous and endogenous variables but also among endogenous variables. Furthermore, this error correction model explains the impact of a variable by using the Granger-Causality test. Thus, the dynamic panel VECM frame describes the association between transportation infrastructure investment and output growth as follows:

$$\Delta lnY_{it} = \beta_0 + \beta_1 \sum_{i=1}^{p} \Delta lnY_{it-1} + \beta_2 \sum_{i=1}^{p} \Delta lnTE_{it-1} + \beta_3 \sum_{i=1}^{p} \Delta lnSIE_{it-1} + \beta_4 \sum_{i=1}^{p} \Delta lnTE * SIE_{it-1} + \beta_5 \sum_{i=1}^{p} \Delta lnL_{it-1} + \beta_6 \sum_{i=1}^{p} \Delta lnY_{it-1} + \lambda_1 ECM_{it-1} + \mu_{1it}$$

(3.13).

$$\Delta lnTE_{it} = \beta_0 + \beta_1 \sum_{i=1}^{p} \Delta lnY_{it-1} + \beta_2 \sum_{i=1}^{p} \Delta lnTE_{it-1} + \beta_3 \sum_{i=1}^{p} \Delta lnSIE_{it-1} + \beta_4 \sum_{i=1}^{p} \Delta lnTE * SIE_{it-1} + \beta_5 \sum_{i=1}^{p} \Delta lnL_{it-1} + \beta_6 \sum_{i=1}^{p} \Delta lnY_{it-1} + \lambda_2 ECM_{it-1} + \mu_{2it}$$

(3.14).

$$\Delta lnSIE_{it} = \beta_0 + \beta_1 \sum_{i=1}^{p} \Delta lnY_{it-1} + \beta_2 \sum_{i=1}^{p} \Delta lnTE_{it-1} + \beta_3 \sum_{i=1}^{p} \Delta lnSIE_{it-1} + \beta_4 \sum_{i=1}^{p} \Delta lnTE * SIE_{it-1} + \beta_5 \sum_{i=1}^{p} \Delta lnL_{it-1} + \beta_6 \sum_{i=1}^{p} \Delta lnY_{it-1} + \lambda_3 ECM_{it-1} + \mu_{3it}$$

(3.15).

$$\Delta lnTE * SIE_{it} = \beta_0 + \beta_1 \sum_{i=1}^{p} \Delta lnY_{it-1} + \beta_2 \sum_{i=1}^{p} \Delta lnTE_{it-1} + \beta_3 \sum_{i=1}^{p} \Delta lnSIE_{it-1} + \beta_4 \sum_{i=1}^{p} \Delta lnTE * SIE_{it-1} + \beta_5 \sum_{i=1}^{p} \Delta lnL_{it-1} + \beta_6 \sum_{i=1}^{p} \Delta lnY_{it-1} + \lambda_4 ECM_{it-1} + \mu_{4it}$$

(3.16).

$$\Delta lnL_{it} = \beta_0 + \beta_1 \sum_{i=1}^{p} \Delta lnY_{it-1} + \beta_2 \sum_{i=1}^{p} \Delta lnTE_{it-1} + \beta_3 \sum_{i=1}^{p} \Delta lnSIE_{it-1} + \beta_4 \sum_{i=1}^{p} \Delta lnTE * SIE_{it-1} + \beta_5 \sum_{i=1}^{p} \Delta lnL_{it-1} + \beta_6 \sum_{i=1}^{p} \Delta lnY_{it-1} + \lambda_5 ECM_{it-1} + \mu_{5it}$$

(3.17).

$$\Delta lnY_{it-1} = \beta_0 + \beta_1 \sum_{i=1}^{p} \Delta lnY_{it-1} + \beta_2 \sum_{i=1}^{p} \Delta lnTE_{it-1} + \beta_3 \sum_{i=1}^{p} \Delta lnSIE_{it-1} + \beta_4 \sum_{i=1}^{p} \Delta lnTE * SIE_{it-1} + \beta_5 \sum_{i=1}^{p} \Delta lnL_{it-1} + \beta_6 \sum_{i=1}^{p} \Delta lnY_{it-1} + \lambda_6 ECM_{it-1} + \mu_{6it}$$

(3.18)

Δ = the first difference of the variables in the model.

β_0= the constant and, 1 , 2 , 3 , 4 , 5 and 6 are coefficients of transport infrastructure investment and output growth variables.

p=the lag length.

λ_i=the speed of adjustment parameter.

ECM_{it-1} = an error correction model, and the lagged value of the residual is obtained from the cointegrating regression of the dependent variable on the regressors. Further, it carries long-run information derived from the long-run cointegrating relationship.

μ_{it}= residuals (stochastic error terms).

3.7.5 Optimal Lag Length Selection

Brooks (2019) stated that the rule of thumb, cross equations systems, and information criterion are three main techniques that can be used to determine the optimal lag length.

The rule of thumbs applies the frequency of the data to select the lag order, therefore

p =12 for monthly, p =5 for daily data, p =4 for quarterly data and p =1 for annual data.However, if a system has many variables, then a value of a big lag length for instance in monthly data would be impracticable. Nonetheless, it is common to employ a random fixed number of lags (1,2, or 3) without conducting further tests. A lower value is the best to adopt a model (Brooks, 2019). Another technique to arrive at is to employ cross-equation systems, that is F-tests, nonetheless, this method is considered incorrect as the test would be applied separately for the set of lags in each equation.

The information criterion is yet another alternative technique. The three common criteria are Akaike Information Criterion (AIC), Schwarz Bayesian Information Criterion (SBIC) and the Hannah-Quinn Information Criterion (HQIC). The SBIC introduces a penalty term to solve problems of likelihood. This penalty term is larger than AIC and HQIC is somewhere in between. The SBIC is reliable, yet it is ineffective.

The AIC, on the other hand, is less reliable but more effective. This suggests that despite having infinite data, the AIC will typically produce a model that is too large ;whereas the SBIC will deliver the correct model order. In addition, the average variation in the chosen model orders will be greater with SBIC than with AIC (Brooks, 2018). Nonetheless, between the two no criterion is superior to the other and these criteria are known to over and underestimate the true lag length (Burns and Stern, 2018). Therefore, taking everything into account, the optimal lag length selected for this study is the rule of thumb. This indicates that for this model =1 given that annual data is employed. In closing, this technique was selected since it has a lower value, therefore, implying a better model.

3.7.6 Panel Granger-Causality

This study employs a panel Granger-Causality test to examine whether transport infrastructure investment influences output growth. Additionally, Foresti (2007) argued that a panel Granger-Causality test can be conducted in three types of situations: (i) in a simple panel Granger-Causality test with two variables and their lags, (ii)In a multivariate test with more than two variables included, (iii) In a VECM framework, where the multivariate model is extended for simultaneity testing all included variables. Granger (1969) proposed that if one variable is the cause of another, knowing the status of the cause at an earlier time can improve the prediction of the effect later, hence this test is a statistical concept of predictability.

Similarly, Konya (2004) argued that in the Granger-Causality test variable $\times$ is said to Granger-cause variable Y if the current value of Y_{it} is conditional on the past values of

$X(x_{it}-1, x_{it}-2, \ldots, x0)$. As a result, history is likely to aid in predicting. Mohmand et al. (2016) noted that the Granger-Causality relationship between $X$and Ycan be unilateral or bilateral if the causation is found in both and concurrently. Moreover, the panel variant of the causal relationship will beX_{it} and Y_{it} where i refers to cross-sectional units and t refers to time. In this study, the Granger-Causality examines the causal link between transportation infrastructure investment and output growth. In addition, it examines whether investing heavily in transport infrastructure leads to higher output growth if the panel of GDP in the past improves when transportation infrastructure lags are considered (Mohmand et al., 2016). Therefore, the panel Granger-Causality test is mathematically written as follows$lnY_{it} = \sum_{i=1}^{k} \beta_i \, lnY_{it-1} + \sum_{i=1}^{k} \varphi_i \, lnTE_{it-1} + \varepsilon_{1it}$ (3.19).

$$lnTE_{it} = \sum_{i=1}^{k} \beta_i \, lnTE_{it-1} + \sum_{i=1}^{k} \alpha_i \, lnY_{it-1} + \varepsilon_{2it} \quad (3.20)$$

lnY_{it}= the logarithmic of output growth.

$lnTE_{it}$= the logarithmic of transport expenditure.

ε_{1it} andε_{2it} = the error terms.

k= the optimal lag length.

Bruns and Sterns (2018) argue that Granger Causality is sensitive to lag length. This implies that the Granger-Causality is attentive to the number of included lags. In closing, there are four practicable outcomes expected from this test:

1. lnY_{it} granger causes if $lnTE_{it} \sum \alpha \neq 0$and $lnTE_{it}$ causes lnY_{it} if $\sum \varphi \neq 0$

2.Bidirectional causality exists if both lnY_{it} and $lnTE_{it} \sum \alpha \neq 0$ and $\sum \varphi \neq 0$

3.One-way causality from $lnY_{it}$to if $lnTE_{it} \sum \alpha \neq 0$ and $\sum \varphi \neq 0$

4.No causality iflnY_{it} and i$lnTE_{it}$mply that both $\sum \alpha \neq 0$ and $\sum \varphi \neq 0$

3.7 Conclusion

This chapter discussed the methodology that informs the dissertation. It also provided and discussed the methodological steps tackled to examine the impact of transport infrastructure investment and output growth in rural nodal district municipalities within South Africa.

Further, this chapter discussed the research approach and data analysis structure alongside the variables, data sources, and measurements. This chapter also explored the model specification and tests such as, panel unit root tests to check for stationarity, panel cointegration to check for the existence of the long-run equilibrium relationship, and the panel causality to assess the existence and direction of causality between transportation infrastructure investment and output growth. The next chapter details the discussion on data, results. and analysis.

CHAPTER FOUR

DATA RESULTS AND ANALYSIS

4.1 Introduction

This chapter presents an argument about the results estimated by employing the methods discussed in Chapter Three. Mouton (2001) argued that this chapter describes and summarises the main result obtained and the main trends and patterns in the data with reference to the hypotheses. It also draws the discussion together by interpreting the primary findings and highlighting the main results. Section 4.2 presents a summary of descriptive statistics and correlations and section 4.3 stationarity tests to check for unit roots– the methods employed are namely Fisher ADF and Fisher PP. After confirming the stationarity of the panel, the next section checks for the existence of cointegration between variables using Pedroni tests. Section 4.4 presents the results of these tests. Section 4.5 presents and interprets the panel VECM findings. The existence of a causal relationship and its direction between transport infrastructure and output growth are presented in the panel Granger-Causality test results in section 4.6 and section 4.7 provides a summary of the chapter.

4.2 Descriptive Statistics and Correlation

Descriptive statistics is crucial because they summarise the statistical properties of the panel in the model to the extent where some reasoning about the behaviour of the panel can be illustrated at glance (Gashu, 2021). Therefore, prior econometric estimation and descriptive statistics ~~is~~ shown. In addition, correlation is offered to illustrate the strength of the relationship between output growth and transport infrastructure.

Prior to estimation, descriptive statistics variables are used to assess the statistical characteristics of the relevant variables. The strength of a relationship between output growth and transportation infrastructure investment is measured by correlation. **Table 4.1** below shows the summary of descriptive variables.

Statistics	InYit	InTEit	InSIEit	InTEitSIEit	InLit	InYit-1
Mean	22.19318	12.53165	15.50716	3.208776	11.2658	2.633354
Median	22.95	12.82151	15.4816	2.448804	11.68487	3.067782
Maximum	55.44	15.63977	18.52801	6.801089	12.66705	3.995077
Minimum	1.834	5.545611	10.02366	.2557516	4.128359	-1.609438
Std.Dev	14.6863	1.253101	1.550004	2.174249	1.505154	1.078785
Skewness	.2921061	-1.940123	-.9380258	.422299	-3.436498	-1.214092
Kurtosis	2.08823	12.34275	4.599038	1.643787	16.28313	4.405766
Sum	1953	1102.786	1364.63	282.3723	991.3902	231.7352
Observations	88	88	88	88	88	88

Notes: InYit= log of output growth; InTEit= log of transport expenditure; InSIEit= log of social investment expenditure; InTEitSIEit= log of the interactions of transport expenditure and social investment expenditure; InLEit=log of labour and InYit-1=log of the lagged value of dependent variable.

***Source**: Author's own estimates (2022).*

The summary of descriptive statistics in this dissertation is shown in **Table 4.1**. There have been 88 observations. According to the table, all variables do not display greater dispersion from one another because their mean and median appear to spread equally across the sample. However, for the variables of interest output growth and transport infrastructure investment (InYit and InTEit), skewness is zero for the other, while it is negative for another. In both variables, the median is greater than the mean: InYit, median (22.95) and mean (22.1931) while for InTEit, the median (12.82151) and mean (12.53165) which implies that there is a high possibility of outliers in this sample. In addition, InYit has a kurtosis of (2.08823) which is near the expected value of 3 thus implying a normal distribution while InTEit has a kurtosis of (12.34275) which indicates that the dataset has heavier tails a normal distribution. The standard deviation shows that there is some dispersion in all the variables. InYit has a high standard deviation therefore applying that the data is more spread out. On the other hand, InYit-1 displays the lowest standard deviation of (1.078785).

4.2.1 Correlation

Table 4.2: Correlation

	InYit	**InTEit**	**InSIEit**	**InTEitSIEit**	**InLit**	**InYit-1**
InYit	1.0000					
InTEit	0.0041	1.0000				
InSIEit	0.3759	0.1948	1.0000			
InTEitSIEit	0.1517	-0.2577	-0.1692	1.0000		
InLit	0.5716	-0.1345	0.2433	0.1854	1.0000	
InYit-1	0.8736	0.0528	0.3513	0.0723	0.4878	1.0000

Notes: InYit= log of output growth; InTEit= log of transport expenditure; InSIEit= log of social investment expenditure; InTEitSIEit= log of the interactions of transport expenditure and social investment expenditure; InLit=log of labour and InYit-1=log of the lagged value of dependent variable.

***Source**: Author's own estimates (2022).*

Table 4.2 shows correlation among the variables that are included in the model. Shober et al., (2018) argued that correlation is a measure of monotonic association such that as the value of one variable increases so does the value of the other or when as the value of one variable increases, the other variable's value decreases. Regarding the variables of interest InYit and InTEit which is closer to zero (0.0041) this implies that there is low sensitivity of movement between the variables. While InYit and InYit-1 display a meaningful relationship, which is closer to one (0.8736). InLit and InYit also display more sensitivity of movement between the variables.

4.3 Panel Stationarity

The aim of conducting the unit root test was to see if the variables are stationary or not. The hypothesis states that, if each series in the panel has a unit root, the author can reject the null hypothesis and can accept the alternative hypothesis. Further, if some but not all individual series have a unit root, we cannot reject the null hypothesis we accept the null hypothesis. The **tables** below show unit root summary at levels and first differences respectively.

Table 4.3: Unit Root Summary at levels

Reported in Level form.						
Test Type	***InYit***	***InTEit***	***InSIEit***	***InTEitSIEit***	***InLit***	***InYit-1***
Fisher ADF	53.8131 (0.0002)	16.8748 (0.7702)	30.8481 (0.0993)	25.9093 (0.2556)	13.0167 (0.9327)	32.7264 (0.0658)
Fisher PP	54.7132 (0.0001)	55.1049 (0.0001)	40.2098 (0.0102)	35.1632 (0.0373)	50.1163 (0.0006)	81.2874 (0.0000)
P-values are reported in parentheses. All tests include individual effects.						

Notes: InYit= log of output growth; InTEit= log of transport expenditure; InSIEit= log of social investment expenditure; InTEitSIEit= log of the interactions of transport expenditure and social investment expenditure; InLit=log of labour and InYit-1=log of the lagged value of dependent variable. Denotes a rejection of $_0$ at 5% significancelevel.

Source: *Author's own estimates (2022).*

Table 4.4: Unit Root Summary at first differences

First differences.						
Test type	***InYit***	***InTEit***	***InSIEit***	***InTEitSIEit***	***InLit***	***InYit-1***
Fisher ADF	77.6822 (0.0000)	17.6861 (0.7244)	38.5633 (0.0158)	35.7373 (0.0324)	30.4350 (0.1083)	19.4731 (0.6160)
Fisher PP	35.6390 (0.0332)	62.8782 (0.0000)	83.4787 (0.0000)	81.5002 (0.0000)	108.257 (0.0000)	45.1243 (0.0026)

P-values are reported in parentheses. All tests include individual effects.

Notes: lnYit= log of output growth; lnTEit= log of transport expenditure; lnSIEit= log of social investment expenditure; lnTEitSIEit= log of the interactions of transport expenditure and social investment expenditure; lnLit=log of labour and lnYit-1=log of the lagged value of dependent variable. Denotes a rejection of $_0$ at 5% significancelevel.

Source: *Author's own estimates (2022).*

As shown by Fisher ADF and PP tests, output growth does not have a unit root at the 5% significance level at both level form and first differences. While transport infrastructure investment, at level and after first differences the Fisher ADF test indicates that each series in the panel does have a unit root. However, the Fisher PP test illustrates otherwise since at both level and first differences, some but not all the individual series contain a unit root.

The results of social investment expenditure and the interactions of transport expenditure and social investment expenditure are similar, and both variables contain a unit root under the Fisher-ADF at level form, so we do not reject the null hypothesis. Further, at first differences, neither variable has a unit root at the significance level, so we reject the null hypothesis. Under Fisher PP both variables do not have a unit root at the 5% significance level at the level form and first differences; therefore, we reject the null hypothesis that each series in the panel has a unit root.Regarding variables such as labour and the lagged value of the dependent variables, their Fisher ADF results at level and first differences indicate that they do have a unit root at the significance level; therefore, we fail to reject the null hypothesis that each series in the panel has a unit root. While, contrary to these findings, the Fisher PP for the above variables indicates they do not have a unit root at the 5% significance level, at both level and at first differences. For these reasons we ought to reject the null hypothesis that each series in the panel has a unit root and that the panel is non- stationary allowing for some (but not all) individual series to have a unit root. As a result, it is concluded that the panel is stationary.

These results are consistent with Dipendra (2009) who conducted the energy consumption-GDP nexus, panel data evidence for 88 countries. Similarly, this study also used Fisher ADF and Fisher PP along with others to check for stationarity. Both variables at first differences, do not have a unit root thus implying that the panel is stationary and the rejection of the null hypothesis. In a similar vein, Selamolela (2018)concludes that the

GDP variable is stationary and does not have a unit root. This indicates that these results are consistent and similar to the findings of this dissertation. Therefore, since the stationarity of the panel variables has been confirmed, a cointegration test must be conducted to check whether there is a long- run association among variables of interest.

4.4 Panel Cointegration

The purpose of the cointegration test is to check for the existence of a long- equilibrium relationship between the variables. The existence of cointegration indicates a long-run association among economic variables (Pradhan and Bagchi, 2013). Pertaining to this dissertation, the cointegration relationship is examined between output growth, transport expenditure, social investment expenditure, the interactions of transport expenditure and social investment expenditure, labour, and the lagged value of the dependent variable in rural nodal district municipalities within South Africa. The null hypothesis is that for each member in the panel, the variables of interest are not cointegrated whereas the alternative a single cointegrating vector exists, although it does not need to be the same for each member. **Table 4.5** below shows Pedroni Cointegration results between output growth and transport infrastructure investment. This leads to the question of whether there is possible cointegration between the two variables.

Table 4.5: Pedroni Cointegration: output growth and transport infrastructure investment

	STATISTIC	P-VALUE
Modified Phillips-Perron t	2.7499	0.0030
Phillips-Perron t	-2.6627	0.0039
Augmented Dickey Fuller t	-2.7984	0.0026

Denotes a rejection of $_0$ at 5% significance level.

Source: *Author's own estimates (2022).*

Table 4.5 above illustrates that the t -statistic for the Modified Phillips-Perron t(2.7499) is above the critical value (0.05) however the -value (0.0030) is less the 5% significance level; thus, we reject the null hypothesis that each member in the panel, the variables of interest are not cointegrated whereas the alternative a single cointegrating vector exists, although it does not need to be the same for each member. The Phillips-

Perron t (-2.6627) and Augmented Dickey Fuller t (-2.7984) are below the the critical value (0.05) and the -values (0.0039) and (0.0026) respectively are less than the 5% significance. Therefore, we reject the null hypothesis that each member in the panel, the variables of interest are not cointegrated.

All these three tests jointly and significantly reject the null hypothesis and accept the alternative hypothesis that a single cointegrating vector exists (although it does not need to be the same for each member). Therefore, it can be concluded that there is an association in the long-run between output growth and transportation infrastructure investment across all rural nodal district municipalities in South Africa.

These findings are like that of Hlotywa and Ndaguba, (2017) and Selamolela (2018) who conducted similar studies. Hlotywa and Ndaguba (2017) assessed how infrastructure investment on road transport affects economic development while Selamolela (2018) examined how transportation infrastructure investment impacts economic growth. Both studies employed South Africa as a case study area. Most importantly these studies found and conclude that cointegration exists between economic development/growth and investment in transport infrastructure, thus concluding that a long run relationship exists between the two variables which is alike with the results illustrated in **Table 4.5**.

After confirming the existence of cointegration between the two variables of interest, **Table 4.6** below illustrates Pedroni cointegration results between output and all variables included in the model to check whether there is a long-run association among the variables.

Table 4.6: Pedroni Cointegration: output growth and all other variables

	STATISTIC	P-VALUE
Modified Phillips-Perron t	5.5539	0.0000
Phillips-Perron t	-4.7967	0.0000
Augmented Dickey Fuller t	-8.0962	0.0000

Denotes a rejection of $_0$ at 5% significance level. The lag length is automatically selected.

Source: *Author's own estimates (2022).*

As illustrated in **Table 4.6**, the Modified Phillips-Perron t statistic (5.5539) is above the (0.05) critical value. However, the p-value is less than the 5% significance level, so we reject the null hypothesis that each panel member's variables of interest are not cointegrated. The t-statistic for Phillips-Perron t (-4.7967) and Augmented Dickey-Fuller t (-8.0962) is less than the (0.05) critical value, and both p-values (0.0000) and (0.0000) are less than the 5% significance level thus, these two tests jointly and significantly reject the null hypothesis and accept the alternative hypothesis. As a result, a single cointegrating vector exists, though it does not have to be the same for each member. Further, there is a long-run relationship between output growth and across all rural nodal district municipalities.

When both (t-statistic and p-value) results are compared, the long-run association between output growth and all other variables is more significant than the long-run relationship between output growth and transportation infrastructure. The optimal lag length was selected using the rule of thumb, thus implying that $= 1$.A lower lag length is most preferred since it Indicates a better model (Brooks, 2019).

4.5 Panel VECM

The panel vector error correction model detects the long and short-run relationships between the variables and can establish the sources of causation (Selamolela, 2018). In addition, the author argues that this model is an error correction of figures taken from long-run cointegrating relationships further, short-run dynamics are taken through the coefficients $_1$ of the explanatory variables (Selamolela, 2018).

Output growth is considered as the endogenous variable on transport expenditure, social investment expenditure, the interactions of transport infrastructure investment and social investment expenditure, labour, and the lagged value of the dependent variable. For this study, two tests were conducted namely: long-run and short-run causality.

4.5.1 Long-run Causality

Long-run causality is about the significance of the error correction model or speed of adjustment to the equilibrium (ce1), (Granger and Lin, 1995) which if has a negative sign and is significant implies that long- run causality exists from exogenous variables, (transport expenditure, social investment expenditure, the interactions of transport infrastructure investment and social investment expenditure, labour and the lagged value of the dependent variable) to the dependent variable(output growth). Consequently, in this case the coefficient (-.0070153) is negative of error correction term (ce1) and the -value of (0.606) which is not significant. As a result, the decision is that long-run causality does not exist from exogenous variables towards the endogenous variable (output growth). **Table 4.7** below illustrates Long-run Causality results.

Table 4.7: Long-run Causality

	Coefficient	**Std. Error**	**z**	**P.|z|**	**95% confidence interval**
D_Yit _ce1					
L1	-.0070153	.0136111	-0.52	0.606	.019662

D_Yit: conversion of log of output growth in first difference.
ce1: error correction term or speed of adjustment to equilibrium.
Source: *Author's own estimates (2022).*

4.5.1 Short-run Causality

The short-run dynamic relationship between the dependent variable (outgrowth) and the independent variables (transport expenditure, social investment expenditure, the interactions of transport infrastructure investment and social investment expenditure, labour, and the lagged value of the dependent variable) is stated by the null hypothesis: no existence of short-run causality running from the endogenous variable towards the exogenous variables. This was based on the lag length selected in section 3.7.5. **Table 4.8** below shows Short-run Causality results.

Table 4.8: Short-run Causality

Dependent Variable	**Independent Variables**	**Chi2**	**P>chi2**	**-value**
D_Yit	1 D_TEit	.5190791	0.7714	0.728
	1D_SIEit	.8930166	0.6399	0.347
	1D_TEitSIEit	1.417085	0.4924	0.453
	1D_Lit	8.587352	0.0137	0.273

	$_1$D_Yit1	10.62291	0.0049	0.849

Denotes a rejection of $_0$ at 5% significance level.

Source: *Author's own estimates (2022).*

The results illustrated in **Table 4.8** above demonstrate that all probability values are greater than 0.05. This indicates the failure to reject the null hypothesis of no existence of short-run causality running from the endogenous variable (output growth)towards the exogenous variables transport expenditure, social investment expenditure, the interactions of transport infrastructure investment and socialinvestment expenditure, labour, and the lagged value of the dependent variable). Consequently, there is no short-run causality running from the dependent and independent variables.

4.6 Panel Granger-Causality

In the panel Granger-Causality test, variables must be stationary; nonetheless this was confirmed in section 4.3. **Table 4.9** below reveals the causality results between output growth and transport infrastructure investment. The conclusion of the direction of causality is based on probability values(-values). The level of significance is 5%, therefore, if the -value is 0.05 or more then we reject the null hypothesis; but if it is below 0.05 we fail to reject the null hypothesis.

Table 4.9: Panel Granger -Causality

Null hypothesis	Obs	F-statistic	Prob.
YIT does not Granger Cause TEIT	77	0.16386	0.6868
TEIT does not Granger Cause YIT		0.00487	0.9446

YIT: log of output growth and TEIT: log of transport expenditure. Denotes a rejection of H_0: at 5% significance level. After adjustments, the number of observations decreased to 77.

Source: *Author's own estimates (2022).*

4.6.1 Statistical and Economical Interpretation

H_0::Transport infrastructure investment does not cause output growth.

H_A: Transport infrastructure investment does cause output growth.

The probability value is (0.6868) greater than 0.05; therefore, we fail to reject the null hypothesis. This indicates that transport infrastructure investment does not cause output growth.

H_0::Output growth does not cause transport infrastructure investment.

H_A: Output growth does cause transport infrastructure investment.

The p-value of the same null hypothesis illustrated in the table (0.9446) is also greater than 0.05, implying we do not reject the null hypothesis. This indicates that output growth does not cause transport infrastructure investment. Out of the four expected outcomes of causality presented in the methodology section 3.7.6, themost applicable one for these findings is that there is no causality between the two variables which implies that they do not affect one another in any way.

The Granger-Causality revealed that transport infrastructure investment does not cause output growth in rural nodal district municipalities within South Africa. These results differ from previous studies by Kumo (2012), who concluded that there is a strong bidirectional causality between economic growth and transport investment and Selamolela (2018) found a unidirectional relationship between GDP and transport infrastructure investment implying that one causes the other. Differing from the two, Kayode et al., (2013) established that investment in transport does not cause output growth. These results are in line with those of this dissertation, which similarly found that there is no causal relationship between spending on transportation infrastructure and economic growth.

4.7 Conclusion

Descriptive statistics and correlation results were presented, and it was discovered that there is low sensitivity between transport infrastructure investment and output growth.Further, Fisher ADF and Fisher PP were employed to check for the stationarity of the variables in the panel. It was established that variables such as output growth was stationary at both level form and first differences, while transport infrastructure investment for Fisher ADF at level and first differences had a unit root. Nonetheless, Fisher PP at level and first differences illustrated that, some but not all, of the individual series contain a unit root. Regarding other variables in the model, Fisher-ADF at level and at first differences illustrate that they contain a unit root. However, Fisher-PP at both levels and first differences show that they did not have a unit root. Given many of the results, it was concluded that the panel is stationary. The lag length was selected using the rule of thumb. Furthermore, the Pedroni test results indicate that there is a long-run equilibrium relationship between output growth and transport infrastructure investment as well as the other variables. The presence of cointegration indicate that a panel VECM must be employed. Moreover, the panel VECM was used to determine the long-run and short-run effects. The results illustrate that no long-run and short-run causality is running from the dependent variable to the independent variable. In conclusion the panel Granger Causality results indicate that there is no causality between transport infrastructure investment and output growth, and from the latter to the former. This implies that the two variables do not affect one another. The next chapter presents a conclusion and gives the recommendations on the study.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The previous chapter, provided an analysis of the impact of transport infrastructure investment on the output growth of rural nodal district municipalities within South Africa from 2012- 2019 using secondary data. Therefore, this chapter presents a summary of the study chapters and the achievements of the research objectives stated in section 1.3. This chapter also provides recommendations and a proposalfor future research.

5.2 Summary of Study Chapters

This section provides a brief outline of the contents presented in each chapter. Chapter One provided an introduction, a background and context relating to the study and the research problem. In addition, it set out the overall aims and objectives which inform the main and sub-objectives and the research questions and research hypotheses. Finally, it discussed the significance of the study. Chapter Two provided the conceptual framework where keywords relating to the study such as transport infrastructure, rural areas, rural transport infrastructure, and transport infrastructure investment were highlighted. It also discussed the theoretical framework which informs the study and examined the empirical literature. The empirical literature was divided into two themes that were relevant to the study. International and domestic studies were discussed and debated with the gaps in research. Chapter Three outlined the methodological steps employed to examine the impact of investment in transportation infrastructure and output growth in rural nodal district municipalities within South Africa from 2012-2019. Chapter Four presented the data analysis results alongside discussions and interpretations that were informed by the methodological steps discussed in Chapter Three.

5.3 The Achievements of Research Objectives

The primary objective of this study as highlighted in section 1.3 was to examine how investment in transport infrastructure affects the output growth of rural nodal district municipalities in South Africa. Chapter One provided a thorough background as to how the former affects the latter. It highlighted how pivotal investing in transport infrastructure is for a country’s system and how this form of infrastructure investment yields growth in the long-run. Chapter Two gave extensive coverage on concepts and theories, and literature. Section 2.4.3 thoroughly discussed how the two interplay from both an international and domestic perspective and on a national and regional basis. Chapter

Three carried out the methodology to examine the relationship between transport infrastructure investment and output growth in rural nodal district municipalities within South Africa. Chapter Four presented data analysis discussions and interpretations between the association of the two variables. The level of sensitivity between transportation infrastructure investment and output growth was presented and discussed.

Sub-objective one of this dissertation, highlighted in section 1.3, was to examine the relationship between transport infrastructure investment and output growth in rural nodal district municipalities. Section 2.3 highlighted economic growth theories of which one was deemed relevant to examining the association between the variables (section 2.3.3), this Growth Theory states that investments are critical for output growth, and transport infrastructure investment creates opportunities and jobs within a country. Section 2.4.3 provided an extensive literature review where studies from an international and domestic perspective were discussed and debated as well as the research gaps being identified. Most of the studies from both international and domestic literature conclude that there is a positive relationship between transport infrastructure investment and output growth.

Further, some of these studies Ng et al. (2018) and Hanyurwumutima and Gumede (2021) highlighted that, to yield growth transport infrastructure must be combined with other socioeconomic investments. Chapter Three presented the methodologies that were used to investigate the relationship between the two variables. Section 3.7.2 highlighted cointegration tests that were used to check whether there is a long-run equilibrium relationship between transport infrastructure investment and output growth in rural nodal district municipalities within South Africa. Section 4.2.2 highlighted the level of sensitivity between the two variables which was low in this case. Section 4.4 analysed and presented results which stated that there was a long-run equilibrium relationship between transport infrastructure investment and output growth.

Sub-objective two of this study, highlighted in section 1.3, was to understand the causality between transport infrastructure investment and output growth of rural nodal district municipalities. Section 3.7.2 highlighted the test (panel Granger-Causality) which was employed to check for causality between the two variables. Section 4.6 presented the results of the test mentioned above and it was found that there is no causality between transport infrastructure investment and output growth, and from the latter to the former. This implies that the two variables do not affect one another. This result was unexpected since previous studies from a South African perspective concluded that causality exists between transport infrastructure investment and output growth. Further, the introduction and background presented in Chapter One looked at how transportation infrastructure promotes growth and how rural nodal districts experience poverty in the absence of adequate infrastructure, among other causes. Finally, improved transportation infrastructure increases mobility, which increases access, resulting in more opportunities andemployment opportunities.

5.4 Recommendations and Proposal for Future Research

Examining how investment in transport infrastructure affects the output growth of rural nodal district municipalities within South Africa exposed interesting results. These results should be taken under consideration in the planning and implementation process of transport and rural development policies in South Africa.

It is suggested that the government should have a greater public investment in transport to contribute significantly to the output growth of rural nodal district municipalities within South Africa. Further, in addition to transportation infrastructure investment, the government should prioritise other social investments as they are important in promoting growth. These recommendations are in line with other studies that show transportation infrastructure alone does not generate growth. As a result, its investments must be prioritised alongside those that lead to infrastructure usage.

Future studies could include the nodal areas that were excluded due to data availability constraints. Further, they could extend the analysis until 2022 to allow for a wider range of data. Rather than collecting data from the sources highlighted in section 3.5, they could potentially add more data sources, such as IHS Markit, which produces readily available data. Future research could take a different approach, focusing on one rural nodal area and implementing a qualitative research approach which may entail conducting interviews to collect more data and improve the knowledge gap, as no previous study has done so for this phenomenon.

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APPENDICES

Masters revision

ORIGINALITY REPORT

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UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

9 Nov 2022

Miss Fatima Mbali Palesa Jili (216026800)
School Of Acc Economics&Fin
Pietermaritzburg

Dear Miss Fatima Mbali Palesa Jili,

Original application number: 00019601
Project title: The impact of transport infrastructure investment on the output growth of rural nodal district municipalities in South Africa.

Exemption from Ethics Review

In response to your application received on 2 Nov 2022 , your school has indicated that the protocol has been granted **EXEMPTION FROM ETHICS REVIEW.**

Any alteration/s to the exempted research protocol, e.g., Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through an amendment/modification prior to its implementation. The original exemption number must be cited.

For any changes that could result in potential risk, an ethics application including the proposed amendments must be submitted to the relevant UKZN Research Ethics Committee. The original exemption number must be cited.

In case you have further queries, please quote the above reference number.

PLEASE NOTE:
Research data should be securely stored in the discipline/department for a period of 5 years.

I take this opportunity of wishing you everything of the best with your study.

Yours sincerely,

[redacted]

Prof Josue Mbonigaba
Academic Leader Research
School Of Acc Economics&Fin