THE IMPACT OF BASIC AND SOCIAL INFRASTRUCTURE INVESTMENT ON INEQUALITY IN SOUTH AFRICA

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JOHAN HENDRIK GNADE

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SUPERVISOR:

PROFESSOR DERICK BLAAUW

CO-SUPERVISOR:

DOCTOR TALITA DALTON-GREYLING

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DECLARATION

I,

JOHAN HENDRIK GNADE,

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is my own work, that all the sources used or quoted have been indicated and acknowledged by means of complete references, and that this research was not previously submitted by me for a degree at another university.

Signature **Date**

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Table of Contents

List of Tables and Figures

Abstract

Basic infrastructure investment and social infrastructure investment have different impacts on economic growth and social development in urban and rural municipalities respectively. Empirical analysis of the impact that basic and social infrastructures have on economic growth and social development in urban and rural municipalities respectively is however largely lacking. Such estimates could be used to influence basic and social infrastructure investment decisions towards correcting inequalities that exist between urban and rural municipalities. A balanced panel dataset containing infrastructure, economic, demographic and social indicators are used to compile synthetic indices for basic and social infrastructure (using principal component analysis) and the analysis. Restricted within the least square dummy variable (LSDV), estimation techniques are used to calculate the respective elasticities and to evaluate if the differences between urban and rural municipalities are statistically significant. The results indicate that basic and social infrastructure have different impacts on economic growth and social development in urban and rural municipalities. The results also indicate that both basic and social infrastructure investment generally have a greater economic growth and social development impact in rural municipalities. The research provides an empirical framework and actionable elasticities for the respective impact that basic and social infrastructure investment have on urban and rural municipalities, which is largely under-researched. Knowing that basic and social infrastructure investment have a greater impact on economic growth and social development in rural municipalities can therefore influence policy and investment decisions towards the reduction of inequalities experienced between urban and rural municipalities.

Keywords: basic and social infrastructure, economic growth, social development, principal component analysis, fixed effects within LSDV, balanced panel data, National Development Plan.

JEL classification: I130, I250, I380, O110, O150, O180, O210, O470, C310, C330, C230, C520

1 Research background

The Bill of Rights in the Constitution of the Republic of South Africa – instituted by the democratically elected government of 1994, promulgated on 10 December 1996, and coming into effect on 4 February 1997 – aimed to ensure a more equal and inclusive economy and social society for its citizens. The newly elected government promised the nation sustainable human settlements where all human activities such as residence, work, education, health, culture and leisure were supported by the required physical structures. Security and bulk transport service responsibilities were assigned to the national government while provinces had to deliver housing, schools and clinics. In turn municipalities were tasked with planning and delivering water, electricity, sanitation and refuse removal services (National Planning Commission, 2011a:19).

The three tiers of government had to plan accordingly to ensure that the basic human rights of the nation's citizens are met and to comply with the Bill of Rights (RSA Constitution, Chapter 2, Section 27.1 (a, b, c)). The Bill of Rights promised that a citizen's ability to access collective goods, such as water, electricity, sanitation and refuse removal (basic infrastructure) in addition to education, health and security (social infrastructure) were ensured irrespective of geographical location, race, gender or income level. Providing equal access to social and basic infrastructure as a basic human right was to ensure that the whole nation could participate equally in the economy and society. The government subsequently formulated and implemented numerous pieces of legislation and policies aimed to promote economic and social transformation.

The Reconstruction and Development Programme (RDP) was adopted in 1994 with its aim to remove poverty and socio-economic inequalities. The RDP was deemed socio-economic in nature, as opposed to an integrated macroeconomic policy (Hanival & Maia, 2010:3). Factors contributing to the failure of the RDP to meet its objectives included funding problems, insufficient capacity of implementing staff and poor coordination between institutions (Hemson, 2004:17; Khosa, 2003:48). The failure of the RDP to remove poverty and socio-economic inequalities resulted in the Growth Employment and Redistribution (GEAR) programme being implemented in 1996.

Being more of a macroeconomic framework, GEAR aimed to target economic stability predominantly through economic growth, national debt and inflation targeting, while still providing basic services for the poor, alleviating poverty and reducing inequality. Hanival and Maia (2010:33) argue that GEAR suffered severe setbacks due to external factors such as the Asian crises in 1998 and the effect of the global instability experienced at the turn of the century. The GEAR programme was subsequently abandoned and replaced by the Accelerated and Shared Growth Initiative of South Africa (ASGISA) in 2006.

ASGISA set out to achieve an economic growth rate deemed necessary to halve poverty and unemployment by 2014. ASGISA identified six binding constraints to economic growth, which included relative volatility of the currency, cost and efficiency of the national logistics system and infrastructure, shortage of suitably skilled labour and disjointed spatial settlement patterns, barriers to entry and competition in sectors of the economy, and the regulatory environment and its burden on small, medium and micro enterprises (SMMEs), in addition to deficiencies in state organisation, capacity and strategic leadership impacting on delivery (The Presidency, 2008:4). ASGISA was criticised for not meeting its unemployment and inequality targets (Organisation for Economic Co-operation and Development, 2013:28) and was replaced by the New Growth Path (NGP) released by government in November 2010 and subsequently the National Development Plan (NDP), which was adopted in 2012.

In order to achieve a more equal and inclusive economy and social society, the South African government tasked the National Planning Commission (NPC) to determine a vision of what South Africa should look like by 2030 and how it could be achieved. A diagnostic overview was released, which suggested that absolute poverty can be eliminated and inequality reduced if attention was given to the following nine challenges: Poor education outcomes; a high disease burden; divided community; uneven public service performance; divided spatial patterns; low employment levels; corruption; a resource-intensive economy; and crumbling infrastructure. The NPC added that the nine challenges facing poverty and inequality were more severe in rural areas, which resulted in economic growth and social development levels generally being lower in rural compared to urban municipalities. (National Planning Commission, 2011a:7).

The NDP had to be significantly different from previous programmes in order to address persistent poverty, inequality and unemployment problems that past programmes failed to address

(Jahed & Brey, 2011:14). They continue to argue that past programmes failed from a policy perspective, as social and economic policies needed to be better defined, stakeholder buy-in lacked, strategies failed to be implemented and government and institutions in the implementation phases lacked capacity. Such policy failures resulted in unequal basic and social infrastructure delivery, which resulted in visible differences between the economic growth and social development in rural and urban municipalities respectively (Department of Cooperative Governance and Traditional Affairs, 2009:8). The NDP recognised such failures in part by identifying poor education outcomes, a divided community, uneven public service performance, divided spatial patterns and crumbling infrastructure as some of the challenges that must be addressed. Central to the aforementioned challenges identified by the NPC are infrastructure delivery constraints that inhibit the reduction of poverty and inequality.

Calderón and Servén[1] (2004:26) suggest that infrastructure development should be principal in poverty and inequality reduction policy. López[2] (2003:13) argues that public infrastructure investment would yield an increase in economic growth in addition to reducing poverty. Both López[2] (2003:17) and Calderón and Servén[1] (2004:26) indicate that infrastructure investment would benefit the poor more than proportionally. The two cited studies however only comment on the impact of infrastructure investment on economic growth and social development at a national level. Within South Africa cognisance has to be taken of the impact of infrastructure investment on a sub-national level, due to spatial inequalities as highlighted in the NDP. Differences in basic and social infrastructure levels between urban and rural municipalities, in addition to challenges facing rural infrastructure reform, have been identified as inhibiting factors in reducing poverty and inequality (National Planning Commission, 2011a:24). It therefore stands to reason that national government should investigate what impact basic and social infrastructure investment have on urban and rural municipalities' economic growth and social development in order to optimise economic and social returns, given its limited financial resources in addition to planning and implementation capacity constraints.

1. Using economic growth and income distribution figures from 1960 to 2000 for over 100 countries in panel data analyses.

2. Using a transformed inequality (Gini) database from Dollar and Kraay (2002), resulting in 200 observations for 65 countries in addition to transformed growth estimates from Loayza, Fajnzylber, and Calderón (2002), which resulted in only 183 observations from 62 countries being used in the analysis.

1.1. Problem statement

Even though government has made significant inroads in basic and social infrastructure delivery, it generally failed to keep abreast of changing household size dynamics and the urban-rural infrastructure service divide (National Planning Commission, 2011b:195; The Presidency, 2014:13; Bhorat & Van der Westhuizen, 2004:4). The average national household size has decreased from 4.6 in 1996 to 3.6 in 2012 in a still growing population. The average household size has also decreased faster in rural (from 5.3 in 1996 to 3.9 in 2012) as opposed to urban (from 4.4 in 1996 to 3.3 in 2012) municipalities (IHS, 2013). This results in ever increasing pressure to deliver basic infrastructure services at a household level, especially in rural municipalities. Bogetic and Fedderke (2005:12) confirm that, while South African urban areas are generally well-serviced in terms of water, sanitation and electricity infrastructure, their rural counterparts fall significantly short in terms of access. Metwally et al.[3] (2007:61) adds that basic infrastructure is a necessary condition for effective social infrastructure delivery. The lack of basic infrastructure in rural areas therefore affects unequal social service infrastructure delivery, which results in poor education outcomes, and a high disease burden in especially rural communities (National Planning Commission, 2011b:196). It is therefore these rural citizens that are in most need of basic and social infrastructure services to lift their standards of living, to help them become part of a more inclusive economic and social society (COGTA, 2009:8). Focused policies addressing the higher infrastructure investment requirements in rural areas are therefore needed, given the increased demand due to the growth in number of households in addition to higher backlogs experienced in rural areas.

In addition to infrastructure demand dynamics, the NPC also faces challenges in supplying such infrastructure services. Persistent problems include budget constraints, service delivery unit cost, planning and implementation constraints, limited skills and lack of coordination, which often results in insufficient quality and quantity of basic and social infrastructure service delivery in especially rural areas (Khosa, 2003:49). The NPC has identified and aims to address the challenge of uneven public service performance. The fact that the state has a central role in providing collective goods, places them in an ideal position to influence infrastructure policy and planning programmes aimed at inclusive economic growth and social development.

3. Using Egyptian household survey figures from four communities called Fayoum, Beni, Suef and El-Menia.

Understanding how basic and social infrastructure investment impacted on the economic growth and social development in urban and rural areas respectively in the past might provide direction on how government could optimise economic and social development returns in future basic and social infrastructure investment. The research that follows aims to investigate the following research question: Did basic and social infrastructure investment yield different economic growth and social development returns in urban and rural municipalities?

1.2 Significance of the research

The impact of selected infrastructure services on growth and development have been well researched in recent years. Infrastructure investment and economic growth are shown to have a strong positive relationship (De la Fuente & Estache[4], 2004:5; Snieska & Simkunaite[5], 2009:16; Foster & Briceño-Garmendia[6], 2009:10), while the exact impact on social development remains inconclusive. Consensus has however been reached that, under the right conditions, basic and social infrastructure investment do contribute to reducing inequality and poverty (Calderón & Servén[7], 2008:1). The collective impact of comprehensive infrastructure investment in rural and urban municipalities respectively have however remained largely understudied due to the lack of comparative data (Bogetic & Fedderke, 2005:12). This statement is confirmed by Svendsen (2009:25), who notes that the respective impact of infrastructure investment in urban and rural areas remain largely understudied in terms of empirical analysis. Jerome and Ariyo (2004:39) confirm that empirical research on the impact of infrastructure reforms aimed at the poor, in typically rural areas, is limited due to the unavailability of consistent data. Empirical research conducted on the impact of infrastructure on rural and urban growth and development in the South African context would therefore be limited.

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4. Analysing 102 results of studies on the impact of infrastructure investment on economic growth and productivity.

5. Comparing estimated results for Lithuania, Latvia and Estonia.

6. Focussing on 24 African countries , accounting for 85% of GDP in the continent. Countries include: Benin, Burkina Faso, Cameroon, Cape Verde, Chad, Côte d'Ivoire, the Democratic Republic of Congo, Ethiopia, Ghana, Kenya, Lesotho, Madagascar, Malawi, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, South Africa, Sudan, Tanzania, Uganda, and Zambia.

7. Using a constructed set of infrastructure quantity and quality indicators covering 136 countries from 1960 to 2005.

Poverty and inequality levels in addition to the cost of servicing rural areas remain relatively high when compared to urban areas. Basic and social infrastructure delivery also impact differently on economic growth and social development in urban and rural municipalities. Taking cognisance of these three dynamics would therefore require innovative basic and social infrastructure policy solutions. Prioritising basic and social infrastructure delivery according to the most deprived areas in addition to where it would have the greatest economic and social impact could yield optimal returns in terms of relieving poverty and reducing inequality for the country as a whole.

1.3 Chapter breakdown

The theoretical framework for the study is detailed in the literature review in Chapter 2. The aim of the chapter is to inform the research question on what theory, studies and empirical research have to say on the individual, as well as the respective interaction of the concepts in question. Any knowledge gaps in answering the research question are also highlighted within this chapter.

Chapter 3 is dedicated to the methodology employed in the empirical analysis in addition to the data used. A large amount of publically and privately sourced data is used in a spatial dimension. A clear description of the data used in the empirical analysis is included to facilitate an understanding of the economic growth and social development concepts. The chapter also alludes to the definitions and classifications used in determining the urban and rural grouping of South African municipalities. A detailed account of the methodology employed in determining what impact basic and social infrastructure investment had on the economic growth and social development of urban and rural municipalities respectively is then provided.

Chapter 4 describes the empirical results of the respective impacts that basic and social infrastructure investment have on the economic growth and social development of urban and rural municipalities respectively.

Chapter 5 comprises of the conclusions given the results that were obtained in the empirical section (Chapter 4).

2. Literature review

2.1 Introduction

Basic infrastructure investment reduces the cost of production and consumption for business and citizens alike. Increasing investment in basic infrastructure should improve economic growth and social development (DBSA, 2006:15). It allows citizens to interact with society, to communicate and participate in the community in addition to providing sufficient access to resources to obtain a decent living (Ilhamdaniah et al.[8], 2005:2). Chong et al.[9] (2007:344) confirm that when a community has access to a comprehensive set of basic infrastructure services, the welfare effect is greater when compared to communities where certain components of infrastructure services are missing. Metwally et al. (2007:61) add that basic infrastructure also lays the foundation for effective social infrastructure delivery such as schools, hospitals and police stations. Social infrastructure has the ability to increase economic growth and social development of a nation's citizens. Education (Kalil & Kunz, 2002:1748; Levine et al., 2001:358), health (Kalil & Kunz, 2002:1750; Brenneman & Kerf, 2002:5) and safety (Pradhan & Ravallion, 1999:19) have been cited as having a positive impact on the overall economic growth and social development of a country. Social infrastructure also ensures that basic infrastructure is better utilised (Economic and Social Commission for Asia and the Pacific [10], 2006:5).

Comprehensive access to quality basic and social infrastructure should therefore increase economic growth and social development, which will lead to an equitable increase in welfare and the reduction of poverty and inequality (Heymans & Thorne-Erasmus[11], 1998:663; Bogetic & Fedderke[12]; 2005:1). Understanding the channels through which basic and social infrastructure impact on economic growth and social development is essential in order to optimise infrastructure investment efforts.

8. Case study of social infrastructure provision in Ahmedabad, India.

9. Using panel data for households in Peru for the period 1994-2000.

10. Countries in the Asia and Pacific regions.

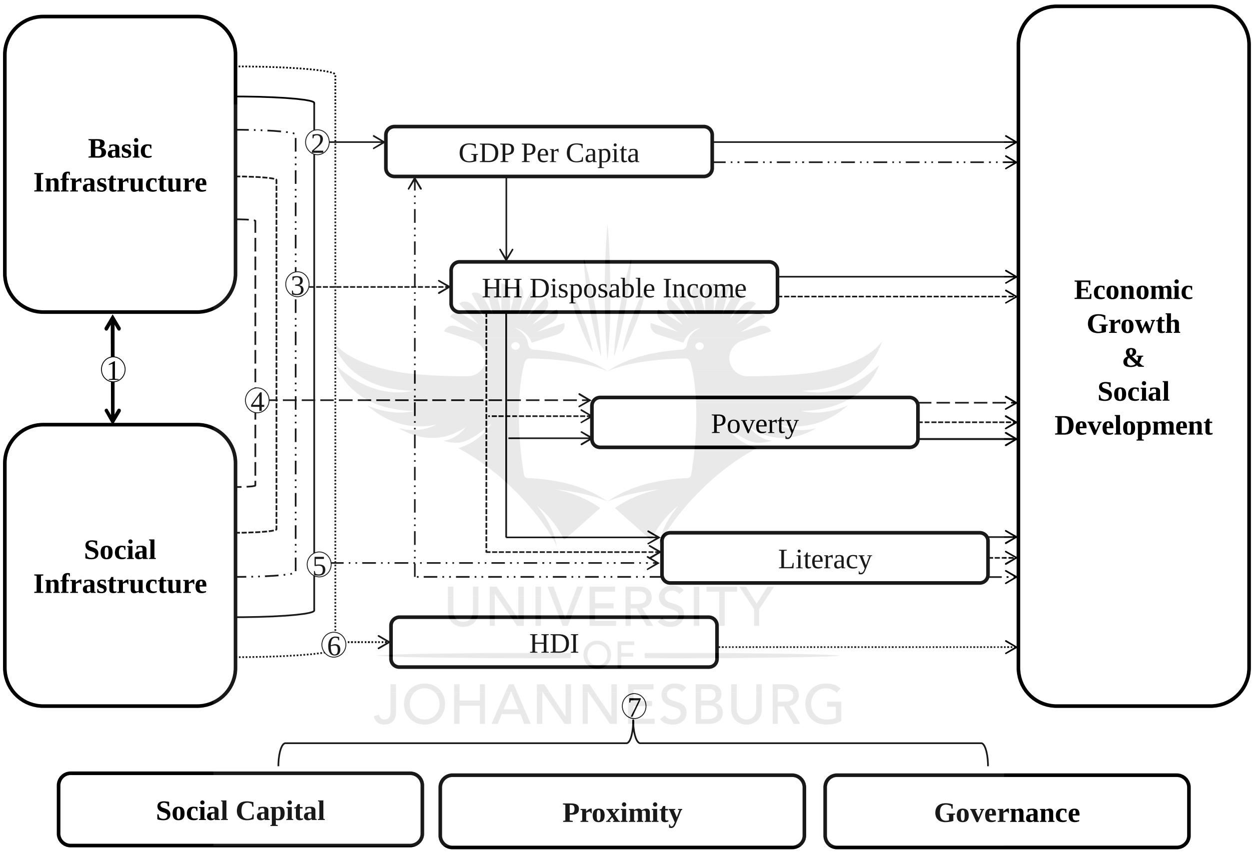
11. Southern African countries.

12. International comparison of South Africa's infrastructure performance using the Eustache and Goicoechea, 2005 World Bank database.

2.2 Conceptual framework

The literature review will aim to present research conducted on the impact that basic and social infrastructure investment have on economic growth and social development, utilising various empirical studies and discussed according to the following conceptual framework:

Figure 1: Conceptual framework for literature review



Source: Author's own construct

The conceptual framework indicates a number of dominant economic and social linkages that will be discussed in the literature review. These linkages will also provide direction for the empirical analysis that follows. While an array of additional factors and linkages are discussed in the field of research, the study that follows will focus on the impact that basic and social infrastructure have on economic growth and social development. The following linkages will be discussed:

(1) Basic infrastructure investment’s impact on social infrastructure, which in turn impacts on basic infrastructure.
(2) Basic and social infrastructure investment and its impact on gross domestic product per capita (GDP per capita), household disposable income, the percentage of people living in poverty, and literacy, which in turn affects overall economic growth and social development.
(3) Basic and social infrastructure and its impact on household disposable income, which impacts on both literacy and poverty and ultimately overall economic growth and social development.
(4) The impact of basic and social infrastructure on the percentage of people living in poverty.
(5) The impact of basic and social infrastructure investment on literacy, literacy and its impact on GDP per capita, which ultimately impacts on economic growth and social development
(6) Basic and social infrastructure and its impact on human development as measured by the human development index (HDI).
(7) The overarching need for basic and social infrastructure investment to be conducted in an integrated manner and in close proximity to the intended recipients through consultation with all the stakeholders, ensuring further social capital creation.

2.2.1 Interaction between basic and social infrastructure investment

The addition of basic and social infrastructure service not only has a direct economic growth and social development effect on a household, but also allows for the better utilisation of other infrastructure services (Ilhamdaniah et al., 2005:2; Chong et al., 2007:344). Electrification for example allows households to switch from traditional to modern fuels. The switchover reduces indoor air pollution, which negatively affects health. Electricity also allows households to practice safer food storage practices associated with refrigeration, reducing the incidence of associated illnesses and the cost related to remedying such illnesses (Barnes et al., 2004:16). Cooking water allows for safer consumption and reduces health risks associated with unsafe water consumption and storing practices (Ferreccio et al., 1991:620; Yamashiro et al., 1998:2198). Allowing for better storing and cooking practices also increases nutrition and health awareness, reducing health problems in a society. Electricity, water and sanitation also increase the ability of learners to attain an education by reducing incapacity due to illness in addition to less time being spent on collecting wood, while lighting itself enables students to study into the night (Brenneman & Kerf, 2002:5). While basic infrastructure impacts on economic growth and social development through various avenues, it is also deemed a necessary precursor for effective social infrastructure delivery (Metwally et al., 2007:61).

Social infrastructure, in turn, ensures that basic infrastructure is better utilised (Economic and Social Commission for Asia and the Pacific, 2006:7). Jalan and Ravallion[13] (2003:160) indicate the provision of piped water (basic infrastructure) alone to be an insufficient condition to increased child health (social development). Metwally et al. (2007:64) argue that the impact of water infrastructure is increased when packaged with sanitation, as well as sanitary and hygiene education. Increasing education will reduce inefficient water, sanitation and electricity usage practices, which will reduce the overall strain on basic infrastructure services. Comprehensive basic and social infrastructure investment is therefore needed to ensure that the respective basic and social infrastructure components achieve optimal economic growth and social development results.

2.2.2 Basic and social infrastructure investment and its impact on economic growth and social development

There are however various ways in which basic and social infrastructure have been found to impact on economic growth and social development. For example: increasing electricity infrastructure has a strong impact on the productivity of a business by reducing the loss of output resulting from power outages and surges. Water and sanitation infrastructure has a lesser but still significant impact on the productivity of business by improving the health of employees, thus increasing their productivity. Increased access to electricity, water and sanitation also saves time and effort of the poor (collecting wood, water etc.), allowing for increased time allocated towards productive activities.

13. Household survey conducted by India's National Council of Applied Economic Research in 1993-94, which included education and health status of 33 000 rural households from 1 765 villages covering 16 states of India.

A number of studies have also found basic infrastructure to have a strong impact on the efficiency of education and health facilities itself (Brenneman & Kerf, 2002:5).

The majority of recently released research, following the seminal work of Aschauer (1989), conclude that infrastructure investment has a significant positive impact and economic growth (see De la Fuente & Estache, 2004; Snieska & Simkunaite, 2009; Foster & Briceño-Garmendia, 2009). The issue of identification has however raised concerns regarding an overestimation of basic and social infrastructure's impact on economic growth, as it is subject to two-way causality. Fedderke et al. (2005:223) and Kularatne (2006:21) for instance both found bi-directional relationships between basic and social infrastructure investments. In its most basic form they conclude that economic growth creates the demand for and the resources needed to fund various types of infrastructure. Calderón and Servén (2008:9) further argue that GDP per capita and infrastructure stock variables typically display stochastic trends that could result in positive and significant association between the variables where in fact there is none, causing the upward biasness of coefficients in for instance Aschauer's (1989) seminal work. Calderón and Servén (2008:8) comment that similar identification, measurement and heterogeneity concerns apply in relation to researching the impact of infrastructure investment on other social development concepts. They also suggest that the construction of synthetic indices should be able to address the problem of high collinearity among individual infrastructure indicators. Additionally, the inclusion of instrumental variables will also account for potential endogeneity and/or reverse causality. Philips and Moon (1999:1092) add that the possibility of spurious regressions can be reduced when using panel data where the cross section dimensions are sufficiently large. These measures are discussed in more detail in the methodology chapter (Chapter 3).

Consensus remains that there is a strong relationship between basic infrastructure and economic growth (e.g. Aschauer, 1989:197; Easterly & Robelo, 1993:442; Sanchez-Robles, 1998:106). Easterly and Servén (2003:130) indicate that inadequate infrastructure investment in Latin America in the 1990s reduced long run growth by between 1.5% and 3.0%, depending on the country. Inadequate infrastructure was also found to account for approximately a third of the divergence in output per worker when comparing countries in Latin America with Asian nations. Esfahani and Ramirez (2003:468) came to a similar conclusion that if Africa experienced infrastructure investment in the 1980s and 1990s similar to that of Asia (over the same period), growth rates could have been higher by 1.3% annually. De la Fuente and Estache (2004:5) summarised the findings of studies conducted in the fifteen years leading up to 2004 regarding the impact of infrastructure investment on productivity and growth. The summary of 102 studies indicates that very few studies found that infrastructure investment had a negative impact on growth and productivity. All of the studies conducted in developing countries conclude that basic and social infrastructure had a positive effect on productivity and growth. Bogetic and Fedderke (2005:1) also mention that this is especially the case for countries in Sub-Saharan Africa. The relationship holds true for South Africa, as discussed in research by Fedderke et al. (2006:1052).

However, the exact impact of basic and social infrastructure investment on social development remains inconclusive. Consensus has however been reached that, under the right conditions, basic infrastructure investment does contribute to reducing inequality and poverty (Calderón & Servén, 2008:1). Expanding infrastructure investment to the poor has been credited to have a disproportionate effect on the welfare and income of poor citizens, resulting from the increased value of assets they hold after infrastructure investment (Estache et al.[14], 2000:20). López (2003:4) and Calderón and Servén (2008a:16) add that basic and social infrastructure investment is associated with reduced income inequality. In order for basic and social infrastructure investment to achieve such socially desired outcomes, it has to be accompanied by pro-poor policies.

Calderón and Servén (2004:5) note that investing in education and health services increase the growth and development prospects of the poor, especially in developing countries. Increased levels of education and health are seen to increase income levels due to increased productivity. Increased income levels result in reduced poverty and increased welfare. Higher levels of disposable income also allow a household to afford access to higher education as opposed to the poor who would typically depend on social assistance. Alesina and Perotti (1996:1223) confirm that increased access to education resulting from increased disposable income leads to further education increases. Estache et al. (2002:9) indicate that the literature on the impact of infrastructure indicates growth elasticity resulting from increased infrastructure to be between 0.14 and 1.12. Using an elasticity value as low as 0.14 would suggest that if infrastructure increases by 10%, it would increase GDP by 1.4%.

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14. Latin America countries compared to other peer income group countries globally

Considering that a 1 percentage point increase in GDP per capita reduces poverty by 0.5 percentage points, the impact is rather dramatic (Estache et al., 2002:8). Hoogeveen and Özler (2005:23) note that economic growth alone will not reduce poverty in South Africa. They continue that even if the GDP per capita increased by an average annual rate of 8% it would take ten years for the poor households in South Africa to escape poverty. Growth in addition to pro-poor policies is therefore needed to alleviate poverty and inequality.

2.2.3 Basic and social infrastructure investment and its impact on disposable income

There seems to be little empirical evidence of the direct impact that infrastructure investment has on income. Estache (2004:5) confirms that little evidence exist on even the basic impact of infrastructure on household income, citing only two empirical studies in his research completed in 2004. The first is the work of Komives et al.[15] (2001:20), which rather comments on how demand for infrastructure changes as income increases as opposed to the impact of infrastructure on income. The second is a study of Estache et al.[16] (2002:90), which focuses on savings, rather than increases in income, that resulted in higher disposable income levels.

Brenneman and Kerf[17] (2002:5) summarised research that focuses on the topic of infrastructure investment and its impact on income. The summary study also comments on how basic and social infrastructure increases disposable income of households as opposed to increasing income itself. Basic and social infrastructure investment was credited with saving time and increasing savings, resulting in increased disposable income. The research that follows will therefore investigate the impact of basic and social infrastructure investment on disposable income.

15. Using the World Bank's living standards measurement study (LSMS) surveys from fifteen countries (more than 55 500 households), which include: Pakistan, Vietnam, Nepal, Russia, Kazakhstan, Bulgaria, Albania, Kyrgyz, Panama, Jamaica, Ecuador, Nicaragua, South Africa, Cote d'Ivoire and Ghana.

16. Latin American countries: Mexico, Colombia, Argentina, Peru, Venezuela, Chile, Ecuador, Guatemala, Cuba, Haiti, Bolivia, Dominican Republic, Honduras, Paraguay, El Salvador, Nicaragua, Costa Rica, Puerto Rico, Panama and Uruguay.

17. Study conducted in 1989, figures adjusted using 1998 US$ prices for the purposes of the research.

Whittington and Hanemann[18] (2006:16) found that water and sanitation infrastructure reduces the incidence of disease and the associated medical expenditure, which leads to savings for households. The study further comments that the provision of water and sanitation services in rural areas results in increased disposable income of households. In Pakistan, for instance, median monthly household expenditure on water decreased from $7,50 (when buying from vendors) to $1 when households were provided with piped water within the household. Basic infrastructure therefore has the ability to increase a household's disposable income, particularly in rural areas. Such findings conform to the summary findings of Brenneman and Kerf (2002:5), who conclude that increased investment in education, water, electricity and sanitation infrastructure lowers the cost of the respective service, resulting in further savings for households.

2.2.4 Basic and social infrastructure investment and its impact on poverty

In recent years more research attention has been directed towards the impact of basic infrastructure investment on poverty and inequality (Estache et al., 2002:15; World Bank, 2003:147, 2006:14). De la Fuente and Estache (2004:2) note that basic and social infrastructure can reduce poverty and assist in achieving the Millennium Development Goals (MDGs), even though empirical literature has been far from conclusive on the exact impact that basic infrastructure investment has on poverty and inequality. Nevertheless, consensus has been reached in that, under the right conditions, basic infrastructure investment does contribute to alleviating inequality and poverty (Calderón & Servén, 2008:1). A recent report by UN-Habitat, however, states explicitly that that there will be no poverty alleviation in Africa without significant increases in basic infrastructure (Jerome 2011:66).

18. Various studies summarised according to (i) growth-enhancing impacts; (ii) increase of economic opportunities specifically targeted to the poor; (iii) direct savings; (iv) improved education; (v) improved governance framework; (vi) improved health; (vii) direct impact on well-being; (viii) fiscal impact (coupled with pro-poor policies).

Even though research might be inconclusive regarding the direct impact that basic infrastructure development has on poverty, its impact on poverty might be induced through other avenues that will result in poverty alleviation. One such example is the study of Estache et al. (2002:9), which indicate the growth elasticity resulting from increased infrastructure investment to be between 0.14 and 1.12, suggesting that a 10% increase in infrastructure would lead to a 1.4% to 11.2% increase in GDP, inducing a 1 percentage point increase in per capita income that leads to a 0.5 percentage point decrease in poverty. Exploring such channels, and whether it differs between urban and rural municipalities, could assist in optimising the economic growth and social development impact of basic and social infrastructure investment.

2.2.5 Basic and social infrastructure investment and its impact on education

Research conducted by Leipziger et al.[19] (2003:7) show that increasing the availability and quality of basic infrastructure services for the poor in developing countries have a significant and positive impact on education of the poor and therefore potentially their income and welfare. Seethepalli et al.[20] (2008:13) confirm that there is a high and statistically significant correlation between basic infrastructure and education (even though the causal relationship is not clear).

19. Include low income countries (27 countries), lower middle income countries (19 countries) and upper middle income countries (28 countries) for a total sample of 74 developing countries. Demographic and health figures where obtained from the Demographic and Health Survey (DHS) and included the following countries: Bangladesh , Haiti, Nigeria, Benin, India, Pakistan, Bolivia, Indonesia, Paraguay, Brazil, Kazakhstan, Peru, Burkina Faso, Kenya, Senegal, Cameroon, Kyrgyz Rep., Tanzania, Central African Rep., Madagascar, the Philippines, Chad, Malawi, Togo, Colombia, Mali, Turkey, Comoros, Morocco, Uganda, Côte d'Ivoire, Mozambique, Uzbekistan, Dominican Republic, Namibia, Vietnam , Ghana, Nepal, Zambia, Guatemala, Nicaragua, Zimbabwe, and Niger.

20. Researching the impact of infrastructure sub-sectors energy, telecommunications, water supply, sanitation, and transport on growth in East Asia during 1985-2004 using the World Development Indicators (WDI), PPI database in addition to the Governance Indicators. Countries included in the study: Australia, Cambodia, China, Fiji, Indonesia, South Korea, Laos, Malaysia, Mongolia, Papua New Guinea, Philippines, Singapore, Thailand, Tonga, Vanuatu, and Vietnam.

Basic infrastructure investment affects literacy through a number of channels. Brenneman and Kerf (2002:5) indicate that increased water and sanitation infrastructure improve education performance due to the reduction of water-related diseases, which decreases absenteeism in schools. Electricity infrastructure also increases literary due to lighting that enables students to study into the night. Electricity also increases education at an institutional level through the use of technology (Bond, 1999:47). Increasing water, sanitation and electricity infrastructure also reduce the time needed to collect wood for lighting, heating and cooking, which increase the available study time, in addition to increasing the likelihood of children attending school. Basic and social infrastructure investment could therefore possibly have a greater economic growth and social development impact on the rural poor.

Hoogeveen and Özler (2005:21) confirm that, should household heads in South Africa with less than seven years of education attain an additional seven years of education, then poverty (using a $2/day poverty line translating to R174 and lower-bound poverty line of R322) would decline by 8 and 5 percentage points in urban and rural municipalities respectively. The study further notes that if the number of those decline by 16 and 14 percentage points in urban and rural municipalities respectively. Sanchez and Sbrana (2009:1) also indicate that increasing education will impact on employability and productivity, which will ultimately lead to increased real wages. Such increases in household incomes will ultimately lead to the reduction of poverty and the ability of households to attain further education. The findings of Hoogeveen and Özler (2005:21) suggest that a higher than proportionate education investment in rural poor areas is needed to bring about a more equal society in terms of employability and ultimately a household's ability to increase their income. Such a higher than proportionate education investment effort would also be needed to reduce the poor education outcomes in especially rural areas in South Africa, as identified by the NPC.

2.2.6 Literature review on qualitative issues of importance

Merely providing basic and social service infrastructure within a community will not necessarily ensure that social and economic objectives are met. Cognisance has to be taken of the unique cultural nuances within a society to ensure that its economic and social demands are met.

Delivering basic and social infrastructure that addresses the social vulnerabilities and economic needs within a community will create the necessary social capital that will yield optimal economic and social benefits within a community (Putnam, 1993; 1995a; 1995b). Government, in its role as the responsible delivery agent, also needs to ensure that it has the necessary capacity and skills when planning and delivering social and economic returns. Corruption has to be kept in check, while planning implementation practices should yield optimal social and economic returns given the resources deployed. Planning basic and social infrastructure service delivery should furthermore involve collaboration between the different spheres of government in addition to the respective basic and social infrastructure service departments to ensure that geospatial opportunities are leveraged. Government's basic and social infrastructure agents therefore need to include the specific cultural nuances of society in a community, ensure accountability within government and ensure that basic and social infrastructure are easily accessible by the intended recipients, complementing each other. Including such qualitative issues in basic and social infrastructure service delivery will ensure optimal social and economic returns.

2.2.6.1 Society

Further to the direct and indirect welfare effects of basic and social infrastructure on a community, social infrastructure also creates induced social and economic effects. In particular it creates a platform that facilitates social interaction within a community. Putnam (2000:19) defines social capital as follows:

> Social capital refers to connections among individuals – social networks and the norms of reciprocity and trustworthiness that arise from them. In that sense social capital is closely related to what some have called 'civic virtue'. The difference is that 'social capital' calls attention to the fact that civic virtue is most powerful when embedded in a sense network of reciprocal social relations. A society of many virtuous but isolated individuals is not necessarily rich in social capital.

Social interaction therefore creates social capital that can lead to further economic and welfare benefits within a community.

This flow of information and the creation of social ties generated by interaction are conceptualised as social capital. Generally it is agreed that communities endowed with a diverse stock of social networks and civic associations will be in a stronger position to confront poverty and vulnerability (Moser, 1996:82; Narayan & Nyamwaya, 1996:45), resolve disputes (Schafft & Brown 2000:212; Varshney, 2000:139) and/or take advantage of new opportunities (Isham, 2002:34). Social capital is therefore seen as a key indicator of a socially healthy, engaged and equal society (Putman, 1993; 1995a; 1995b). The decline in social capital is also identified as an underlying cause of poor health, crime, low education and poverty (Putnam, 2000).

Furthermore, social capital facilitates a mutual responsiveness between government and citizens, as suggested by Chapin and Denhardt (1995:215), which is essential in addressing communities' social needs. A better understanding of respective communities' social, economic and cultural characteristics will allow the state to better plan and direct initiatives aimed at development. Such interaction will involve government gaining local information from communities' social and institutional networks (Raagmaa, 2003:17). Social capital allows for the effective flow of information between communities and government, which will lead to the best development solutions for a community. When a community gets to a point where basic and social infrastructure needs are catered for, it can embrace the benefits of the economic and social capital that regular interaction in a community generates. Such interaction extends to the public sector, which ensures a more responsive relationship between a community and its needs and what the state can offer in response (Potapchuk et al., 1997).

2.2.6.2 Spatial proximity of infrastructure services

Another point of discussion is the importance of social infrastructure services and its spatial proximity in relation to the intended recipients, as well as its proximity to each other. Various studies have indicated that the travel cost and time savings associated with accessing basic services in close proximity to each other have a profound effect on the welfare of rural communities (Luo & Wang, 2003:876; Perry & Gesler, 2000:1182; Friedmann et al., 2000:455). Adams and White (2005:80) illustrate, for instance, that the further a household within an urban community is located from health services, the more socially deprived it tends to be. This study focused on urban municipalities where citizens generally have more options in terms of public and private transport services. Rural areas generally have different social, spatial and economic dynamics and generally do not have the same level of access to transport. It might therefore follow that accessibility to health services could have a more pronounced effect on the welfare of citizens in rural municipalities. Policy makers might also find that an effective tool in urban development could yield unsatisfactory results in rural areas.

Furthermore, empirical studies suggest that a close relationship exists between physical cohesion and social capital (Svendsen, 2009:1). Social capital decreases in areas where the distance between meeting points increases or where fewer meeting places are available (Rutten et al., 2010:869). Adams and Krauth (1995:89) further argue that there is a need to replace fragmented systems with centralised coordinated networks of services at neighbourhood level to increase social capital. Svendsen (2009:1) argues that multifunctional centres could be used as an approach to achieve such physical cohesion. Three case studies were conducted in Denmark and Holland and aimed to validate theoretical models of rural multifunctional centres. The case studies found that such rural multifunctional centres created physical cohesion that lead to social cohesion and ultimately higher social welfare, as seen through higher learning levels, increased house prices and population growth. The case studies were however cited as being qualitative in nature. Rural multifunctional centres and its effects on the welfare of small rural communities still have to be tested empirically (Svendsen, 2009:25).

The importance of spatial proximity in terms of development should therefore not be underestimated. It impacts on both the cost of basic and social infrastructure services delivery and the benefits intended for recipients. Considering the combination of geographical remoteness along with providing social infrastructure services in close proximity to the intended recipients in rural communities might require that certain costs are shared or economies of scale are leveraged (Chong et al., 2007:2). Collective action by the respective public sector departments might therefore be required to ensure that small and remote communities receive basic and social services.

2.2.6.3 Governance

The NPC eludes to a divided community, corruption, uneven public service performance and crumbling infrastructure as four of the nine challenges to reducing poverty and inequality (National Planning Commission, 2011a:7). Addressing these four challenges will require better governance. Khosa (2003:49) states that the gap between South African policy and implementation result from unrealistic policy expectations. Insufficient staff compliments in addition to a lack of capacity at all spheres of government have also been noted to inhibit implementation of public services. He further identifies insufficient levels of coordination as hampering the implementation of policies in almost all sectors. The inability of local municipalities for instance to fill certain key positions will limit the ability of such a municipality to plan, budget, implement and manage services. In 2009 the Auditor General reported that 73% of key municipal financial positions are vacant and that 71% of municipalities still depend on consultants to assist in financial reporting. This resulted in only 9% of municipalities receiving clean audits for the financial year ending 2013 (Auditor-General South Africa, 2014:16). The Department of Cooperative Governance and Traditional Affairs (2009:41) also notes that 12% of senior manager positions in local government were vacant in June 2009. The inability of municipalities to fill key positions would therefore rightfully contribute to the ability of municipalities to deliver services in the local communities of South Africa, as indicated by Khosa (2003:49).

South Africa has made some progress in addressing coordination problems by undertaking various cluster approaches in order to improve service delivery. The cluster approach allows for multi-sector alignment and is implemented on a national and provincial level. The development would improve delivery of security, bulk transport services, housing, schools and clinics, which is planned and implemented at a national and provincial level. The cluster approach does not benefit the planning and delivering of water, electricity, sanitation and refuse removal at grassroots level, as it does not include the third tier of government, i.e. municipalities (Brynard, 2007:66). While progress has been made in coordinating service delivery activities through various cluster approaches, local municipality participation should be increased. The high vacancy rate of key positions in local municipalities however poses further risks to cluster programmes' success in delivering basic and social infrastructure (Brynard, 2007:67).

2.3 Concluding remarks on the literature review

The impact of basic and social infrastructure vary across studies due to the respective infrastructure indicators used, methodologies employed, and the country or group of countries the analysis focus on. The literature review suggests that increased literacy, resulting from increased education and institutional quality, will have the greatest impact on economic growth and social development (Calderón, 2009:12). However, the literature rarely comments whether the basic and social infrastructure investment will impact differently on economic growth and social development in urban and rural areas respectively. In some of the reviewed studies, the authors do however comment that basic and social infrastructure will have a proportionately different effect on the rural poor (Asian Development Bank, 2012:68) as opposed to urban areas.

Given the different levels and concentration of poverty in rural and urban areas, it stands to argue that basic and social infrastructure investment can likely have a different impact on economic growth and social development in rural and urban municipalities respectively. The collective impact of comprehensive infrastructure investment in rural and urban municipalities respectively has however remained largely understudied, mainly due to data availability and quality (Bogetic & Fedderke, 2005:12; Svendsen, 2009:25; Jerome & Ariyo, 2004:39). Overcoming such data availability and quality concerns through the use of a proprietary municipal economic, socio-economic and infrastructure databank will allow for analysis on the impact of basic and social infrastructure on economic growth and social development in urban and rural municipalities respectively. The result can assist planning and policy institutions to optimise the overall economic growth and social development return of basic and social infrastructure investment.

21. Based on econometric estimates for a sample of 136 countries from 1960 to 2005, which include 39 African countries.

22. Analysis of infrastructure on 48 Asian countries. Focus was also directed towards the landlocked countries which include 12 nations: Afghanistan, Armenia, Azerbaijan, Bhutan, Kazakhstan, Kyrgyz Republic, the Lao PDR, Mongolia, Nepal, Tajikistan, Turkmenistan, and Uzbekistan.

3. Methodology

Empirical research on the impact of infrastructure on economic growth and development indicators proliferated after the seminal work of Aschauer (1989). Comprehensive surveys on the impact of infrastructure on growth, productivity, poverty and other development indicators and the data and methodologies used are reviewed by Estache[23] (2006), Romp and De Haan[24] (2007:40-51), Calderón and Servén[25] (2008), Straub[26] (2010:18-20) and Pereira and Andraz[27] (2013:20-32). A brief summary of the evolution, findings, constraints and critique of research as summarised by the previously mentioned studies are outlined below.

The bulk of empirical literature following from the seminal work of Aschnaur (1989) focused on the long run contribution of infrastructure on the level or growth rate of aggregate output or productivity using time series data. Empirical analysis predominantly focused on estimating the aggregate production (or cost) function, utilising a plethora of datasets for various country groupings or regional focus areas. Infrastructure measures typically included physical stocks and public spending measures. Straub[28] (2008:20) summarises that most studies using physical indicators of infrastructure found a positive long run impact on economic output and/or productivity. When public spending measures were used as measurement instruments, the results were mixed in terms of the long run impact of infrastructure on economic output and/or productivity.

Recent literature also focuses on the effects of infrastructure on income inequality (Calderón & Servén, 2008:5). The premise is that access to infrastructure may raise the value of assets held by lowering transaction costs, and that the effect will be disproportionately biased towards the poor.

23. The survey covers discussions on the linkages between infrastructure and, respectively, institutions, growth, equity, finance and corruption drawing from quantitative analytical assessments of the key lessons on these interactions from the 1990s and the early part of the 2000s.

24. Numerous. See Table A1 in the study for a summary.

25. Includes analysis of 30 macro-level studies investigating the link between infrastructure and economic performance.

26. 64 contributions were reviewed, 43 were published in peer-reviewed journals outlets, while 21 were not.

27. Numerous. See Table 1 & 2 in the study for a summary.

28. Analysis of 140 specifications from 64 recent empirical papers covering: type of data used, level of aggregation, econometric techniques and nature of the sample in addition to the macro-econometric and micro-econometric contributions of these papers.

López (2003:10), utilising telephone line density as proxy for infrastructure, and Calderón and Servén (2008:12), utilising synthetic indices, found that infrastructure investment reduces income inequality and, under the right conditions, could be a powerful policy to reduce poverty.

Attention is also directed towards the development impact of infrastructure investment in Africa. The empirical literature predominantly comments on infrastructure development and its impact on growth and productivity, using pooled OLS growth regression methods based on Solow's growth model (e.g. Estache et al.[29], 2005:7), the production function approach (e.g. Ayogu[30], 1999:174), and dynamic panel estimations (e.g. Boopen[31], 2006:41). The studies reviewed predominantly made use of a single infrastructure indicator such as telephone density, roads or power as a proxy for total infrastructure (Straub, 2010:20; Calderón & Servén, 2008:6). The macro-economic analysis exhibited mixed results, although findings generally indicated that power and communication, but not water and sanitation infrastructure, contribute to long run growth on the continent (Calderón & Servén, 2008:6).

The empirical literature reviews conducted by Romp and De Haan (2007), Calderón and Servén (2008), Straub (2010) and Pereira and Andraz (2013) also point towards a number of caveats and methodological debates stemming from the data and empirical methodologies used in the respective research papers surveyed. The listed surveys identified measurement concerns (using a single infrastructure variable as proxy for infrastructure), collinearity among infrastructure assets, identification (simultaneity biasness or endogeneity/causality), and heterogeneity (varying quality and productivity of infrastructure) as problems commonly encountered in empirical evaluations. Each of these concerns and the suggested solutions will be discussed below.

29. Using World Bank data covering 41 of the 48 Sub-Saharan African countries (dropping Comoros, Equatorial Guinea, Eritrea, Liberia, Mayotte, Sao Tome and Principe, and Somalia due to data quality concerns).

30. Using regional panel data from Nigeria, finding a strong association between infrastructure and output.

31. Sub-Saharan African countries: Algeria, Angola, Benin, Botswana, Burundi, Burkina Faso, Cameroon, Congo, Chad, Central Africa Republic, Cote D'Ivoire, Gabon, Gambia, Ghana, Guinea-Bissau, Egypt,, Ethiopia, Kenya, Lesotho, Madagascar, Mozambique, Mauritania, Mauritius, Malawi, Mali, Morroco, Namibia, Niger, Nigeria, Rwanda, Senegal, Seychelles, South Africa, Togo, Tunisia, Uganda, Zambia, Zimbabwe & Small Island Developing States (SIDS): Barbados, Cape Verde, Dominican Republic, Fiji, Haiti, Jamaica, Mauritius, Papua New Guinea, St Vincent, Seychelles, Salomon Island, Trinidad and Tobacco.

Calderón and Servén (2008:7) argue that the use of a single indicator as proxy for infrastructure would likely result in invalid inferences as a result of omitted variable biases in the conducted research they surveyed. In order to sufficiently measure all components of infrastructure, Calderón (2009:3) suggests that a synthetic index, using principal component analysis (PCA), will reduce not only measurement concerns but also collinearity among different infrastructure indicators This is due to PCA extracting different dimensions of infrastructure that are mutually uncorrelated (Theil, 1971).

Calderón and Servén (2008:7) further argue that infrastructure investment, output and productivity are subject to two-way causality and therefore subject to an upward simultaneity bias, which is arguably more of a concern when using time series data. In order to overcome such concerns Calderón and Servén (2008:8) and Straub (2010:692) suggest using an instrumental variable approach. Empirical analysis should also use a demographics variable, such as the absolute number of households, as an outside instrumental variable in order to normalise infrastructure between regions. This will allow for absolute increases in basic and social infrastructure to be comparable in relative terms, i.e. being able to compare for example the impact of 10 extra electricity connections in a municipality of 50 household to a municipality of 50 000 households. Calderón and Servén (2008:8) and Straub (2010:692) furthermore suggest the use of a generalised method of moments (GMM) panel framework, as employed by Roller and Waveman (2001:913), for empirical analysis of infrastructure on economic growth and social development. Research by Phillips and Moon (1999:1057) however show that such upward biasness, or spurious regression, is far less of a concern in panel data with sufficient cross-sectional dimensions. Using a homogenous balanced panel dataset (with sufficient cross-sections) that sufficiently measures all pertinent infrastructure components, will therefore be required to overcome the concerns raised above. Straub (2008:38) concludes that panel data is an absolute requirement when attempting to test dynamic changes of distributed economic output as infrastructure investment occurs.

The last of the concerns raised was that of heterogeneity of infrastructure variables in cross-country analysis. In other words, the quality and resulting productivity of basic and social infrastructure investment differs between counties. Such differences in quality of basic and social infrastructure result in varying economic and social development returns in countries, which is not always accounted for in empirical analysis. The problem is further exasperated by the difference in quality of surveys measuring the respective variables between countries. Calderón and Servén (2008:9) found that quality and productivity of infrastructure may vary across countries due to, among other, institutional capacity factors. The research that follows, however, only focuses on urban and rural municipal analysis within South Africa, therefore addressing the previously mentioned issue.

Basic and social infrastructure service delivery, as mandated by the three tiers of government, is governed by a single piece of legislation by means of the constitution. Measurement of the respective basic and social infrastructure services are consequently measured by homogenous surveys. These homogenous surveys used to measure basic and social infrastructure indicators, as governed by a single piece of legislation, will therefore imply greater homogeneity of basic and social infrastructure variables used in the analysis that follows.

Overcoming heterogeneity, homogeneity and endogeneity concerns raised in the literature review will require the use of a dataset that will overcome some of the initial concerns. Using a balanced panel dataset with sufficient cross sections, as well as a synthetic infrastructure index using PCA and subjecting the synthetic index and control variables to an outside instrumental variable, will counter measurement and identification concerns raised by Calderón and Servén (2008:16) and Pereira and Andraz (2013:6). For the purpose of this study, infrastructure and control variables will be assumed to be homogenous due the legislation that govern infrastructure delivery and the respective surveys that calculate the variables being homogenous.

3.1 Constructing principal component analysis (PCA) indices: Basic and social infrastructure

PCA is used to construct a synthetic basic and social infrastructure index. PCA provides a roadmap for how to reduce a complex data set to a lower dimension to reveal the sometimes hidden, simplified structures that often underlie it (Shlens, 2009:1). PCA is calculated by organising the data in a $m \times n$ matrix (m represents the number of measurement types and n is the number of samples), whereafter the mean is subtracted from each measurement type, the covariance matrix is calculated and finally the eigenvectors and eigenvalues of the covariance matrix are calculated. The underlying PCA components quantify the variability of each dimension in PCA indices. The respective infrastructure stock indices will provide an indication of the extent to which basic and social infrastructure is delivered in each of the municipalities in the country. While the method has been used in cross-country analyses, or in a few country-specific sub-national analyses, it has not been deployed to analyse urban and rural analysis using sub-national data.

The choice of basic and social infrastructure indicators used in the construction of the synthetic indices are somewhat contentious. The body of literature reviewed not only uses various physical or expenditure approximations of infrastructure, but also differs in the specific choice of infrastructure measure or combination of measures used.

Two types of data have been used as infrastructure proxies in past empirical literature in the subject of infrastructure investment and its impact on economic growth and social development. The two measures are that of public capital and physical indicators of infrastructure (Straub, 2010:693). Concerns stemming from the use of public capital as a proxy infrastructure investment include: (i) private sector infrastructure is on the increase, (ii) public infrastructure spending is likely to be less than optimal, (iii) developing countries reportedly miss-appropriate public investment capital towards current expenditure, and (iv) the concept of public sector typically used in analyses does not fully correspond to the national accounts definition (Calderón & Servén, 2004; Romp and De Haan, 2007; Straub, 2010). Such concerns will point towards the use of a physical measure of basic and social infrastructure as opposed to a public capital spending measure. A literature review by Straub (2008:19) also found that while only 28% of related studies in the 1990s used infrastructure stock indicators, the trend reversed at the turn of the century with 76% of recent studies using infrastructure stock measures as the measure of choice.

The use of physical measures of basic and social infrastructure in empirical research are however not without its own pitfalls. The main concerns raised are those of homogeneity and inconsistent measurement of infrastructure stock indicators (Calderón & Servén, 2008:7). Straub (2008:3) also comments that there is no satisfactory solution to capturing the state of infrastructure (such as water, electricity and sanitation) in and across many poor countries. Homogeneity will however be less of a concern in the panel data set used for the empirical analysis that follows. Infrastructure delivery is judged to be homogenous as it is governed by a single piece of legislation, in addition to being measured by the same surveys. Measurement concerns will also be addressed through the use of a synthetic index of infrastructure that accounts for the majority of the respective basic and social infrastructure services, provided by the three tiers of government, that are mutually uncorrelated. The respective infrastructure components will include the basic and social services that are provided by the three tiers of government. The basic infrastructure synthetic index will comprise of physical water, sanitation and electricity connections, while social infrastructure will consist of health, safety and education proxies. The sources of the respective basic and social infrastructure components will also be discussed in detail.

3.1.1 Calculating the basic infrastructure synthetic index

The basic infrastructure index will be based on the number of households that has access to water, electricity and sanitation for each of the municipalities from 1996 to 2012, with the number of households used to normalise the synthetic index (Straub, 2010; Calderón & Servén, 2004; Romp & De Haan[24], 2007). The estimation of the basic infrastructure synthetic index is as follows:

$$\mathrm{BINF}_{it} = \beta_1 * ln\left(\frac{SAN}{HH}\right)_{\mathrm{it}} + \beta_2 * ln\left(\frac{WATER}{HH}\right)_{it} + \beta_3 * ln\left(\frac{ELEK}{HH}\right)_{it} + U_{it}$$

Where:

β_{i-n}	Respective infrastructure variable weights
i -	Municipality 1-234
t	Time 1996-2012
BINF	Synthetic of basic infrastructure
SAN	Number of households with hygienic toilets
WATER	Number of households with water connections above RDP-level
ELEK	Number of households with electricity connections
HH	Number of households

Data is obtained from the IHS Regional eXplorer, which calculates the variables using a demand (household usage) and supply (institutions delivering the infrastructure) approach. The demand side utilises the publications from Stats SA and include general household surveys (GHSs), October household surveys (OHSs), labour force surveys (LFSs), community survey 2007 (CSs) and censuses (1996, 2001 & 2011) and is supplemented with municipal documentation such as local economic development (LEDs), integrated development plans (IDPs) and infrastructure surveys. Water and sanitation supply data was collected from the Department of Water Affairs and Forestry (DWAF). Electricity connection (supply) data was collected from Eskom and supplemented with household billed data collected from municipalities (see Appendix A).

The basic infrastructure index components captures actual water, sanitation and electricity connections as indicators of physical infrastructure stock, as suggested in the literature review by Straub (2008:19). The literature reviewed does not provide a clear indication of what infrastructure measure or combination of measures should be used in the composition of the PCA methods index. Utilising water, electricity and sanitation connections in the calculation of the basic infrastructure index will however fall within the range of infrastructure measures used in the studies cited in the literature review, in addition to aligning to the service delivery mandates of government.

The PCA method takes the log transformation of each of the infrastructure components, which have been standardised by subtracting its mean and dividing by its standard deviation (Calderón & Servén 2008:12). The estimated basic infrastructure index, at the first principal component, is calculated as follows:

$$\mathrm{BINF} = 0.567 * ln\left(\frac{SAN}{HH}\right) + 0.594 * ln\left(\frac{WATER}{HH}\right) + 0.571 * ln\left(\frac{ELEK}{HH}\right)$$

Each of the three basic infrastructure indicators account for approximately the same weight in the newly generated synthetic basic infrastructure index. The Levin-Lin-Chu (2002) test for unit roots is used to determine if the constructed basic infrastructure index is stationary. The null hypothesis that each individual time series contains a unit root is rejected at a 5% level of significance (P-value: 0.0000) in favour of the alternative null hypothesis of the basic infrastructure synthetic index series being stationary. The first principal component accounts for 85%, while the second and third principal component account for 10% and 5% of the total scaled variance in the synthetic index. The index ultimately accounts for 85% of the overall variance of the three underlying basic infrastructure variables and is highly correlated with the underlying infrastructure measures as shown in Table 1. The synthetic basic infrastructure index is positively correlated with all the dependent variables, with the exception of percentage of people in poverty, which shows a negative correlation (Table 2). The correlations conform to the expectations indicated in the literature review.

3.1.2 Calculating the social infrastructure synthetic index

Social infrastructure will incorporate number proxy variables for health, education and safety, due to the lack of direct measures on a municipal level, in order to calculate the social infrastructure synthetic index. The theoretical representation of the social infrastructure synthetic index will look as follows:

$$\mathrm{SINF}_{it} = \beta_1 * ln\left(\frac{Functionally\ Lit}{Pop\ aged + 20}\right)_{\mathrm{it}} + \beta_2 * ln\left(1 - \frac{Crime}{HH}\right)_{it} + \beta_3 * ln(D\left(\frac{Med\ spending}{HH}\right))_{it} + U_{it}$$

Where:

β_{i-n}	Respective infrastructure variable weights
SINF	Social infrastructure synthetic index
Functionally Lit	Number of people over the aged of 20 with Grade 7 completed
Nr of crimes	Actual number of crimes reported
Med spending	Medical expenditure per household in nominal rand values
HH	Number of household

The PCA method once again takes the log transformation of each of the infrastructure components, which have been normalised by subtracting its mean and dividing by its standard deviation, estimating the basic infrastructure index at the first principal component (Calderón & Servén 2008:12). The data is obtained from the IHS Regional eXplorer data service, which utilises information from income and expenditure surveys (IESs), censuses 1996, 2001 and 2011, P0100 - income and expenditure of households, and SARB quarterly bulletins (S-110), Final consumption expenditure by households, classification of individual consumption according to purpose (COICOP), SAPS Crime Research and Statistics Unit and the Department of Education (see Appendix A). Validating the use of the respective variables for education, health and safety variables are detailed below.

Crampton (2009:317) and Estache et al. (2007:2) note investment in physical school infrastructure to be a significant contributor to the levels of academic achievement a person can reach. Gupta et al. (2002:732) also find that increased education spending increases education attainment, but warn that evidence confirming the causal relationship is lacking. Nevertheless, these studies indicate that higher education attainment is associated with higher spending on education infrastructure. For this reason we employ primary education attainment as a proxy for education infrastructure investment. The primary school completion rate similar to that used in Estache et al. (2007:11) will be used as a proxy for school infrastructure in the research that follows. An indication of education infrastructure will be calculated using the number of people, older than 20, who have completed grade 7 (*Functionally Lit*).

Studies by Novignon and Olakojo (2012:5), Berger and Messer (2002:2105) and Or (2000:56) found that there is a positive relationship between health expenditure and health outcomes. These studies used either public spending figures or combined health expenditure figures for the public and private sectors in levels or expressed as a percentage of GDP. The research that follows will make use of health expenditure figures for both the private and public sectors similar to the research conducted by Novignon and Olakojo (2012:5). Health expenditure per household will be used as an indication of overall health (*HEALTH*) per municipality for the period from 1996 to 2012. Health expenditure is calculated using figures obtained from the national accounts as well as the final consumption expenditure by households report on medical expenditure, in addition to the income and expenditure survey of households from Statistics South Africa (Stats SA). The respective surveys are used to calculate municipal medical expenditure as prescribed by the classification of individual consumption according to purpose (COICOP) sub-expenditure items of expenditure on 'medical schemes' and 'medical other'. Health-related expenditure categories include: Medical products, appliances and equipment (pharmaceutical products, other medical and therapeutic appliances and equipment), outpatient services (medical services, dental services and paramedical services), and hospital services.

Becker's (1968) theory (based on rational behaviour) that crime will decrease as policing increases largely failed to gain support from subsequent empirical studies. This was largely due to endogeneity within the research not being addressed (Tella & Schargrodsky, 2004:115). More recent studies, however, did address such endogeneity concerns and found that increased policing would decrease crime (Levitt, 2004:176). For the purpose of the empirical analysis that follows it will be assumed that a reduction in crime was as a result of increased policing. Safety (*SAFETY*) will therefore be approximated by the crime rate reported per municipality for the years 1996 to 2012, as reported by Crime Research and Statistics - South African Police Service (SAPS) (see Appendix A).

The synthetic social infrastructure index will be calculated in a similar fashion to the basic infrastructure synthetic index. The underlying components will comprise of health (using medical expenditure as proxy), education (using people over the age of 20 with Grade 7 and higher as proxy), and safety (inverted crime index) as detailed above. The number of households in each municipality from 1996 to 2012 is used to normalise safety and health components in the index, while the total number of people over the age of 20 is used to normalise the education component in the index. The estimated basic infrastructure index, at the first principal component, is calculated as follows:

$$\text{SINF} = 0.715 * ln\left(\frac{Functionally\ Lit}{Pop\ aged + 20}\right) + 0.691 * ln\left(1 - \frac{Nr\ Crimes}{HH}\right) + 0.103 * ln\left(\frac{Med\ Spending}{HH}\right)$$

The education and safety components of the social infrastructure carry approximately the same weights in the social infrastructure index, while health accounts for a smaller weight. The first, second and third principal component account for 41%, 34% and 25% of the total scaled variance in the synthetic index. The index ultimately accounts for 41.18% of the overall variance of the three underlying variables and is highly correlated with the underlying infrastructure measures as shown in Table 1 below. The synthetic social infrastructure index is also highly and positively correlated with all dependent variables with the exception of percentage of people in poverty, which shows a negative correlation (Table 2). The correlations conform to the expectations detailed in the literature review.

Table 1: Synthetic basic and social infrastructure index: Correlation with underlying measures

BINF	
Electricity connections	0.911 (0.000)
Sanitation connection	0.906 (0.000)
Water connection	0.948 (0.000)
SINF	
Education	0.795 (0.000)
Safety	0.768 (0.000)
Health	0.114 (0.000)

(…) P-Value

Table 2: Synthetic basic and social infrastructure index: Correlation with control measures

Control Variable:	**Synthetic Index**	
	BINF	**SINF**
Log GDP per capita (LGDPPC)	0.756	0.581
Log household income (LHHINC)	0.704	0.469
Log percentage of people in poverty (LPOV)	-0.739	-0.627
Δ Log human development index (DLHDI)	0.036	-0.038.
Log percentage literacy (LPLIT)	0.783	0.610

The correlation between the synthetic basic and social infrastructure index is calculated as 0.685 (p-value: 0.000), indicating that the basic and social infrastructure have a positive relationship.

3.2 Model estimation and specification tests

A precondition for the use of the respective dependent and explanatory variables is to test for unit roots (stationarity). Each series used in the estimations will undergo the Levin, Lin and Chu t* (2002) test (individual and intercept), which assumes a common unit root (Levin, Lin & Chu, 2002). Should the series be stationary, it will either undergo a fist order I(1) or second order I(2) difference transformation. The stationary variables will then be used in the respective estimations. Thereafter, model validation tests aimed to determine if indeed the restrictions and individual effects are statistically significant will be conducted. The chosen estimation will then undergo specification tests for serial correlation, heteroskedasticity, and endogeneity in order to assess if measurement concerns, collinearity among infrastructure assets, identification and heterogeneity concerns have been addressed (Romp & De Haan, 2007; Calderón & Servén, 2008; Straub, 2010; Pereira & Andraz 2013). The unit root tests, model validation tests and specification tests are detailed below.

The Levin, Lin and Chu t* (2002) test for unit roots (stationarity) will be used to determine if the respective series are stationary. The critical value t_{ρ}^{*} ~ N(0,1) (one tail) is given as -1.645. The hypothesis being tested is defined as follows:

$$H_0: \rho_1 = .. = \rho_n = \rho = 0$$

$$H_1: \rho_1 = .. = \rho_n = \rho < 0$$

Here ρ is considered a persistent parameter of the process. The lag order $\hat{\rho}$ is unknown and is allowed to vary across individuals. In other words, the null hypothesis states that each individual time series contains a unit root as opposed to the alternative null hypothesis that each individual time series is stationary. The Levin, Lin and Chu (2002) t* test will take into consideration the individual intercept and trend in the specification test.

Choosing the correct model estimation technique will involve testing whether restrictions (dummy variables) and fixed effects are statistically significant. The use of dummy variables in the unrestricted between least square dummy variable (LSDV) estimation in favour of an unrestricted ordinary least square (OLS) models will be conducted. The chosen estimation technique will then undergo a test of endogeneity using the Hausman specification test, as suggested by Calderón and Servén (2008:8).

Empirical analysis will firstly involve the construction of an unrestricted OLS regression model, followed by a restricted within LSDV estimation. The unrestricted OLS regression estimation is needed to statistically validate the use of urban and rural slope and interaction dummy variables in the restricted between LSDV estimation in favour of the unrestricted OLS regression. Validating the use of the restricted (between) LSDV estimation, which includes the intercept and interaction dummy variables, will involve a restricted/unrestricted t-test. Rejecting the null hypothesis will conclude that the urban/rural intercept and interaction dummy variables are statistically significant, signalling that basic and social infrastructure impact differently on economic growth and social development in urban and rural municipalities. The use of the restricted between LSDV estimation will then be compared to the fixed effects (FE) LSDV estimation to determine if period and/or cross-section effects are significant (Hausman, 1978; Wooldridge, 2002:288; Baltagi, 2005:66). The respective models and validation tests are detailed below:

Unrestricted OLS regression estimation:

$$Y_{it} = \alpha + \beta_1 * BINF_{it} + u_{it}$$

$$Y_{it} = \alpha + \beta_1 * SINF_{it} + u_{it}$$

Where Y represent the respective control variables, i indicate the respective municipality (1-234) and t indicates the period (1996-2012). BINF represents the synthetic index for basic infrastructure while SINF denotes the synthetic index of social infrastructure. The error term which varies over i and t is denoted by u_{it}. The dependent variables will comprise of the log transformed gross domestic product per capita (*LGDPPC*), household income (*LHHINC*), human development index (*LHDI*), percentage of people in poverty (*LPPOV*) and functional literacy (*LPLIT*). The log transformation of the dependent variables will allow for interpreting the estimation results in terms of elasticities. Interpreting the results in terms of elasticities will further facilitate comparisons with existing research. The chosen model will then undergo a number of specification tests in order to confirm that estimates are unbiased and consistent.

The restricted between LSDV regression estimations are detailed below:

$$Y_{it} = \alpha + \beta_1 * BINF_{it} + \beta_2 * RUDUM_{it} + \beta_2 * BRU_{it} + u_{it}$$

$$Y_{it} = \alpha + \beta_1 * SINF_{it} + \beta_2 * RUDUM_{it} + \beta_2 * SRU_{it} + u_{it}$$

Where RUDUM represents the dummy variable for rural (1) and urban (0) municipalities, BRU represents the basic infrastructure interaction dummy variable calculated as BINF $*$ RUDUM and SRU the social infrastructure interaction dummy variable calculated as SINF $*$ RUDUM.

The restricted/unrestricted t-test performed on the efficiency and validity of use of the slope and dummy variables is defined as follows (Greene & Hensher, 2010:363):

$$F[(K-1),(NT-K-1] = \frac{(\text{RSSR} - \text{USSR})/\#Restrictions}{(\text{USSR})/d.f.}$$

K indicate the number of restrictions, N represents the number of cross sections and T the number of years. RSSR would be the restricted sum of square residuals and USSR the unrestricted sum of square residuals, while $d.f.$ indicate the degrees of freedom. The critical value, at 1% level of significance, is calculated as $F(2{,}3974)_{(critical\ 1\%)} = 4.6105$ for the model specified. The hypothesis being tested is defined as follows (δ being on the coefficient of the dummy variables):

$$H_0: \delta = 0$$

$$H_1: \delta \neq 0$$

In other words, the null hypothesis states that the impact of basic and social infrastructure on economic growth and social development do not differ between rural and urban municipalities. Should the dummy variables be statistically significant and the use of the restricted between LSDV estimation validated, it would be required to test for individual effects.

The restricted between LSDV estimation is expected to omit cross-section and period effects as panel data suffer from dynamic bias (Bond, 2002:1). Such static panel datasets will typically cause models to be miss-specified (Greene, 2013:727). In order to determine if period and/or cross-section effects are significant will require that the FE within LSDV estimation be subjected to the restricted between LSDV estimation, utilising the Chow fixed effects F-test.

Accepting the null hypothesis will suggest that individual effects are not significant and that the restricted within LSDV estimation technique will produce optimal estimates. Should the null hypothesis be rejected, it can be assumed that individual effects exist and that they are statistically significant. Rejecting the null hypothesis will necessitate that the FE within LSDV estimation be used, as it will produce more efficient and precise estimates. The FE within LSDV estimation is detailed as follows (Baltagi, 2005:33):

FE within LSDV two-way error component regression estimations:

$$Y_{it} = \alpha + \beta_1 * BINF_{it} + \beta_2 * RUDUM_{it} + \beta_2 * BRU_{it} + u_{it}$$

Where: $u_{it} = \mu_i + \lambda_t + v_{it}$, $v_{it} \sim idd(0, \sigma^2)$

$$Y_{it} = \alpha + \beta_1 * SINF_{it} + \beta_2 * RUDUM_{it} + \beta_2 * SRU_{it} + u_{it}$$

Where: $u_{it} = \mu_i + \lambda_t + v_{it}$, $v_{it} \sim idd(0, \sigma^2)$

μ_i represents unobserved individual effects, λ_t represents unobserved time effects and v_{it} represents the stochastic disturbance term, with u_{it} being the sum of the three components. The average of the error term is zero, its variant is fixed and distributed normally, independently and identically distributed, or $idd\ (0, \sigma^2)$. In order to determine if the restricted between LSDV or FE within LSDV models provide better estimates, it is required that the joint Chow fixed effect test (F-test) be conducted. The null hypothesis of no individual effects between municipalities will be tested in order to determine if fixed effects are significant between municipalities. The test is however only valid if individual cross-section and time effects are also judged to be individually significant, as indicated by Thomas (2004:32). Accepting the null hypothesis will suggest that period and/or cross-section effects are not significant when comparing the restricted between LSDV with the FE within LSDV estimation. The null hypothesis for a two-way error component model is defined as follows (Baltagi, 2005:33):

$$H_0: u_1 = u_2 = \cdots = U_i = 0 \ \& \ \lambda_1 = \lambda_2 = \cdots = \lambda_t = 0$$

$$H_1: u_1 \neq u_2 \neq \cdots \neq U_i \neq 0 \ \& \ H_1: \lambda_1 \neq \lambda_2 \neq \cdots \neq \lambda_t \neq 0$$

The Chow test statistic for a two-way error correction model, assuming Gaussian errors, is defined below (Thomas 2004:32):

$$F[(n-1)+(T-1),(n-1)(T-1)-K]=\frac{(\mathrm{RSSR}-\mathrm{USSR})/\#Restrictions}{(\mathrm{USSR})/d.f.}$$

The critical value, at a 1% level of significance, is calculated as $F(249{,}3725)_{(critical\ 1\%)} = 1.2294$ for the model specified. Should the null hypothesis be rejected it can assumed that cross-section and/or time effects exist between the municipalities and that the within LSDV estimation will produce more efficient and precise estimates. The test is however only valid if individual cross-section and time effects are judged to be individually significant. The individual cross-section specification is defined as follows (Thomas, 2004:32):

$$H_0: u_1 = u_2 = \cdots = u_i = 0$$

$$H_1: u_1 \neq u_2 \neq \cdots \neq U_i \neq 0$$

The Chow test statistic for the one-way fixed effects model with cross-section effects are defined as follows (Thomas, 2004:32):

$$F[(n-1),((n-1)(T-1)-K]=\frac{(\mathrm{RSSR}-\mathrm{USSR})/\#Restrictions}{(\mathrm{USSR})/d.f.}$$

The critical value is calculated as $F(233{,}3725)_{(critical\ 1\%)} = 1.2370$ for the model specified. The individual period specification is defined as follows (Thomas, 2004:32):

$$H_0: \lambda_1 = \lambda_2 = \cdots = \lambda_t = 0$$

$$H_1: \lambda_1 \neq \lambda_2 \neq \cdots \neq \lambda_t \neq 0$$

The Chow test statistic for the one-way fixed effects model with period effects are defined as:

$$F[(T-1),((n-1)(T-1)-K]=\frac{(\mathrm{RSSR}-\mathrm{USSR})/\#Restrictions}{(\mathrm{USSR})/d.f.}$$

The critical value is calculated as $F(16{,}3725)_{(critical\ 1\%)} = 2.0048$ for the model specified. Rejecting the null hypothesis that joint and individual period and cross-sectional effects are significant will signal the use of the FE within LSDV model.

Once the model validation tests have confirmed what estimation technique to use, it is required to complete specification tests for serial correlation, heteroskedasticity and endogeneity. Each of these tests will be detailed below.

The joint LM test for serial correlation will be used to determine the presence of serial correlation. The joint LM test is distributed as chi-square with one degree of freedom X_1^2 under the null hypotheses of no serial correlation. More formally, the null hypothesis is defined as follows (Baltagi, 2005:90):

$$H_0: \sigma_\mu^2 = \sigma_\lambda^2 = 0$$

$$H_1: \sigma_\mu^2 \neq 0 \ and/or \ \sigma_\lambda^2 \neq 0$$

The corresponding test statistic is calculated as follows:

$$F(X^2, 1): LM = LM_1 + LM_2$$

Rejecting the null hypothesis implies that cross-sections are heterogeneous in addition to dynamic adjustment taking place over time. We therefore have to include both individual (cross-sectional) and time (period) effects in the specification.

The test for heteroskedasticity is taken from Greene (2013:714). For the fixed effects model, heteroskedasticity can only be introduced in v_{it} . If v_{it} is heteroscedastic we can define $\mu_i \sim IDD\left(0, \sigma_\mu^2\right)$ and $v_{it} \sim (0, w_i^2)$. The joint LM test is distributed as chi-square with N-1 degree of freedom X_{N-1}^2 under the null hypotheses of homoscedasticity. More formally, the null hypothesis is defined as follows:

$$H_0: \sigma_i^2 = \sigma^2 \ for \ all \ i$$

$$H_1: \sigma_i^2 \neq \sigma^2 \ for \ all \ i$$

The corresponding test statistic is calculated as follows:

$$LM = \frac{T}{2} \sum_{i=1}^{n} \left[\frac{\sigma_i^2}{\sigma^2} - 1\right]^2 \sim X_{N-1}^2$$

Should the null hypothesis of homoscedasticity be rejected, then it can be concluded that standard errors are subject to heteroskedasticity. The standard errors can be corrected with the white period coefficient covariance method to correct for regular residual heteroskedasticity in light of N > T (Arellano, 1987:431; White, 1980:817). The proposed test for heteroskedasticity does however not tell us anything about the form of heteroskedasticity.

Exogeneity of the variables will be tested using the Hausman (1978) specification test with a chi-square distribution and K degrees of freedom. The null hypothesis (H_0) is specified as no misspecification in the model, or correlation between individual effects and exogenous variables. The alternative null hypothesis (H_1) being misrepresentation in model or correlation between individual effects. The hypothesis is constructed as follows (Greene, 2013:379):

$$H_0: E(\lambda_t|X_{it}) = E(\mu_i|X_{it}) = 0$$

$$H_1: E(\lambda_t|X_{it}) \neq E(\mu_i|X_{it}) \neq 0$$

Should endogeneity persist, it will require that inside (lagged and differenced) instrumental variables are used in a generalised methods of moments (GMM) framework to correct for endogeneity. The GMM modelling technique will allow for all variables that are not correlated with the error term, including lagged and differenced versions of such variables, to be used as instrumental variables that will address endogeneity concerns (Greene & Hensher, 2008:394). Efendic et al. (2009:9) suggest that one then has to choose between either a difference GMM or system GMM. Baltagi (2005:148) suggests that a system GMM will be preferable as it generally reduces sample bias in addition to providing more precise and efficient estimates when compared to a difference GMM. The representation of the system GMM estimation is detailed below:

$$y_{it} - y_{it-1} = \alpha y_{it-1} + \beta_1' * BINF_{it} + \beta_2' * RUDUM_{it} + \beta_3' * BRU_{it} + \mu_i + \lambda_t + v_{it}$$

$$= \alpha y_{it-1} + \beta' X_{it} + \mu_{it}$$

Where $X_{it} = (BINF_{it}', RUDUM_{it}', BRU_{it}')$, $\beta' = (\beta_1', \beta_2', \beta_3')'$ and $u_{it} = \mu_i + \lambda_t + v_{it}$.

The estimation might exhibit the potential problem of regressors in addition to the lagged dependent variable being endogenous. The presence of unobserved cross-section and time-specific effects might result in $E(\lambda_t|X_{it}) \neq E(\mu_i|X_{it}) \neq 0$ rendering the instrumental variables invalid.

Taking the first difference of the equation above also eliminates cross-section and time-specific effects. Baltagi (2005) and Kiviet (1995) argue that while within LSDV estimations may produce biased results, its consistency will depend on T being relatively large relative to N and that biasness will also decrease as $t \to \infty$. For the panel dataset used in the empirical analysis it will be assumed that T is sufficiently large to produce consistent and sufficiently biased estimates utilising within LSDV estimation techniques. The coefficients produced in the within LSDV estimation will therefore be used to estimate the respective urban and rural economic growth and social development equations.

Regressing the economic growth and social development variables against basic (*BINF*) and social infrastructure (*SINF*) will provide the coefficients needed to compile the respective urban and rural basic and social infrastructure equations for each of them on the economic growth and social development variables. The reasoning behind utilising the respective explanatory variables in addition to a detailed description of the respective variable will be detailed in the data section that follows.

3.3 Data

The following section will describe the choice of variables and sources used for the economic, demographic and social development variables. The selected demographic, economic and growth and development indicators will be sourced from the IHS Information and Insight Regional explorer database, which provides economic, development and socio-economic data for each of the municipalities in South Africa from 1996 to 2012. The respective municipality boundaries sets are in accordance with the Demarcation Board revision used for the 2012 municipal elections. The urban/rural municipality classifications will be done according to information obtained from the National Department of Cooperative Governance and Traditional Affairs (COGTA).

The IHS Information and Insight Regional eXplorer database provides a consolidated platform from where national, provincial, and municipal economic demographic and development data can be obtained for the years 1996 to 2012. The database ensures that areas (demarcations) in addition to the definitions of variables are comparable over time. The country has undergone a number of demarcation changes (as advised by the Demarcation Board) since 1994. Such changes can make the analysis of municipalities over time extremely cumbersome, as boundary changes imply that variables are not comparable from one boundary set to another. The Regional eXplorer database ensures that a fixed boundary set is used in order to allow for analysis over time. Should the municipal boundaries undergo a significant change (such as experienced at the beginning of 2012), the data is reworked to fit the new boundaries retrospectively. The definitions or manner in which primary data providers collect data are also not consistent over time and between publications. One example of this is the difference in questions regarding access to water. A number of Stats SA surveys measure the distance of the water supply from a household by asking the respondent either a) how long it takes them to walk to the water supply, or b) how far away the water supply is. Both of these methods are likely to cause inaccuracies, as (i) different people walk at different speeds and (ii) different people perceive distances and/or or time differently. Such inconsistencies or inaccuracies stretch across boundaries and a number of variables, and are too many to mention given the focus of this study. It is however worth mentioning that these "inaccuracies" are accounted for in the IHS Regional eXplorer database, ensuring more consistent and comparable figures as far as possible.

3.3.1 Demographic, economic growth and social development indicators

Infrastructure and its impact on economic growth has been noted as one of the most widely covered themes on the topic of infrastructure investment (Estache, 2006:7). Taking direction from a number of mentionable studies, such as Calderón (2009:9), Loayza et al. (2005:27), and D´emurger (2001:97), real output per capita is used to determine economic output. Gross domestic product (GDP), as a measure of output (or total production), measures the total output of the region by considering the value that was created within that region and will be used to determine economic growth in the country and urban and rural municipalities respectively. Essentially GDP calculates the difference between the inputs obtained from outside the region and the outputs of the region and includes the effect of subsidies and taxes. The GDP figures will be normalised through corresponding population figures deriving a GDP per capita (*GDPPC*) estimate in order to address, in part, some of the endogeneity concerns highlighted in the literature and methodology reviews (see Appendix A).

Limited empirical research was found on the impact that infrastructure development has on human development. Kusharjanto and Kim (2011:116), Suescún (2007:27), and Sapkota (2014:6) do however provide direction on the use of a human development index (HDI) in the analysis of the impact of infrastructure investment on overall human development. The HDI is defined as a composite index consisting of three basic dimensions of human development, namely being able to live a long and healthy life, knowledge and a decent standard of living.

Household income as opposed to household disposable income will be used for the purposes of the empirical analysis that follows. This will allow for capturing the direct cost saving stemming from lower unit costs of receiving service, as well as the increased potential to earn higher incomes resulting from higher education, productivity and the increased availability of hours per day to actually work (see Brenneman and Kerf (2002) for a summary of the interactions).

Notable research that investigated the impact of infrastructure on household income include De la Fuente (2010:23), Rioja (2003) and Estache et al. (2002:32). Household income (*HHINC*) is derived from total income for all households in a municipality, which include: labour remuneration, income from property (including dividend receipts, interest receipts less interest payments rent receipts less maintenance cost, mortgage interest and consumption of fixed capital), current transfers from general government, current transfers from incorporated business enterprises and transfers from the rest of the world. Income per household is presented in constant prices.

Research on the impact of infrastructure on poverty by Estache et al. (2000) and Jerome and Ariyo (2004:1) relied on standard $2 a day and $1 a day income poverty lines for their empirical analysis respectively. The research that follows will however employ an income poverty estimate using a slightly different approach to determine the poverty line as calculated by IHS Regional eXplorer. The first reason for the deviation from the traditional use of $1 and $2 estimates is for the sake of consistency with other variables, the second being that the data conforms to the municipal level detail required for the empirical analysis. The poverty figures used also differ slightly from the measures mentioned before in that it is calculated using a minimum monthly income figure needed to sustain a household and varies according to the size of that household. The percentage of people in poverty (*PPOV*) is defined as the number of people living in households that have a combined household income which is less than the respective household poverty income divided by the total population.

Studies by Jerome and Ariyo (2004:38) and Jerome (2011:22) use variations of literacy (adult, male and female) when analysing the impact of infrastructure investment on education. The analysis that follows will therefore use a similar approximation of education in the form of functional literacy, which is similar to adult literacy. Functional literacy (*PLIT*) is defined as people older than 20 who have completed their primary education (Grade 7) and are functionally literate. People who are functionally literate are assumed to have a level of reading and writing skills that enable them to manage daily life and employment.

The national and sub-national demographic variables are calculated using a cohort-component model. It incorporates large data releases such as the censuses (1996, 2001 & 2011) to establish a base line population figure for the country, province, and the respective municipalities. Various other indicators (which can be obtained at a higher frequency than the censuses) are utilised, such as deaths, births, fertility rates, HIV/AIDS, life expectancy, emigration, immigration and cross-municipal movements, which allow for the estimation of annual sub-national population figures within the cohort component model. The municipal demographic figures will be used as a denominator in the basic and social infrastructure synthetic indices. The model estimates consistent and comparable population and household figures on an annual frequency (see Appendix B).

3.3.2 Defining urban and rural municipalities

Estashe (2006:8) summarises that a large part of the related literature also discuss the trade-off between basic and social infrastructure delivery in urban and rural areas, which relates to the issue of urban and rural poverty relief policies. Estache (2006:13) further states that the urban and rural debate predominantly relies on case studies, and that empirical evidence is scarce. Such constraints have also been cited in the significance of the research. The analysis that follows will therefore include an urban and rural municipality component, which will allow for the analysis to be extended to determine urban and rural effects respectively. Defining whether a municipality is deemed urban or rural will be directed by an official definition obtained from the responsible national department.

The National Department of Cooperative Governance and Traditional Affairs (COGTA) classifies each of the local municipalities in the country into one of the following groups:

- B1 – With large budgets and containing secondary cities;
- B2 – Local municipalities with a large town as a core;
- B3 – Local municipalities with small towns, relatively small populations and a significant proportion of urban population but with no large town as a core; and
- B4 – Local municipalities which are mainly rural with communal tenure and with, at most, one or two small towns in their area.

Category B1 and B2 municipalities are deemed to be urban, while category B3 and B4 municipalities are considered to be rural (see Appendix C).

4 Empirical results

The respective restrictive (OLS), unrestricted between LSDV and FE within LSDV two-way error correction estimation results are presented in Table 3 and Table 5 below. The presented coefficients and its respective t-stats and p-values are detailed in addition to the overall F-stat estimates and p-values. The adjusted R^2 values are also reported. The basic infrastructure and social infrastructure model validation t-test and F-test statistics in addition to their calculated critical values are also presented in Table 3 and Table 5 respectively. The test statistics and the corresponding critical values for serial correlation, heteroskedasticity and endogeneity are also detailed in the respective tables.

The validated model and its corresponding values are used to construct the respective urban and rural economic growth and social development equations for basic (Table 4) and social (Table 6) infrastructure. The results will be used to indicate if, and to what extent, basic and social infrastructure impact on urban and rural gross domestic product per capita (*LGDPPC*), household income (*LHHINC*), human development index (*LHDI*), percentage of people in poverty (*LPPOV*) and functional literacy (*LPLIT*).

The results will be compared to previous studies in order to determine whether estimates conform to the expectations. It will also highlight the empirical results not yet provided by the body of literature reviewed, to affirm the significance of the research.

4.1 Basic infrastructure results

Results for the respective impact of social infrastructure on economic growth and social development variables are detailed in Table 5 below.

Table 3: Summary of basic infrastructure regression results

Row	Dependent Variable	LGDPPC			LHHINC			LPOV			LDHDI			LPLIT		
	Modelling Technique	**OLS**	**Between LSDV**	**Within LSDV**	**OLS**	**Between LSDV**	**Within LSDV**	**OLS**	**Between LSDV**	**Within LSDV**	**OLS**	**Between LSDV**	**Within LSDV**	**OLS**	**Between LSDV**	**Within LSDV**
A	C	9.6874 *11313.18* (0.000)	9.6079 *1005.11* (0.000)	9.6913 *3825.02* (0.000)	10.9352 *1835.10* (0.000)	10.8936 *1615.05* (0.000)	10.9410 *4286.40* (0.000)	-0.7341 *-209.18* (0.000)	-0.6901 *-182.24* (0.000)	-0.7587 *-66.07* (0.000)	0.0136 *21.8727* (0.000)	0.0134 *21.5215* (0.000)	0.01389 *31.6056* (0.000)	-0.5636 -243.788 (0.000)	-0.6028 *-255.53* (0.000)	-0.5446 *-128.57* (0.000)
B b	Basic Infrastructure (BINF)	0.3905 *72.8107* (0.000)	0.3612 *62.7905* (0.000)	0.0874 *18.3913* (0.000)	0.2332 *62.5024* (0.000)	0.2112 *52.0178* (0.000)	0.04340 *9.06318* (0.000)	-0.1521 - *69.1967* (0.000)	-0.1293 *-56.727* (0.000)	-0.1217 *-26.186* (0.000)	0.0132 *2.3963* (0.017))	0.0200 *3.4359* (0.001)	0.0245 *6.41675* (0.000)	0.11518 *79.4868* (0.000)	0.0994 *72.9024* (0.000)	0.0295 *19.3944* (0.000)
C	Urban Rural Dummy (RUDUM)		0.3868 *13.7612* (0.000)			0.1045 *5.2684* (0.000)			-0.1179 *-10.5890* (0.000)	0.1087 *2.1571* (0.031)			-0.0042 *-6.1789* (0.000)		0.1734 *33.3210* (0.000)	-0.0646 *-3.71501* (0.000)
D	Interaction variable (BRU)		-0.0348 *-1.7068* (0.090)	-0.0172 *-1.8665* (0.062)		0.0781 *5.4313* (0.000)	-0.0254 *-2.7239* (0.000)		-0.0749 *-9.2780* (0.000)			-0.0396 *-3.54576* (0.1069)	-0.02589 *-3.6097* (0.000)			-0.0187 *-5.9971* (0.000)
E	R2 Adj	0.5713	0.6000	0.9889	0.4955	0.5159	0.9745	0.5462	0.60423	0.9379	0.0015	0.0049	0.7135	0.61368	0.6979	0.9860
F	F-Stat	5301.39 (0.000)	1989.51 (0.000)	1423.32 (0.000)	3906.55 (0.000)	1413.52 (0.000)	568.07 (0.000)	4788.19 (0.000)	2024.95 (0.000)	224.580 (0.000)	5.74241 (0.0166)	9.166269 (0.000)	520.0542 (0.000)	6318.15 (0.000)	4595.59 (0.000)	1118.04 (0.000)
	Model Validation & Specification tests															
G	R/UR t-test CV $F(2,3974)_{(critical\ 1\%)}$		143.5291 4.6105			84.7342 4.6105			292.4047 4.6105			6.6780 4.6105			555.0050 4.6105	
H	Chow 2W test CV $F(249,3725\backslash 6)_{(critical\ 1\%)}$			592.0962 1.2294			271.2847 1.2294			82.5489 1.2294						331.1312 1.2294
I	Chow CS test CV $F(233,3975\backslash 6)_{(critical\ 1\%)}$			615.8460 1.2371			107.5373 1.2371			74.4449 1.2371						335.2598 9 1.2371
J	Chow Period test CV $F(16,3725\backslash 6)_{(critical\ 1\%)}$			49.7675 2.0048			1231.2304 2.0048			1906436 2.0048			614.6831 0 2.0048			341.1893 2.0048
K	Serial correlation given FE CV:$N(0,1)_{(critical\ 1\%)}$			48.8123 2.326			48.7697 2.326			46.9653 2.326			0.0974 2.326			46.5778 2.326
L	Heteroskedasticity CV: $X^2(233)_{(critical\ 1\%)}$			3974.8326 286.1389			2712.0122 286.1389			3035.0114 286.1389			633.9764 286.1389			2876.238 4 286.1389
M	Haussmann test for endogeneity CV: $X^2(2/3)_{(critical\ 1\%)}$			18.11598 9.2103			264.1117 9.2103			3.2077 9.2103			307.0569 9.2103			4.8682 9.2103

Row A-F: Coefficient, *t-stat*, (..) Probability

The Levin, Lin and Chu (2002) t*, test for unit roots is utilised to determine if the respective series used in Table 3 are stationary. The Levin, Lin, and Chu (2002) t* test assumes a common unit root process and is tested on the level with individual intercept and trend included in the test equation. *BINF* (-8.1207, p = 0.000), *BRU* (-4.99627, p = 0.000), *LGGDP* (-15.8509, p = 0.000), *LHHINC* (-16.5707, p = 0.000), *LPPOV* (-15.4276, p = 0.000) and *LPLIT* (-16.2228, p = 0.000) Results indicate that the calculated test statistic is smaller than the critical value t_{ρ}^{*} ~ N(0,1) (one–tail) of -1.645, additionally all p-values are < 0.05. The null hypothesis is therefore rejected in favour of the alternative hypothesis. The individual series intercept and trend in level form are therefore stationary. The *LHDI* (31.5784, p = 1.000) test statistics result in the null hypothesis not being rejected, indicating that the *LHDI* intercept and trend in level form are non-stationary. *LHDI* is however found to be stationary in the first difference I(1). The presence of a unit root will be accounted for by using *LHDI* in the first difference form and denoted as *LDHDI* for the regressions presented in Table 3 and Table 5.

The basic infrastructure OLS, between LSDV and within LSDV regression results indicate that the individual explanatory variables in the respective equations are statistically significant at a 5% (10%) level of significance. The explanatory variable(s) is also found to be jointly significant, at a 5% level of significance, in explaining the respective economic growth and social development models.

Validating the use of the between LSDV model in favour of the restricted OLS model utilises a restricted between LSDV and unrestricted OLS dummy variable specification t-test. Each of the calculated t-test values (Table 3, row G) are greater than the critical value of $F(2{,}3974)_{(critical\ 1\%)} = 4.6105$, which results in the null hypothesis being rejected in favour of the use of the restricted (between) LSDV regression results. The test therefore confirms that basic infrastructure investment has a statistically significant and different effect on economic growth and social development in urban and rural development respectively. The adjusted R^2 values in each of the restricted within LSDV estimations also increase when compared to the unrestricted OLS models, signalling that more of the variation in the dependent variables are accounted for in the respective restricted between LSDV models. Next it would be required to determine if individual period and/or cross-section effects are present and significant, validating the use of the FE within LSDV model.

The Chow specification F-test for two-way error correction models is used to determine if fixed (period and/or cross-section) effects are significant by comparing the restricted between LSDV and FE within LSDV models. The test is however only valid if individual cross-section and time effects are also judged to be individually significant, as indicated by Thomas (2004:32). The joint (period and cross-section) two-way error correction Chow test found the calculated F-stat (Table 3, row H) to be greater than the critical $F(249{,}3725/6)_{(critical\ 1\%)}$ value of 1.2294 in each of the respective regressions, with the exception of *LDHDI*, thus rejecting the null hypothesis of no individual effects. Period and cross-section effects are therefore present, which should be controlled for. Testing for individual cross-section effects individually also rejects the null hypothesis of no individual cross-section effects with the calculated F-stat being greater than the critical value of $F(233{,}3725/6)_{(critical\ 1\%)}$ of 1.2371 in each of the respective equations, with the exception of *LDHDI* (Table 3, row I). Cross-sectional heterogeneity should therefore be controlled for.

Lastly, testing for individual period effects individually results in the null hypothesis also being rejected as the calculated F-stat is greater than the critical $F(16{,}3725/6)_{(critical\ 1\%)}$ value of 2.0048 (Table 3, row J), once again with the exception of the *LDHDI* estimation. It is therefore needed to control for period effects (dynamic adjustments over time) for the municipalities in the panel. The Chow specification tests comply with all three requirements of rejecting the joint and individual null hypothesis of no period and/or cross-sectional effects in favour of using the FE within LSDV model. The *LDHDI* estimation produces better coefficients, considering expectations from the literature review, when only period effects are fixed. Testing for individual period effects in the *LDHDI* estimation result in the null hypothesis being rejected as the calculated F-stat is greater than the critical $F(16{,}3725/6)_{(critical\ 1\%)}$ value of 2.0048 (Table 3, row J).

The adjusted R^2 values in each of the within LSDV, with the exception of *LDHDI* estimations, also increase noticeably to range between 0.93 and 0.99 when compared to the restricted between LSDV models, which ranged from 0.52 to 0.73, signalling that more of the variation in the dependent variables are accounted when taking fixed period and cross-section effects into account in the model. The R^2 value of the *LDHDI* estimation also increases noticeably from 0.0015 in the OLS to 0.7135 in the within LSD estimation.

The within LSDV is then subjected to specification tests for serial correlation (Table 3, row K), heteroskedasticity (Table 3, row L) and endogeneity (Table 3, row M) in order to determine if the FE within LSDV model is correctly specified and produces unbiased and consistent estimates. Each of these specification tests are discussed below.

The joint LM test for serial correlation confirms that all of the respective economic growth and social development FE within LSDV regressions (with the exception of the *LDHDI* estimation) are non-stationary. All calculated F-stats (Table 3, row K) are greater than the critical $N(0,1)_{(critical\ 1\%)}$ of 2.326 (with the exception of the *LDHDI* estimation). The null hypothesis of no serial correlation is therefore rejected. Serial correlation is therefore present in the respective FE within LSDV models, excluding the *LDHDI* estimation. Serial correlation is expected to not affect the unbiasedness or consistency of the estimates, only its efficiency.

Heteroskedasticity is tested as suggested by Greene (2013:714) with the joint LM test distributed as chi-square with N-1 degree of freedom. The calculated LM statistic (Table 3, row L) is greater than the critical $X^2(233)_{(critical\ 1\%)}$ value of 286.1389 in each of the estimations. This results in the null hypotheses of homoscedasticity being rejected, indicating the presence of heteroskedasticity in the residuals. The presence of heteroskedasticity in the residuals can be corrected with the White period coefficient covariance method to correct for regular residual heteroskedasticity in light of N > T (Arellano, 1987:431; White, 1980:817).

Exogeneity of the explanatory variables is tested using the Haussman specification test, which is distributed chi-square with $m - k$ degrees of freedom. The calculated chi-square statistic (Table 3, row M) is greater than the critical $X^2(2/3)_{(critical\ 1\%)}$ value of 9.2103 in the *LGDPPC*, *LHHINC* and *LDHDI* estimations, resulting in the null hypothesis of exogeneity being rejected. The three models are therefore either miss-specified or correlation between individual effects and exogenous variables exist in the respective economic growth and social development estimations. The calculated chi-square statistic is however smaller than the critical value of 9.2103 in the case of the *LPOV* and *LPLIT* estimations, resulting in the null hypothesis of exogeneity being accepted. Comments made by Baltagi (2005) and Kiviet (1995), which indicate that if the T in the estimations is sufficiently large the coefficients are considered consistent and sufficiently unbiased, will validate the use of the FE within LSDV estimates, even though it may not be optimal. The coefficients produced in the within LSDV estimation will therefore be used to estimate the respective urban and rural economic growth and social development equations.

The FE within LSDV estimation can however still be used, as the estimation sweeps out individual and/or time specific effects. The estimates should therefore not be biased in the presence of endogeneity of the explanatory regressors. The coefficients will hence be used to calculate the urban and rural economic growth and social development equations (Table 4) that will be used for further analysis.

The FE within LSDV coefficients are used to construct the urban and rural intercept and slope coefficients for the economic growth and social development equations. The urban equations are constructed by adding the interaction dummy coefficient (*BRU*) from Table 3, row D, to the basic infrastructure (*BINF*) coefficient (Table 3, row B) in order to form a slope coefficient for urban basic infrastructure. The urban intercept is calculated by adding the slope dummy (*RUDUM*) from Table 3, row C, to the intercept coefficient (Table 3, row A). The rural municipality equations simply use the intercept (Table 3, row A) and basic infrastructure (BINF) slope coefficient due to the rural dummy variable (*RUDUM*) being 0 in addition to the interaction dummy (*BRU*) also being 0.

The dependent variable log transformation and the PCA methods producing a basic infrastructure index (*BINF*) in log format allows for a log-log interpretation of the results. The log-log transformation facilitates the process of analysing elasticities in each of the estimations. The respective constructed urban and rural economic growth and social development indicators are presented below:

Table 4: Basic infrastructure urban-rural municipality results

Variable:	***Area***	***Result:***
LGDPPC	Urban	$LLGDPPC = 9.6913 + 0.0702BINF$
	Rural	$LGDPPC = 9.6913 + 0.0874BINF$
LHHINC	Urban	$LHHINC = 10.956 + 0.0180BINF$
	Rural	$LHHINC = 10.9410 + 0.0434BINF$
LPPOV	Urban	$LPERPOV = -0.6500 - 0.1217BINF$
	Rural	$LPERPOV = -0.7587 - 0.1217BINF$
LDHDI	Urban	$LDHDI = -0.0097 - 0.0014INF$
	Rural	$LDHDI = 0.039 + 0.0245BINF$
LPLIT	Urban	$LPLIT = -0.6092 + 0.0108BINF$
	Rural	$LPLIT = -0.5446 + 0.0295BINF$

When increasing basic infrastructure by 10%, GDP per capita (*LGDPPC)* will increase by 0.702% in urban and 0.874% in rural municipalities. A 10% increase in basic infrastructure leads to a 0.180% and 0.434% increase in urban and rural household income (*LHHINC)* respectively. Increasing basic infrastructure by 10% will have a similar impact on rural and urban poverty (*LPPOV),* due to the slope dummy being statistically insignificant and being omitted from the within LSDV results, which is set to decrease by 1.217%. Increasing basic infrastructure by 10% will also increase the human development index (*LDHDI*) in rural municipalities by 0.245%. The resulting negative impact of a 10% increase in basic infrastructure leading to a decline of 0.014% in the urban human development index (*LDHDI*) does not conform to the expectations indicated in the literature review, possibly signalling either omitted variable bias or misspecification in the estimation. Lastly, a 10% increase in basic infrastructure will also increase literacy (*LPLIT*) in urban municipalities by 0.108% and 0.295% in rural municipalities. The results (with the exception of *LDHDI*) conform to expectations detailed in the literature review that basic infrastructure delivery has a positive impact on economic growth and social development. It also conforms to the view that the impact of basic infrastructure economic investment on economic growth and social development will be greater in rural municipalities.

4.2 Social infrastructure results

Results for the respective impact of social infrastructure on economic growth and social development variables are detailed in Table 5 below.

Table 5: Summary of social infrastructure regression results

Row	Dependant Variable	LGDPPC			LHHINC			LPOV			LDHDI			LPLIT		
	Modelling technique	**OLS**	**Between LSDV**	**Within LSDV**	**OLS**	**Between LSDV**	**Within LSDV**	**OLS**	**Between LSDV**	**Within LSDV**	**OLS**	**Between LSDV**	**Within LSDV**	**OLS**	**Between LSDV**	**Within LSDV**
A	C	9.6973 *855.651* (0.000)	9.5995 *769.884* (0.000)	9.7060 *4609.398* (0.000)	11.0004 1432.62 (0.000)	10.9382 *1272.56* (0.000)	10.9320 *1992.13* (0.000)	-0.7246 *-173.83* (0.000)	-0.6797 *-148.50* (0.000)	-0.7334 *-378.859* (0.000)	0.0171 *2.2973* (0.000)	0.0063 *10.12765* (0.000)	0.0185 *64.98* (0.000)	-0.5521 *-178.21* (0.000)	-0.5960 *-188.1260* (0.000)	-0.5970 *-202.4447* (0.000)
B	Social Infrastructure (SINF)	0.4312 *2.2821* (0.000)	0.4181 *35.7245* (0.000)	0.0692 *13.5245* (0.000)	0.2172 *31.4375* (0.000)	0.1966 *24.36512* (0.000)	0.1677 *32.3911* (0.000)	-0.1790 *-47.716* (0.000)	-0.1563 *-36.3808* (0.000)	-0.0787 *-16.7290* (0.000)	0.0049 *2.2973* (0.022)	0.0628 *10.12* (0.000)	0.01148 *8.6742* (0.000)	0.1270 *45.57664*(0.000)	0.1146 *38.5383* (0.000)	0.1099 *39.4923* (0.000)
C	Urban Rural dummy (RUDUM)		0.5995 *19.7923*(0. 000)			0.3330 *15.9468* (0.000)	0.3201 *243.0000* (0.0260)		-0.2120 *-19.0619* (0.000)			-0.0153- 11.3976 (0.000)	-0.00397 *-4.3567* (0.000)		0.2431 *31.5900* (0.000)	0.2404 *33.5356* (0.000)
D	Interaction variable (SRU)		-0.2289 *-9.1939* (0.000)	-0.0534 *-5.2922* (0.000)		-0.0809 *-4.7154* (0.000)	-0.0245 *-2.2273* (0.000)		0.0185 *2.20249* (0.000)	0.0536 *5.7769* (0.000)			-0.0178 *-4.3242* (0.000)		-0.0681 *-10.7641* (0.000)	-0.0570 *-9.8188* (0.000)
E	R2 Adj	0.3374	0.4038	0.9911	0.2196	0.2729	0.7038	0.393582	0.4563	0.94913	0.0013	0.0364	0.7215	0.3717	0.5116	0.5769
F	F-Stat	1787.77 (0.000)	793.116 (0,000)	1571.286 (0.000)	988.3181 (0.000)	440.0593 (0.000)	491.4256 (0.000)	2276.793 (0.000)	982.7116 (0.000)	263.9667 (0.000)	5.2777 (0.0216)	71.7583 (0.000)	531.3693 (0.000)	2077.230 (0.000)	1226.0360 (0.000)	282.490 (0.000)
	Model Validation & Specification tests															
G	R/UR t-test CV $F(2,3974)_{(critical\ 1\%)}$		222.4682 4.6105			146.9876 4.6105			231.1745 4.6105			-19.3281 4.6105			570.2751 4.6105	
H	Chow 2W test CV $F(249,3725)_{(critical\ 1\%)}$			1044.5964 1.2294						154.2475 1.2294						
I	Chow CS test CV $F(233,3975)_{(critical\ 1\%)}$			1089.3636 1.2371						114.6273 1.2371						
J	Chow Period test CV $F(16,3725)_{(critical\ 1\%)}$			318.5478 2.0048			365.2682 2.0048			301.1434 2.0048			623.9007 2.0048			39.7010 2.0048
K	Serial correlation given FE CV:$N(0,1)_{(critical\ 1\%)}$			0.06283 2.326			59.9917 2,326			42.0981 2.326			-0.02929 2.326			56.2817 2.326
L	Heteroskedasticity CV: $X^2(233)_{(critical\ 1\%)}$			4522.4004 286.1389			1513.7893 286.1389			3043.2874 286.1389			684.9679 286.1389			1599.2874 286.1389
M	Hausmann test for exogeneity CV: $X^2(3)_{(critical\ 1\%)}$			7.9528 9.2103			17.5266 9.2103			24.5197 9.2103			2749.2837 9.2103			3.8097 9.2103

Row A-F: Coefficient, *t-stat*, (..) Probability

The social infrastructure OLS, between LSDV and within LSDV regression results indicate that the individual explanatory variables in the respective equations are statistically significant at a 5% (10%) level of significance. The explanatory variable(s) is also found to be jointly significant at a 5% level of significance in explaining the respective economic growth and social development models.

The Levin, Lin and Chu (2002) t* test for unit roots is conducted on the *SINF* and *SRU* series not yet tested in the previous section. The *SINF* (-1.6402, p = 0.0505) and *SRU* (-1.6588, p = 0.0486) test statistics however result in the null hypothesis being rejected, at a 10% and 5% level of significance respectively, in favour of the alternative null hypothesis. The individual *SINF* and *SRU* series intercept and trend in level form are therefore stationary.

The validity of using the pooled LSDV model in favour of the restricted OLS model utilises the restricted/unrestricted dummy variable specification t-test. Each of the calculated t-test values (Table 5, row G) are greater than the critical value of $F(2{,}3974)_{(critical\ 1\%)} = 4.6105$, which results in the null hypothesis being rejected in favour of the alternative null hypothesis The test therefore confirms that social infrastructure investment has a statistically significant and different effect on economic growth and social development in urban and rural development respectively. The finding is significant because it indicates that the correct allocation of social infrastructure investment can be used to reduce social and economic inequality that persists between urban and rural municipalities. The adjusted R^2 values in each of the between LSDV estimations also increase when compared to the unrestricted OLS models, signalling that more of the variation in the dependent variables are accounted for in the respective between LSDV models. Next it would be required to determine if period and/or cross-section effects are present in the between LSDV model and if they should be taken into account in the form of a within LSDV estimation.

The Chow specification test for two-way error correction models is used to determine if fixed (period and/or cross-section) effects are significant by comparing the between LSDV and within LSDV models. The test is however only valid if individual cross-section and time effects are also judged to be individually significant, as indicated by Thomas (2004:32). The joint (period and cross-section) two-way error correction Chow test found the calculated F-stat (Table 5, row H) to be greater than the critical $F(249{,}3725/6)_{(critical\ 1\%)}$ value of 1.2294 for *LGDPPC* and *LPOV*, thus rejecting the null hypothesis. Period and cross-section effects are therefore present, which should be controlled for. Testing for individual cross-section effects individually also rejects the null hypothesis of no individual cross-section effects with the calculated F-stat being greater than the critical value of $F(233{,}3725/6)_{(critical\ 1\%)}$ of 1.2371 in the respective *LGDPPC* and *LPOV* equations (Table 5, row I). Testing for individual period effects individually for *LGDPPC* and *LPOV* result in the null hypothesis again being rejected, as the calculated F-stat is greater than the critical $F(16{,}3725/6)_{(critical\ 1\%)}$ value of 2.0048 (Table 5, row J). Period effects (dynamic adjustments over time) for the municipalities in the panel must therefore be controlled for. The three Chow specification tests therefore comply with the requirements of rejecting the joint and individual null hypothesis of no period and/or cross-sectional effects in favour of using the FE within LSDV model for *LGDPPC* and *LPOV*. The *LHHINC*, *LDHDI* and *LPLIT* estimation produce better coefficients, given expectations from the literature review, when only period effects are fixed. Testing for individual period effects in the *LHHINC*, *LDHDI* and *LPLIT* estimation result in the null hypothesis being rejected, as the calculated F-stat is greater than the critical $F(16{,}3725/6)_{(critical\ 1\%)}$ value of 2.0048 (Table 3, row J). Dynamic adjustments therefore occur over time and will be corrected for by including fixed period effects in the respective estimations.

The adjusted R^2 values in each of the within LSDV estimations also increase noticeably when compared to the between LSDV models, signalling that more of the variation in the dependent variables are accounted when taking fixed period and cross-section effects into account in the model. The within LSDV models are preferred and will be used in compiling the respective urban and rural municipality equations detailed in Table 6. The within LSDV models will however be subjected to specification tests for serial correlation, heteroskedasticity and endogeneity in order to determine if the FE/within LSDV model is correctly specified and produces unbiased and consistent estimates.

The joint LM test for serial correlation confirm that the within LSDV *LGDPPC* and *LHDI* regression is stationary. All calculated F-stats (Table 5, row K) are smaller than the critical $N(0{,}1)_{(critical\ 1\%)}$ of 2.326. The null hypothesis of no serial correlation is therefore not rejected. Serial correlation is therefore not present in the respective within LSDV models, given that cross-sections are heterogeneous in addition to dynamic adjustment taking place over time. The *LHHINC*, *LPOV* and *LPLIT* estimations are however not stationary as the calculated F-stats (Table 5, row K) are greater than the critical $N(0{,}1)_{(critical\ 1\%)}$ of 2.326. Serial correlation is once again expected to not affect the unbiasedness or consistency of the estimates, only its efficiency.

Heteroskedasticity is tested as suggested by Greene (2013:714) with the joint LM test distributed as chi-square with N-1 degree of freedom. The calculated LM statistic (Table 5, row L) is greater than the critical $X^2(233)_{(critical\ 1\%)}$ value of 286.1389 in each of the estimations, with the exception of *LPLIT*. This results in the null hypotheses of homoscedasticity being rejected, indicating the presence of heteroskedasticity in the residuals in the case of *LGDPPC, LHHINC, LPOV* and *LDHDI*. The presence of heteroskedasticity in the residuals can be corrected with the white period coefficient covariance method to correct for regular residual heteroskedasticity in light of N > T (Arellano, 1987:431; White, 1980:817).

Exogeneity of the explanatory variables is tested using the Haussman specification test, which is distributed chi-square with $m - k$ degrees of freedom. The calculated chi-square statistics (Table 5, row M) are greater than the critical $X^2(2/3)_{(critical\ 1\%)}$ value of 9.2103, in the case of *LHHINC*, *LPOV* and *LDHDI*, resulting in the null hypothesis of exogeneity being rejected. The model is therefore either miss-specified or correlation between individual effects and exogenous variables exist. The calculated chi-square statistics (Table 5, row M) for *LGDPPC* and *LPLIT* are smaller than the critical value of 9.2103, resulting in the null hypothesis of exogeneity being accepted. As suggested by Baltagi (2005) and Kiviet (1995), the calculation indicate that if the T in the estimations is sufficiently large, the coefficients are considered consistent and sufficiently unbiased, which will validate the use of the FE within LSDV estimates, even though it might not be optimal. The coefficients produced in the within LSDV estimation will therefore be used to estimate the respective urban and rural economic growth and social development for social infrastructure equations.

The FE within LSDV coefficient estimates are used to construct the urban and rural social economic growth and social development equation, similarly as in the preceding basic infrastructure section (Table 4). The impact of social infrastructure on the respective economic growth and social development indicators in urban and rural municipalities are presented below:

Table 6: Social infrastructure urban-rural municipality results

Variable:	***Area***	***Result:***
LGDPPC	Urban	$LGDPPC = 9.7060 + \ 0.0158SINF$
	Rural	$LGDPPC = 9.7060 + 0.0692SINF$
LHHINC	Urban	$LHHINC = 11.2521 + 0.1432SINF$
	Rural	$LHHINC = 10.9320 + 0.1677SINF$
LPPOV	Urban	$LPERPOV = -0.7334 - 0.0251SINF$
	Rural	$LPERPOV = -0.7334 - 0.0787SINF$
LDHDI	Urban	$LDHDI = -0.0145 - 0.0063SINF$
	Rural	$LDHDI = -0.0185 + 0.0628SINF$
LPLIT	Urban	$LPERLIT = -0.3566 + 0.0529SINF$
	Rural	$LPERLIT = -0.5970 + 0.1099SINF$

When increasing social infrastructure by 10%, GDP per capita (*LGDPPC)* will increase by 0.158% in urban and 0.692% in rural municipalities. A 10% increase in social infrastructure leads to a 1.432% and 1.677% increase in urban and rural household income (*LHHINC)* respectively. Increasing social infrastructure by 10% will decrease urban poverty (*LPOV)* by 0.251% and rural poverty (*LPOV*) by 0.787%. Increasing social infrastructure by 10% will also increase the human development index (*LDHDI*) in rural municipalities by 0.628%. The negative impact of a 10% increase in social infrastructure leading to a decline of 0.063% in the urban human development index (*LDHDI*) does not conform to the expectations indicated in the literature review, possibly signalling either omitted variable bias or misspecification in the estimation. Reverting back to the between LSDV *LDHDI* estimation coefficients will yield more sensical urban and rural elasticities of 0.063 and 0.079 respectively. These elasticities would suggest that a 10% increase in social infrastructure will increase the urban and rural human development index (*LDHI*) by 0.63% and 0.79% respectively (given low adjusted R^2 of 0.14). Lastly, a 10% increase in social infrastructure will increase urban and rural literacy rates (*LPLIT*) by 0.529% and 1.099% respectively. The results (with the exception of *LDHDI*) conform to the view that social infrastructure delivery has a positive impact on economic growth and social development, as discussed in the literature review. It also conforms to the view that the economic growth and social development impact resulting from social infrastructure will be greater in rural municipalities.

4.3 Conclusion on empirical results

Problems commonly encountered in empirical evaluations of this nature include measurement concerns (using a single infrastructure variable as proxy for infrastructure), collinearity among infrastructure assets, identification (simultaneity biasness or endogeneity/causality), and heterogeneity (varying quality and productivity of infrastructure). Initial suggestions to correct for measurement, identification and homogeneity concerns raised by Calderón and Servén (2008:16) and Pereira and Andraz (2013:6) have been implemented by using a balanced panel dataset and synthetic indices. The estimations are also able to take restrictions in addition to individual effects into consideration, which ultimately produce more consistent and unbiased estimates compared to the first OLS estimations.

The basic infrastructure *LGDPPC*, *LHHINC*, *LPOV* and *LPLIT* estimations were however found to be serially correlated. All of the basic infrastructure estimations were also found to be homoscedastic before corrective measures were utilised (Arellano, 1987:431; White, 1980:817). The basic infrastructure *LPOV* and *LPLIT* estimations did not exhibit signs of endogeneity and would therefore comply to all three specification tests, producing consistent and unbiased results, although somewhat inefficient. The estimation techniques used would however relax some of the endogeneity concerns, as suggested by Baltagi (2005) and Kiviet (1995), which would result in basic infrastructure *LGDPPC*, *LHHINC* and *LDHDI* estimations producing consistent and sufficiently unbiased results.

The social infrastructure *LHHINC*, *LPOV* and *LPLIT* estimations were however found to be serially correlated. All of the basic infrastructure estimations were also found to be homoscedastic before corrective measures were utilised (Arellano, 1987:431; White, 1980:817). The social infrastructure *LGDPPC* and *LPLIT* estimations did not exhibit signs of endogeneity and would therefore comply to all three specification tests, producing consistent and unbiased results, even though they might not be efficient. The estimation techniques used would however relax some of the endogeneity concerns, as suggested by Baltagi (2005) and Kiviet (1995), which would result in social infrastructure *LHHINC*, *LPOV* and *LDHDI* estimations producing consistent and sufficiently unbiased results.

While the calculated elasticities conform to the expectations detailed in the literature review, they do tend to be on the low side. Output elasticities of infrastructure have been found to range between 0.05 and 0.39. The results obtained from the respective *BINF* (Table 4) and *SINF* (Table 6) urban and rural equations range between 0.02 and 0.09. These results conform to studies from Shah (1992), Esfahani and Ramirez (2003) and Calderón and Servén (2009), producing elasticities of 0.05 (Mexico only), 0.12 (cross-country analysis), and 0.07 to 0.10 (cross-country analysis). Suescún (2007) indicate the infrastructure elasticity of poverty to be -0.32, using a $2/day poverty estimate. The *LPPOV* results obtained in *BINF* (Table 4) and *SINF* (Table 6) suggest elasticities ranging from -0.02 to -0.12 for urban and rural municipalities. Literacy-induced elasticities of infrastructure of 0.12 calculated by Suescún (2007) are also higher than the urban and rural *BINF* and *SINF* elasticities, which range between 0.02 and 0.11. The calculated *BINF* and *SINF* elasticities for the rural municipality *LDHDI* of 0.01 to 0.02 are low when compared to the results from Suescún (2007) of 0.17. Possible reasons for the comparatively lower infrastructure returns would be that quality was not accounted for, as suggested by Calderón and Servén (2008). Another possible reason could be the general institutional capacity of the three tiers of government, as cited by Hemson (2004:17) and Khosa (2003:48), resulting in a general lower economic and social return of infrastructure investment when compared to other countries.

The relatively higher rural elasticities presented in Table 4 and Table 6 conform to the expectations detailed in the literature review. While the findings conform to expectations, it provides actual empirical evidence that basic and social infrastructure do indeed have a greater economic growth and social development impact in rural areas.

While the results might suffer from some degree of biasness (in the presence of endogeneity) and inefficiency, the estimates are consistent and would provide comparative urban and rural results for the economic growth and social development equations. The empirical findings support the hypothesis that basic and social infrastructure investment impact differently on urban and rural economic growth and social development.

5. Conclusion

The NDP recognises poor education outcomes, a divided community, uneven public service performance, divided spatial patterns and crumbling infrastructure as some of the challenges that has to be addressed in order to overcome persistent poverty and inequality within South Africa. Central to the aforementioned challenges identified by the NPC are infrastructure delivery constraints, which inhibit the reduction of poverty and inequality across the country. The fact that the public sector has a central role in providing collective goods, places them in an ideal position to influence infrastructure policy and planning programmes aimed at inclusive economic growth and social development.

It is noteworthy that basic and social infrastructure investment do not yield similar economic growth and social return elasticities when compared to other countries, as cited in the literature review. While it was not the focus of this study, it could be accounted for by including quality of investment measures for basic and social infrastructure respectively. This could also underline governance concerns, ill-considered spatial implementation and the inability of planners to understand cultural aspects required to optimise social capital returns. Many of these factors are identified as constraints to South Africa becoming a growing and inclusive society as identified in the NDP.

The empirical research does confirm that basic and social infrastructure impact urban and rural economic growth and social development differently. The economic growth and social development return will be greater in rural municipalities compared to similar infrastructure investments in urban municipalities. The government should therefore include this dynamic in its basic and social infrastructure delivery planning as a means to reduce the economic growth and social development inequality experienced between urban and rural municipalities.

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7. Appendix A: Basic and social infrastructure data sources

Variable:	Data Provider:	Publication:
Water: Percentage of households above RDP-level	StatsSA	- General Household Survey (GHS) - October Household Survey (OHS) - Labour Force Survey (LFS) - Community Survey 2007 (CS) - Census 2011, 2001, 1996
	DWAF	
	Municipalities	- Local Economic Development (LED) - Integrated Development Plans (IDP)
	IHS Information and Insight	- Regional eXplorer
Sanitation – Percentage of households with hygienic toilets	StatsSA	- General Household Survey (GHS) - October Household Survey (OHS) - Labour Force Survey (LFS) - Community Survey 2007 (CS) - Census 2011, 2001, 1996
	DWAF	- Annual reports - Other
	Municipalities	- Local Economic Development (LED) - Integrated Development Plans (IDP)
	IHS Information and Insight	- Regional eXplorer
Electricity – Percentage of households with electrical connection	StatsSA	- General Household Survey (GHS) - October Household Survey (OHS) - Labour Force Survey (LFS) - Community Survey 2007 (CS) - Census 2011, 2001, 1996
	Eskom	- Annual reports - Other
	Municipalities	- Local Economic Development (LED) - Integrated Development Plans (IDP)
	IHS Information and Insight	- Regional eXplorer
Health	StatsSA	- Income and Expenditure Survey (IES) - Census 2011, 2001, 1996 - P0100 - Income and expenditure of households
	SARB	- SARB Quarterly Bulletin (S-110)). - Final consumption expenditure by households
	Other	- Classification of Individual - Consumption according to - Purpose (COICOP)
Safety	SAPS	- Crime Research and Statistics Unit
Education	StatsSA	- Census 2011, 2001, 1996 - Department of Education

8. Appendix B: Demographic and development variable data sources

Variable:	Data Provider:	Publication:
Population	StatsSA	- Community Survey 2007 - Mid-year population estimates - Census 2011, 2001, 1996
	BMR	- Report 274 - Report 282 - Report 285
	Other	- Human Science Research Council (HSRC) - Actuarial Society of Southern Africa 2003 (ASSA) - United Nations High Commissioner for Refugees (UNHCR)
Number of households	StatsSA	- October Household Surveys (OHS) - Labour Force Surveys (LFS) from 2000 onwards - Community Survey 2007 - Census 2011, 2001, 1996
Functional literacy rate	StatsSA	- October Household Surveys (OHS) - General Household Survey (GHS) - General Labour Force Survey (GLFS) - Labour Force Surveys (LFS) - Census 2011, 2001, 1996
Human Development Index (HDI)	StatsSA	- October Household Surveys (OHS) - General Household Survey (GHS) - General Labour Force Survey (GLFS) - Census 2011, 2001, 1996
	BMR	- Report no. 276
	SARB	- Quarterly Bulletin (S-110)
Gini Coefficient	StatsSA	- October Household Surveys (OHS) - General Household Survey (GHS) - General Labour Force Survey (GLFS) - Census 2011, 2001, 1996
Percentage of people in poverty	StatsSA	- Community Survey 2007 - Income and Expenditure Survey (IES) - Census 2011, 2001, 1996
	BMR	- Report no. 235. Minimum and Supplemented Living Levels in the main and other selected urban areas of the RSA
GDP per capita	Stats SA	- October Household Surveys (OHS) - General Household Survey (GHS) - General Labour Force Survey (GLFS) - Also see population above
	SARB	- SARB Quarterly Bulletin (S-110)).
Household income	StatsSA	- October Household Surveys (OHS) - General Household Survey (GHS) - General Labour Force Survey (GLFS) - Census 2011, 2001, 1996 - Also see population above
Employment	StatsSA	- General Labour Force Survey (GLFS) - Community Survey 2007 - Stats SA Gauteng Travel Survey and others - Census 2011, 2001, 1996
	Other	- Various industry associations (i.e. Chamber of mines)

9. Appendix C: Rural and urban municipality classification

Variable:	Data Provider:	Publication:
Rural municipalities	COGTA	- State of Local Government in South Africa, 2009 - Internal classification list 2012
	Demarcation Board	- GIS Flat files, 2012 Boundary sets
Urban municipalities	COGTA	- State of Local Government in South Africa, 2009 - Internal classification list 2012
	Demarcation Board	- GIS Flat files, 2012 Boundary sets

10. Appendix D: Serial correlation graphs