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Non-Economic Quality of Life and Population Density in South Africa

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ABSTRACT. The main purpose of this study is to investigate the relationship between population density and non-economic quality of life.

Popular opinion has generally been that population density can be seen as beneficial for economic growth, as it allows for greater productivity, greater incomes and can be translated into higher levels of quality of life. Recently though, growing evidence tends to suggest the exact opposite in that increases in productivity and incomes are not translated into better quality of life. As economic or income variables have always played a significant role in any research, questions regarding the relationship between population density and non-economic quality of life has largely remained unanswered.

In this light, the paper utilises a panel data set on the eight metropolitans in South Africa for the period 1996 to 2014 to determine the relationship between population density and non-economic quality of life in the South African context. In the analyses we make use of panel estimation techniques which allows us to compare changes in this relationship over time as well as adding a spatial dimension to the results. This paper contributes to the literature by firstly studying the aforementioned relationship over time and secondly conducting the analyses at a sub-national basis in a developing country.

Our results show that there is a significant and negative relationship between population density and non-economic quality of life. Based on our findings policy measures to encourage urbanisation should not be supported if the ultimate outcome is to increase non-economic quality of life.

Key words: Quality of life, Population density, Urbanisation, South Africa, Panel data analysis

JEL classification codes: O15, O18, O55, R11, R00, C01, C33, C43

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1 Introduction

The main purpose of this study is to provide insights regarding the relationship between non-economic quality of life and population density for regions designated at a sub-national level. The foundation of this study comes from Paul Krugman's (1998) work in that he found large regional inequalities in growth and development within countries and, that often, there were also an associated tendency for populations to concentrate in a few densely populated regions. His findings are important since they allude to a relationship between regions experiencing both more economic activities, i.e. higher economic growth and higher population density. Krugman (1998) argued that there is a tug of war between forces that tend to promote geographical concentration of both economic activity and population and those that tend to oppose it – between *centripetal*[3] and *centrifugal*[4] forces (Krugman 1998).

Buch, Hamann, Niebuhr and Rossen (2014), recapitulates Krugman's theory by stating that the density of a region's population could be influenced by said region's characteristics as it could act both as a repellent or an attraction to within country migration. They divide these characteristics into two distinctive groups: (i) labour market conditions representing unemployment levels and market wages and (ii) amenities representing the natural beauty, consumer facilities and the level of access to public goods.

At first glance, population concentration in a specific urban area seems like a very positive step to achieving not only higher economic growth, as newly developed political and economic structures will attract further investment leading to higher demand for labour, but also in achieving a higher quality of life for those residents within this now increasingly dense populated urban area. The problem however, is that internal and external migrants will also be attracted by the higher quality of life in these urban areas and might generate with their presence unemployment which could lead to increasing poverty levels, environmental decay and in many developing countries, the inception of slum areas, increased violence through riots and rising crime levels. Thereby, vis-á-vis decreasing quality of life in this now highly dense populated urban area (Bloom 2008).

South Africa is classified as a middle income country with a Gross National Income (GNI) of $6800 (current US$) for the year 2014 (Global Insight Regional Economic Explorer 2014). The country's Human Development Index (HDI) was 0.63 pointing to medium development achievements and the Gini coefficient 0.64 – which indicates large income inequality. Of its total population (53,781,908 million) a staggering 45.4 per cent was deemed to fall below the upper poverty line[5]. What is even more problematic is that 40 per cent of South Africa's total population and 31.3 per cent of those perceived as poor were located in only eight large urban areas classified as metropolitan cities[6]. On the whole, this might not seem like such a big problem, unfortunately, these eight highly dense populated metropolitan cities only cover 2 per cent (km^2) of South Africa's total land mass (Global Insight Regional Economic Explorer 2014). Figure 1 on the next page, provides a visual of the exact locations and relative land area of these eight metropolitan cities.

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[3] Centripetal are the three classic Marshallian sources of external economies; market size effects, thick labour markets and pure external economies.

[4] Centrifugal forces include immobile factors, land rents and pure external diseconomies.

[5] To see the formal definition of South Africa's upper poverty line please visit Statistic South Africa at www.statssa.gov.za/publications/Report-03-10-06/Report-03-10-06March2014.pdf

[6] City of Cape Town, EThekwini, Ekurhuleni, City of Johannesburg, Nelson Mandela Bay, City of Tshwane, Mangaung and Buffalo city.

Figure 1 Location of South Africa's eight metropolitan cities.

Source: Wikimedia commons 2016

This highly unequal distribution and clustering of people in these eight urban metropolitan cities provides us with a unique case study to test the influence of urbanisation, through population density, on quality of life.

Table 1, below, provides a social-economic profile on the eight metropolitan cities that will be used in this study.

Table 1 South Africa's metropolitan cities in 2014: Socio-economic profiles

Metropolitan city	Annual per capita income (Rand)	HDI	Gini coefficient	Poverty gap rate	Population density (number of people per km^2)	Total population	HIV (% of total pop)	Unemployment rate
City of Cape Town	72,343	0.72	0.62	26.4%	1586	3,874,504	6.3%	23.0%
EThekwini	56,572	0.63	0.63	28.5%	1560	3,544,822	15.2%	15.5%
Ekurhuleni	63,332	0.69	0.64	27.6%	1749	3,371,734	10%	28.3%
City of Johannesburg	76,524	0.71	0.65	27.3%	2904	4,786,449	9.4%	22.2%
Nelson Mandela Bay	53,056	0.66	0.63	27.7%	621	1,205,065	9.6%	28.3%
City of Tshwane	80,348	0.71	0.64	27.4%	496	3,152,165	8.5%	21.2%
Mangaung	51,097	0.64	0.62	27.0%	125	786,054	11.3%	23.9%
Buffalo City	47,655	0.64	0.64	28.0%	308	778,027	12%	25.5%

Source: Global Insight Regional Economic Explorer 2014

In this study, we will utilise a method made famous by McGillivray (2005) and subsequently used by Rossouw and Naudé (2008), Naudé, Krugell and Rossouw (2009), Rossouw and Pacheco (2012) and Pacheco, Rossouw and Lewer (2013) to construct an index for South Africa that measures non-economic quality of life on a sub-national level as measured by its eight metropolitan cities and to determine what relationship (if any) exists between non-economic quality of life and population density. This study fills the gaps and contributes to the literature in the following ways: (i) it is the first study of its kind (to the knowledge of the authors) that investigates the relationship between *objectively* measured non-economic quality of life and population density; (ii) it is the first study to investigate the abovementioned relationship on a sub-national level; (iii) it utilises panel data modelling techniques, not previously used in this type of research, which controls for unobserved heterogeneity; (iv) the usage of panel data has the additional advantage that by testing for endogeneity that spreads from simultaneity the causal relationship between population density and non-economic can be determined and (v) this study is conducted in a developing country whereas the other studies were conducted in developed countries. We will achieve these aims by firstly discussing the different ideologies behind economic and non-economic quality of life, constructing our index and running panel data regression analysis.

The rest of the paper is structured as follows. The next section explores theoretical and empirical literature regarding population density and quality of life. Section 3 describes the data and empirical model. The results and analysis will follow in section 4, whilst the paper will conclude in section 5.

2 Literature review

In this section we will briefly provide an overview of various literature we deem influential to our study. It provides a solid foundation for the various role players and will encompass population density, quality of life and consequently, non-economic quality of life as we interpret it. As indicated in the introduction section we perceive this study to be the first focusing on the specific relationship between objectively measured non-economic quality of life and population density. In saying this, we will however conclude this section by discussing various studies that share in our area of research and use them as a reference point to illustrate the gaps in the literature that we maintain will be filled by our current study.

2.1 Population density

In 1999, Gallup and Sachs used a geographic information system (GIS) to make three observations regarding population density. First, the relationship between population density and income level is much more complicated than originally thought. Regions with high population density were found to be both rich (Western Europe) and poor (China, India and Indonesia), and regions with low population density were found to be both rich (New Zealand and Australia) and poor (the Sahel[7] of Africa) as well. On a cross-country basis, a weak but positive correlation between population density and gross domestic product (GDP) per capita were found[8].

Second, the great Eurasian landmass has a higher population density than any of the other continents. Third, the coastlines and areas connected to the coast by navigable waters have a higher population density than the hinterlands (regions more than 100 km from the coast or an ocean-navigable waterway) (Gallup and Sachs 1999). As was pointed out by Gallup and Sachs (1999), the level of population density across various regions is problematic in the following two senses: first, there are massive human populations in regions seen as being quite disadvantaged for modern economic growth. Throughout history there has been one inclination for human population densities to rise in areas favourable for growth, so that coastal regions indeed do have higher levels of population density than hinterlands. Second, the more remote regions are currently experiencing higher population growth, mainly because population growth is negatively related to per capita income, and especially inversely related to a mother's education and the market value of a mother's time[9]. Thus, the level of population density in problematic regions is rising.

Third, as a result of the mismatch of economic growth and population growth trends, there is a mass migration of populations from the hinterland and surrounding areas to the coastal regions. The majority of migratory

[7] Sahel is the semiarid region of western and north-central Africa extending from Senegal eastward to the Sudan.
[8] For the universe of 150 countries with population greater than 1 million, the correlation between population density (population per km^2) and GDP per capita in 1995 is 0.32.
[9] In an urban setting, children are net economic costs: they are likely to attend school rather than contribute to household production, and because of urban mortality, are much less reliable as social security for aged parents. Moreover, the opportunity costs of raising children are much higher, especially if women are part of the urban labour force.

movements are within poor countries, leading to unprecedented inflows of population into urban areas and the rise of mega-cities (metropolitans) in developing countries.

History teaches us that there has definitely been an influx of population into urban cities although the last several decades has seen a complete reverse of the aforementioned especially in industrialised countries (Glaeser and Gottlieb 2006). During the 1990s, however, there has been what is coined as an '*urban resurgence*' but interestingly enough, this reversed trend is not representative of all urban areas. Whether a specific urban area is considered to grow or contract all depends on the amount of internal migrants it attracts. It was found by Buch, et al. (2014) that even though labour market conditions are seen as a primary attraction tool, it was also the quality of life of an urban city which influenced residents' choice of where to stay. They highlighted that positive domains of quality of life such as amenities (recreational facilities), climate and accessibility to public goods played a significant role but that one should also take into account the negative domains of quality of life (disamenities) such as crime rate, CO_2 emissions etc. as these decreased the attractiveness of the urban cities.

Bloom (2008) warned that high population density has caused major air, water and land pollution and that there is a massive increase in slum population in and around urban areas. These increasing populations living in deplorable circumstances give rise to economic and social instability in these 'affluent' areas.

From the above discussions, it can be seen that internal migration to specific urban areas driven by the promise of higher economic quality of life as measured by more employment opportunities and/or higher compensation causes a significant increase in those regions population densities. These higher population density regions could possibly give rise to lower non-economic quality of life through various disamenities.

2.2 Quality of life

Rahman, Mittelhammer and Wandschneider (2003:1) stated: "*Given that improving quality of life is a common aim of international development, the long-term future of humanity lies in a better understanding of factors that may have had or will have an impact on the quality of life*".

Since the 1970s, there has been countless studies done to determine not just what quality of life entails but also more importantly how does this translate to real world development. This field of economics and quality of life research has gone through numerous growth spurts (see Sumner (2003) for a comprehensive study) and it is accepted that quality of life is a multidimensional concept which does not merely encapsulates economic domains (GDP per capita) but also non-economic domains (amenities, environment, crime etc.).

When reading the important works done by Sen (1984; 1996) and Griffin (1986; 1991) it is clear that the state of a person, their abilities as well their core prudential values are what enables a human life to 'go well'. This implies that there is some subjective aspect to determining quality of life. Rojas (2003) stated that subjective quality of life refers to the well-being as professed by a specific individual. It is based on a declaration made by an individual and can be seen as a measure that incorporates all life events, aspirations, achievements, failures and emotions.

This clearly aligns with Sen and Griffin's philosophy regarding a 'good' human life. Whilst acknowledging this, there is also economic quality of life sometimes referred to as objective quality of life that needs to be addressed.

Economists have come a long way since simply utilising GDP per capita as a measure for quality of life, as they acknowledge this could provide a warped picture of a country's ability to translate its income into better health, longevity, social amenities etc. However, economists do still prefer to rely on objective measures as it is seen as tangible, easily quantifiable and not very dear. Many researchers have developed theories and indices through which to capture the essence of objective quality of life and to measure across time how these changes impact peoples' life. If one was to focus on the study of quality of life within the field of economics, it is important to note the works done by Towsend (1979), Erikson, Hansen, Ringen and UUsitalo (1987) and certainly Erikson (1993) through which they showed that quality of life is an economic good and should be treated as a multidimensional concept and not purely linked to monetary variables such as GDP per capita.

In 2007, Lambiri, Biagi and Royuela sited that there are two main reasons driving an unrelinquishing interest in studying quality of life within the field of economics: (i) the use of quality of life measures to be used as a political tool; meaning that if one can measure across specific regions and make comparisons then it becomes increasingly beneficial to influence policy change and (ii) quality of life is increasingly influencing the location choices of the population at large.

Many researchers have depicted theories and/or proposed measures for economic or objective quality of life. The main contributors in this field has been the Human Development Index (HDI) which was first released in the 1990 Human Development Report, Calvert-Henderson Index (Flynn 2000), Morris' Physical Quality of Life Index (1979) and Osberg and Sharpe's Index of Economic Well-Being (2000). In ground breaking work done by McGillivray (1991), McGillivray and White (1993) and Cahill (2005) a positive correlation was found between the HDI and Gross National Product (GNP) per capita. This suggested that the HDI was completely 'redundant' in capturing non-economic quality of life (which was its initial goal) as the economic component still dominated. To an extent this positive relationship between HDI and per capita income was due to the fact that per capita income is one component of the HDI – the other two being literacy rate and life expectancy measured in total years. Thus, given that the HDI, and by implication most other development index statistics, is not an exclusive indicator of non-economic quality of life as it contains per capita income, a new non-economic quality of life index had to be constructed. This index must not contain income or any other economic aspects of quality of life.

As was stated by Veenhoven (1996: 2) "*The key aim of Social Indicators Research is to create an all-inclusive measure of quality of life in countries that is akin to Gross National Product in economic indicator research*".

Therefore, this study ascertains that the problem with non-economic quality of life indices so far has been that they are either (i) subjective by nature or (ii) objective but contains an income measure of some sort. This impedes any study that makes use of contemporary non-economic quality of life measures since the impact of income on the proposed results must be eliminated (Diener and Diener 1995).

In 2005 McGillivray proposed a method through which the effect of per capita income could be eliminated from an objective quality of life measure. This would mean that you could measure quality of life by making use of objective indicators, then by taking out the income effect you would be left with a true objective non-economic quality of life measure. This could then be used to see whether countries, regions or cities were able to translate their income levels into better heath, longevity, social amenities etc., thereby increasing their population's quality of life. McGillivray's (2005) methodology has been subsequently utilised by Rossouw and Naudé (2008), Naudé, Krugell and Rossouw, Rossouw and Pacheco (2012) and Pacheco, Rossouw and Lewer (2013) and is also used in this study. This methodology will be discussed in greater detail in section three.

2.3 Relationship between population density and quality of life

This section will be used to identify the caveats in the literature pertaining to the relationship between population density and quality of life. From the discussion to follow, it can be seen that studies either focuses on (i) subjective quality of life as their measure, (ii) where objective indicators are used, income in some form or another is included thereby rendering their measure 'redundant' and (iii) the impact on major metropolitan areas in developing countries have been neglected.

Carnahan, Gove and Galle (1974) studied the supposition that higher population densities was responsible for a decrease in subjective quality of life as was measured by a rise in pathological behaviour. They drew conclusions based on US data for the years 1940 to 1970, on both national and regional level across ethnicity lines and concluded that there was no clear relationship to prove the abovementioned hypothesis. Contradicting this finding, Cramer, Torgersen and Kringlen (2004) in a study that investigated 3590 individuals between the age of 18 and 65 that were registered in the National Population Register for Oslo in 1994 determined lower population density has a positive effect on subjective quality of life.

To test their hypothesis regarding the influence of population density on subjective quality of life, Fassio, Rollero and De Piccolli (2013) studied 344 adults living in Piedmont (North-West Italy) between the ages of 18 and 88. More specifically, they postulated that people living in areas with a higher population density should enjoy higher physical health but should experience lower quality of life in the following three domains; (i) psychological health, (ii) relational and (iii) environmental quality of life. They concluded by excepting their hypothesis in that people did indeed experience lower quality of life in the aforementioned three domains if they resided in areas with higher population density. They marked that their findings were in line with Cramer et al.'s (2004) study in that lower population density does increase subjective quality of life (through higher number of friends and a reduction in negative life events).

When it comes to smaller residential areas or neighbourhoods, the relationship between population density and quality of life is not as clear cut. Walton, Murray and Thomas (2008) tested the aforementioned by making use of various sizes of neighbourhoods in Auckland, New Zealand. The purpose was to see whether there was any effect on perceived environmental[10] quality of life (one of the main four domains). The study was conducted by the completion of surveys which were mailed out to participants. Unfortunately, the authors had a very low response rate of 26 per cent (1998 survey were posted) but they concluded that population density had no significant effect on residential satisfaction, environmental quality of life nor affected the intention/desire to relocate. Walton et al. (2008) concluded that they did not support Cramer et al.'s (2004) finding of higher population density translating into more negative life events and a decrease in perceived neighbourhood quality.

Glaeser and Shapiro (2001) as well as Glaeser (2012) used US data to investigate the impact of population density on urban migration which directly impacts on the regions quality of life. They found that there was no one suitable answer; positive agglomeration effects (increasing returns to scale) due to high population density was observed but there were also negative effects for example congestion costs – this could be argued to translate into lower subjective quality of life.

In the following section, we attempt to fill these caveats by (i) constructing objective non-economic quality of life measures which eliminates the effect of income, (ii) applying these measures on a sub-national level by investigating South Africa's highest populated areas (its eight metropolitan cities) and (iii) provide an insight to the relationship between these two indicators. We do this by using data that is freely available so as to encourage other comparative sub-national studies.

3 Approach

As this study incorporated quite a few techniques, this section is structured as follows; first, we discuss the proposed method for the creation of our objective quality of life indices. Second, we will illustrate how the effect of income is eliminated from our indices. Third, the general function in testing the relationship between our objective non-economic quality of life indices and population density will be discussed. Various panel data estimation and validation tests round of this part which will be followed by a discussion on the data and variables used.

3.1 Outline of methodology

In constructing our non-economic quality of life indices for South Africa's eight metropolitan cities, we follow the method first proposed by McGillivray (2005) where he stated that one could distinguish between economic and non-economic quality of life by extraction, through principal component analysis (PCA), the maximum possible information from various standard national non-economic quality of life indicators. The variation not accounted for by per capita income was defined as μ_i, and was defined as the residual yielded by cross-country regression of the extraction on the natural log of Purchasing Power Parity (PPP) GDP per capita. Thus, μ_i can be

[10] Due to a lack of environmental variables in our data set we were unable to test the effect of environmental factors on non-economic quality of life, though this is a very important matter that should be addressed in future research.

interpreted as a measure of non-economic quality of life as it measures quality of life achieved independently of income.

Subsequently, this methodology has been utilised by Rossouw and Naudé (2008) where two separate non-economic quality of life indices were constructed on a sub-national level for South Africa's 354 magisterial districts for 1996-2004, Naudé, Krugell and Rossouw (2009) where a non-economic quality of life measure was constructed for South Africa's then six metropolitan areas spanning the years 2001-2004, Rossouw and Pacheco (2012) where two non-economic quality of life indices were constructed on a regional level for New Zealand covering the period 1986-2006 and Pacheco, Rossouw and Lewer (2013) where two non-economic quality of life indices were applied in conjunction with other independent welfare measures to an extended gravity model of immigration for 16 Organization for Economic Cooperation and Development (OECD) destination countries for the period 1991 to 2000.

Thus, following the pre-mentioned method, we first compile two separate indices by making use of principal component analysis (PCA) and obtain a single summary measure for each. Second, we take these single measures and run a regression against the natural log of per capita income. Lastly, we save the residuals, μ_i from these regressions and interpret it as true objective non-economic quality of life, as this residual contain the variation in the regression not explained by per capita income.

The regression that we run on the composite summary indices against the natural log of per capita income can be obtained by the following:

$$Q_{it} = \alpha + \beta \ln y_{it} + \mu_{it} \tag{1}$$

Where Q_{it} is the composite summary measure of quality of life in metropolitan area i in period t (t= 1996-2014); and y_{it} is the natural log per capita income in metropolitan area i in period t, with μ_i the residual term. This residual term is the indicator we utilise to identify and specify our true objective non-economic quality of life indices.

To test the robustness of the newly constructed non-economic quality of life indices we correlate them with other single measures of non-economic quality of life available in the data set. If the composite indices are correlated to these single measures, it is assumed that they are robust measures of non-economic quality of life. The results on this section are discussed in 4.2.

As the main purpose of this paper is to determine the relationship between non-economic quality of life and population density for South Africa's eight metropolitan cities, the above compilation of the non-economic quality of life indices were considered step 1. After the compilation of these indices, the following general function was estimated in order to analyse this relationship, which is then seen as step 2:

$$Y_{it} = \beta_1 X_{1,it} + ... + \beta_k X_{k,it} + \mu_{it} \quad (2)$$

Where Y_{it} is the dependent variable (DV), namely the non-economic quality of life index, with *i* being the entity (metropolitan city) and *t* being time (1996-2014). $X_{k,it}$ represents a set of control variables, ($k=1.....m$) and β_k is the estimated coefficients for the independent variables, μ_{it} is the error term.

To estimate the specified model in equation (2) panel data analysis was utilised. Panel data specification exploits the time dimension within the metropolitan cities and controls for the unobserved subject specific effects. In other words, panel data estimation has the advantage over cross sectional analysis in that it controls for endogeneity arising from *unobserved heterogeneity*[11] *(omitted variable bias)*, which is often present in the estimation of quality of life regressions (Balagi 2008). Consequently, both Random Effects (RE) and Fixed Effects (FE) models[12] were estimated for each of the dependent variables. The Hausman test was used to compare the estimation results of each of the aforementioned models and a significant difference was found to be present between the FE and RE models. Consequently, we report and interpret the FE models.[13]. The findings from this part of the analysis are presented in section 4. 2.

Although the problem associated with endogeneity arising from *unobserved heterogeneity* might be addressed by panel data analysis, the endogeneity that results from *simultaneity (reverse causality)* still needs attention. Simultaneity can be solved by using the Instrumental Variable Regression (IVR) method in which a variable to instrument the endogenous variable is introduced (Husain, Dutta and Chowdhary 2014). We investigated the likelihood of reverse causality by instrumenting the conceivably endogenous variable. The Davidson-MacKinnon test of exogeneity was used to test for the presence of endogeneity. If the test statistic is significant we will reject the null hypothesis which states that the independent variables are exogenous and thus accept the alternative hypothesis. In section 4.2 we report the results on the IVRs.

For validation purposes regarding the findings, we estimate three separate regressions on each of the constructed non-economic quality of life indices as well as using adult literacy rate as dependent variables. We compare the results of each of these regressions. In the event of these results being similar our findings are robust and we only interpret the results of the first estimated model in which the most relevant non-economic quality of life index is used as the dependent variable.

[11] . Heterogeneity is the likelihood that there are important independent variables that are not included in a regression model but which are correlated with the dependent variable.

[12] Panel data analysis can be divided into FE and RE methods. The FE method is designed to study the causes of changes within an entity such as a metropolitan city. The model estimates change in the dependent variable from changes in the independent variables (within group variation) and removes estimates of any variables that are time invariant being either observed or unobserved. In this manner the FE model, in particular, deals with unobserved heterogeneity. The main limitation of the FE method is that it can only incorporate the effect of variables that change over time, such as population density or the GDP per region, and not variables that are time invariant. Time invariant variables, however, can be estimated using RE techniques, as it uses both within group and between group variation.

[13] We ran diagnostic tests for homoscedasticity and autocorrelation. To address heteroscedasticity, we made use of robust error estimations. No autocorrelation was detected. To test for multicollinearity we correlated all independent variables and found no correlation of more than 0.3.

3.2 Data and variables

The data used for the analyses were obtained from Global Insight's Regional Economic Focus (REF) (see www.globalinsight.co.za) and is from their Regional eXplorer (ReX) database. ReX is compiled by combining various sources of sub-national information from for example; Statistics South Africa, South African Reserve Bank, South African Revenue Service, Council for Scientific and Industrial Research etc. For this study, we compile a panel data set by appending data for the years 1996 to 2014. It is a balanced panel data set including all eight metropolitan cities in South Africa. The total number of observations are 152.

In South Africa there are three different categories of municipalities with a total of 278. The categories include the eight metropolitan cities, which we are investigating in this paper, 44 district and 226 local municipalities. Our dataset, has its basis in the 2011 Census boundaries.

As discussed in section 3.1 we construct two non-economic quality of life indices and we interpret these as such since they are independent of per capita income (economic quality of life). Through the selection of variables in compiling these indices, we were led by McGillivray (2005) and then Naudé, Krugell and Rossouw (2009), as they modified McGillivray's model to reflect the qualities representative of South Africa.

In compiling his composite index, McGillivray (2005) used life expectancy (years), adult literacy rate and the gross school enrolments ratio whereas Naudé, Krugell and Rossouw (2009) included life expectancy, adult literacy rate and a variable coined 'equal', which they defined as '1 – the Gini coefficient'. The selection of this specific indicator reflects the importance of income distribution's effect on quality of life (Kanbur and Venables 2005). South Africa is classified as the fourth most unequal country in terms of income distribution, therefore the 'equal' variable is a very relevant indicator to be included in a South African specific non-economic quality of life composite index (NEQoLI). As life expectancy is not available for South Africa on a sub-national level, we follow Naudé, Krugell and Rossouw (2009) by using the ratio of the population over the age of 75 years as a sign of longevity. Table 2 below shows the descriptions, source and descriptive statistics across the eight metropolitan cities for the selected variables as well as the proportion of population with no schooling, formal housing and the HDI used as in robustness tests and as comparative measures.

Table 2 Variables used in compiling non-economic quality of life

Variable	Description	Source	Mean	Stand. dev	Min	Max
Over 75 years of age rate	Proportion of people over 75 years of age	Census data from StatsSA	.015	.003	.009	.023
Adult literacy rate	The proportion of people over the age of 15 who have a functional ability of reading and writing.	Census data from StatsSA	.84	.06	.74	.92
School enrolment rate	The proportion of children enrolled in primary education	Census data from StatsSA	.97	.016	.93	.99
Equal	1-Gini Coefficient	Authors' own calculation	.37	.021	.34	.45
Per capita income	Annual mean income per person in a region.	Census data from StatsSA	34680.79	16860.43	10727.79	80348.10
HDI	A composite statistic index of life expectancy, education, and income per capita indicators.	Regional Economic Focus Data from Global Insight	.64	.06	.57	.72
Proportion of population with no schooling	Proportion of the population that has no schooling	Census data from StatsSA	710539	4567	16246	164716

Source: Global Insight Regional Economic Explorer 2014.
Notes: Stand. dev = standard deviation.

The variables included in the regression analysis as specified in equation (2) was gleamed from various development and quality of life literature (see section 2.3) as well as the availability of data. Table 3 below, provides a summary as regards to the description, source, means, distributions and the minimum and maximum values covering the period 1996 to 2014 for the selected independent variables used in the regression analysis as specified in equation (2) (see section 3.1)

Table 3 Summary statistics for the independent variables

Variable name	Description	Source	Mean	Stand. dev	Min	Max
Population density	Number of people per square kilometre of land area	Census data from StatsSA	964.53	707.53	100.41	2904.27
GDP	Nominal GDP per metropolitan area	Gross Domestic Product Data from StatsSA	131 million	115 million	108 million	561 million
Gini coefficient	Distribution of income among the population	Regional Economic Focus Data from Global Insight	.63	.02	.55	.66
Crime	Standardised Crime Index	South African Police Service data	.51	.25	0	1
HIV rate	HIV prevalence rate	Mortality and causes of death data from. StatsSA	.08	.03	.01	.15
Poverty rate	Proportion of people living under the upper bound poverty line.	Census data from StatsSA	.46	.09	.29	.66
Unemployment rate	Proportion of people unemployed	Census data from StatsSA	.23	.04	.14	.32
Education matric rate	Proportion of the population that has successfully completed matric/grade 12	Census data from StatsSA	.18	.03	.11	.23
Formal housing rate	Proportion of people residing in formal housing	Census data from StatsSA	.76	.05	.64	.88

Source: Global Insight Regional Economic Explorer 2014.

We transformed population density (our variable of interest) by using its natural log so as to improve the distribution of the variable and to improve the fit of the model. The control variables included in the regression are: the natural log of GDP, the Gini coefficient (Kanbur and Venables 2005), the standardised crime index (see Carnahan, Gove and Galle 1974), the HIV rate (see Worthington and Krentz 2005 and BER 2006), the poverty rate (see Diener and Diener 1995), the unemployment rate, the proportion of people that successfully completed matric (highest level of high school) and the proportion of people residing in formal housing (see Zakerhaghighi, Khanian and Gheitarani 2015 and Richards, O'Leary and Mutsonziwa 2007). We ran all diagnostic tests and found an absence of multicollinearity and autocorrelation. In order to address heteroscedasticity, we made use of robust error estimations.

4 Results

4.1 Principal Component Indices

Taking the variables from table 2, our two non-economic quality of life indices starts its journey by extracting the first principal component from using PCA:

$PC_e = a_1$Life expectancy + a_1Adult literacy rate + $a_1$school enrolment rate (3)

$PC_g = a_1$Life expectancy + a_1Adult literacy rate + $a_1$1-Gini coefficient (4)

Where PC for enrolment (PC_e) represents non-economic quality of life as measured by McGillivray, PC with the Gini-coefficient (PC_g) represents our own constructed index making use of the specified proxies and a_{1n} represents the factor loading for the 1st principal component and the n_{th} variable.

The standard method when applying PCA in constructing composite indices is to use the factor loadings (a_{1n}) of the indicators on the first extracted component to weight the index (Klasen 2000). For equation (3), using years of life expectancy, the adult literacy rate and the gross school enrolments ratio the first extracted component after conducting PCA explained 83 per cent (eigenvalue = 2.49) of the variance in the data (PC_e).

When the same above method was applied to our constructed index (PC_g) (equation 4) using the proxies for life expectancy, adult literacy rate and the Gini-coefficient it was found that the first extracted component explained 57 per cent (Eigenvalue = 1.59) of the variance in the data. Even though, this is significantly lower when compared to McGillivray's index (equation 3) it is still sufficient to represent the variance observed (for comparative studies see Vyas and Kumaranayake 2006; Rossouw and Naudé´ 2008; Naudé´ et al. 2009; and Rossouw and Pacheco 2012).

After the indices were constructed and the first components saved (PC_e and PC_g), the regression against the natural log of per capita income was conducted:

$$PCe_{it} = \alpha + \beta \ln y_{it} + \mu_{it} \quad (5)$$

$$PCg_{it} = \alpha + \beta \ln y_{it} + \mu_{it} \quad (6)$$

The residual terms derived from equation (5) and equation (6) are designated $NEQoL_{enrolment}$ (NEQoLe) and $NEQOL_{gini}$ (NEQoLg) accordingly.

In order to test for robustness, we correlate these residuals with one another as well as with other standard variables for non-economic quality of life. This proofed to be somewhat problematic since we were left with a limited number of variables pertaining to non-economic quality of life in the available dataset as many indicators were already part of the composite index. Therefore, we selected HIV (proxy for health, see table 3), the proportion of the population with no-schooling (table 2) and the proportion of households that reside in formal housing (table 2). As can be seen from table 4 below, we found that the NEQoLe and NEQoLg are strongly correlated (r=0.93) with each other, indicating that although different indicators of non-economic quality of life were used in the construction of the composite indices the underlying non-economic quality of life it measures are similar. These measures were also found to be statistically significantly correlated to our composite indices representing non-economic quality of life with the expected sign of correlation. We are confident that the above supports the robustness of these non-economic quality of life measures.

Table 4 Pearson Correlation coefficients between selected indicators and our own derived measures for non-economic quality of life.

Indicators	NEQoLe	NEQoLg	HIV (table 3)	Proportion of Population with no schooling(table2)	Formal Housing
NEQoLe	1.00				
NEQoLg	0.93***	1.00			
HIV	-0.37 ***	-0.35***	1.00		
Proportion of population with no schooling	-0.41 ***	-0.49***	-0.35**	1.00	
Formal Housing	0.44 ***	0.53***	0.03	-0.62***	1.00

Source: Authors' own calculation using data derived from Global Insight Regional Economic Explorer 2014.

Note: ***Indicates significance at 1 % confidence level, **indicates significance at 5 % confidence level and * indicates significance at 10 per cent confidence level.

In table 5 below, we report the rankings of South Africa's eight metropolitan cities according to the residuals NEQoLg and NEQoLe. As an added measure we compare these two objective non-economic quality of life indicators with two other well know measures of quality of life, HDI and per capita income for each of these cities.

Table 5 Rankings according to NEQoL Indices, HDI and per capita income.

Metropolitan city	NEQoLg	NEQoLe	HDI	Income per capita	Income per capita (rank) – NEQoLg (rank)
1. Cape Town	0.696(1)	0.676(2)	0.691(1)	41 824.74(3)	2
2. EThekwini	0.364(4)	0.381(4)	0.596(6)	30 312.24(5)	1
3. Ekurhuleni	0.148(8)	0.158(8)	0.66(4)	38 562.20(4)	-4
4. City of Johannesburg	0.211(7)	0.226(6)	0.686(2)	47 543.42(2)	-5
5. Nelson Mandela Bay	0.613(2)	0.678(1)	0.62(5)	29 918.82(6)	4
6. City of Tshwane	0.301(6)	0.16(7)	0.682(3)	48 560.06(1)	-5
7. Mangaung	0.341(5)	0.349(5)	0.595(7)	29 572.63(7)	2
8. Buffalo City	0.387(3)	0.421(3)	0.591(8)	25 552.12(8)	5

Source: Authors' own calculation using data derived from Global Insight Regional Economic Explorer, 2014.

What is interesting to note from the above table is that our two objective non-economic quality of life measures as well as the other two economic quality of life measures tend to group metropolitan cities in the middle ranking similar. However, this is not the case for cities with extreme rankings as can be seen in the difference computed between the income per capita and the NEQoLg rank order (column 6). Cities with relatively high (City of Johannesburg, the City of Tshwane and Ekurhuleni) and low levels of per capita income (Nelson Mandela Bay) are ranked in reversed order when we compare to non-economic quality of life rankings. The big difference in the ranking order of the City of Johannesburg, the City of Tshwane and Ekurhuleni shows that these cities do not translate high levels of per capita income into high levels of non-economic quality of life (the difference in ranking orders are high and negative). This shows that economic quality of life does not necessarily *translate into* non-economic quality of life. Furthermore, the results confirm the importance of measuring non-economic life not affected by income, as only then can we get a true measure of the impact of policy on the non-economic quality of life of people.

One should note that although the average income per capita might be relatively high in these cities it gives no indication of the distribution of income. Cities such as Johannesburg and Tshwane have areas with very high income earners, but also slum areas in which poverty is rife. In Johannesburg 19 per cent and in Tshwane 20 per cent of their residents stay in informal housing characteristic of slum areas (Global Insight Regional Economic Explorer 2014). In the slum areas people have limited access to water, electricity, plumbing, food and work (Davis 2003). These factors contribute to lower levels of non-economic quality of life. Furthermore, as has been shown in the literature (Clark and Kahn 2001), higher population density, which is positively correlated to per capita income, also have drawbacks other than large slum areas, such as pollution, crime, congestion, noise, stressful commutes and expensive housing (disamenities).

4.2 Regression analysis

As was stated in section 3.1, we will only report the findings pertaining to the NEQoLg[14] as this is the preferred composite index and best suited to portray the South African scenario (results on NEQoLe and Adult Literacy Rate, used as validation tests, are reported in annexure A). We ran all regressions using both RE and FE methods, in order to determine the preferred method of estimation we used the Hausman test as a signal. The null hypothesis of the Hausman test stating that the difference in coefficients is not systematic was rejected (*chi-square (9)* = 232.24, *p*=0.00), indicating that the FE estimation is the preferred method. We report the FE and the FE with standardised coefficients in table 6.

Since population density has the potential to have reverse causality (simultaneity) (Rosen 1979) in regards to NEQoL (meaning that it is the level of NEQoL in a metropolitan city that attract more people thereby increasing the amount of people residing per square km of land) we also estimated two stage least squares (2SLS) instrumental variable regressions (IVR). The options of variables to instrument population density was limited. On investigation we found the number of households in the metropolitan city as the most adequate instrument, as it was strongly correlated with the population density variable (*r* = 0.90) and not the optimal uncorrelated relationship, but a weakly correlated with the NEQoLg variable (*r*=-0.19). As we used the natural log of population density in our original estimated regressions we transform the number of household variable in the same manner. The results of the *Wald F statistic* based on the *Kleibergen–Paap rk* statistic showed that the instrument was strong and valid. Assuming endogeneity in the model we estimated the model using IV(2SLS). The *Davidson-MacKinn*on test of erogeneity on the population density variable was found not to be statistically significant (*p*=.20), suggesting that the population density variable is exogenous. Therefore, we concluded that simultaneity was not present in the model and interpreted the results of the FE without considering the IV(2SLS) results, however the estimation results of the IVR (2SLS) pertaining to NEQoLg are reported in table 6.

[14] However, NEQoLg and NEQoLe are very closely correlated (r=0.93), which reflects the robustness of the selection of variables included in our preferred index. To validate our results, we also run all estimations using NEQoLe and adult literacy rate as the dependent variables. We found these results very similar and therefore conclude that our results are valid. Adult literacy rate is often used as a measure of NEQoL (McGillivray 2005). These estimation results are reported in annexure A.

Table 6 Estimation results with NEQoLg as the dependent variable

Variable	FE	FE(Std)	IVR(2SLS)
LnPopulation density SE	-0.680*** (-6.41)	-3.136*** (.489)	-0.601** (-5.04)
LnGDP SE	0.282*** (5.72)	1.324 (.231)***	0.253** (4.79)
Gini-coefficient SE	-3.463*** (-6.83)	-.353 (.052)	-3.446** (-7.00)
Crime rate SE	-0.0640** (-2.73)	-.119 (.043)	-0.0567* (-2.43)
HIV rate SE	-2.072*** (-4.15)	-.342 (.082)	-1.924** (-3.87)
Poverty rate SE	-0.653** (-3.29)	-.289 (.088)	-0.741** (-3.63)
Unemployment rate SE	-0.312 (-1.91)	-.056 (.029)	-0.331* (-2.08)
Education matric rate SE	-1.539* (-2.45)	-.245 (.1000)	-1.426* (-2.33)
Formal housing rate	0.415** (2.98)	.202 (.067)	0.388** (2.84)
Constant SE	2.597*** (5.45)	.283 (.015)	
R-sq. within/ between/overall	0.8960	0.8960	0.8951
F/ Wald Chi^2	F(9.135)=129.28	F(9.135)=129.28	Chi2(9) = 421.74
Probability	0.000	0.000	0.000

Source: Authors' own calculation using data derived from Global Insight Regional Economic Explorer 2014.

Note: ***Indicates significance at 1 % confidence level, **indicates significance at 5 % confidence level and * indicates significance at 10 per cent confidence level using two-tailed tests. FE (std) gives the FE estimations of the standardised variables, the mean of the variables is = 0 and the standard deviation =1

According to the reported FE estimation results (table 6), population density (our variable of interest) is negatively related to NEQoLg and statistically significant at the 1 per cent level. To validate this finding we ran the specified model with alternative dependent variables of non-economic quality of life; namely NEQoLe and adult literacy rate. The results using the alternative measures of non-economic quality of life coincide with and support our initial finding (see annexure A).

Our results agree with the studies of Fassio, Rollero and De Piccolli (2013), Glaeser and Shapiro (2001), Glaeser (2012) and Walton, Murray and Thomas (2008) that studied the related topic of the effect of population density on subjectively measured quality of life and found a negative relationship, but contradicts the study of Cramer, Torgersen and Kringlen (2004). The FE estimation results indicate population density has an elasticity of -0.68 suggesting that a 1 per cent increase in population density will on average, *ceteris paribus*, result in 0.0068 units decrease in the level of non-economic quality of life. Seeing that non-economic quality of life is measured on a scale from zero to one, it is a significant influence. Furthermore, considering the standardised coefficient estimations of the FE model we find that the natural log of population density, compared to the other independent variables, has the largest coefficient (-3.156), though one must remember that this variable is transformed and not population density in itself. Therefore, to affect the non-economic quality of life, population density is a very important factor to consider.

More important than the unit number effect of population density on non-economic quality of life is the fact that the relationship is negative. This implies that as population density increases it negatively affects the non-economic quality of life of the residents in metropolitan cities in South Africa (the endogeneity test also reveals reverse causality). Non-economic quality of life indicators such as education, health, service delivery, the availability of formal housing and pollution therefore is negatively affected by increased population density and outweighs any positive effects of agglomeration such as increasing returns to scale, access to better employment opportunities, wider range of goods and services or increased recreational/educational services.

Based on the results of the endogeneity test there exists no reversed causality between population density and non-economic quality of life, thus there is no *feedback effect* and in this model we can assume that the causality flows from population density to non-economic quality of life. The causality between population density and non-economic quality of life has not previously been tested and these results contribute further to our understanding of the causal relationships that influence non-economic quality of life.

In regards to the control variables: the natural log of GDP, Gini-coefficient, crime rate, HIV prevalence rate, poverty rate, unemployment rate, and the formal housing rate were all statistically significant at either the 1 per cent or 5 per cent level with the expected signs. Education rate (proportion of people with grade 12) was surprisingly only statistically significant at the 10 per cent level according to the results of the FE and the IVR, but not statically significant in the RE model. Interestingly enough, the relationship albeit for the most part statistically insignificant revealed a negative sign. This indicates that if a higher proportion of all people have matric (the highest level of high school education) non-economic quality of life will decrease. This might reflect the lack of employment opportunities for people who have matric, which might include a big proportion of the youth. According to the expanded definition, the unemployment rate for the youth (younger than 25) is at 63.1 per cent, thereby making South Africa one of the countries with the highest rate of youth unemployment (StatsSA, 2015). The high rate of unemployment contributes to much of the social tension and anguish experienced in South Africa, especially among the youth. Previous research conducted by Greyling and Tregenna (2016) and Greyling (2015) found similar results related to the South African scenario with education either being statistically insignificant or negatively related to quality of life in South Africa. A possible explanation is that people with only matric education level is not sufficient to ensure them employment, therefore it is likely that they stay at home in less than desirable surroundings. Increasing employment opportunities should be high on the policy agenda of South Africa.

The impact of GDP on non-economic quality of life is not surprising as without higher levels of production of goods and services, which in turn leads to higher levels of employment, higher levels of income, greater access to better housing, health and education and services, there can be no extra monetary resources to accomplish the aforementioned benefits.

From the standardised estimation results of the FE model it seems that the Gini-coefficient- and the HIV variables, relative to the other independent variables have the largest coefficients (-.353 and 0.342, respectively), not considering the natural logged variables (population density and GDP). This indicates that these variables are important factors in the examination of non-economic quality of life for people residing in South Africa's metropolitan cities. These two variables are very distinct to the South African scenario. The importance of the Gini-coefficient emphasises the important role an unequal distribution of income plays on peoples' non-economic quality of life. According to Rowlingson (2011) income inequality is detrimental to the economy as it creates both social and health related problems. People are ranked according to a hierarchical system coupled to their level of income and this in turns creates pressure manifesting as stress and anxiety to the 'have nots'. Contradictory to believe, income inequality does not act as an incentive to work harder but rather discourages people from seeking employment.

These results also emphasise the unique role of HIV in South Africa, because of its high prevalence rate. HIV and AIDS has a synergistic relationship with Tuberculosis, maternal- and child- morbidity and mortality rates. Globally, South Africa has the largest number of people living with HIV and AIDS, with approximately 6.4 million (12.8 per cent of total population) infected with the disease in 2015 (StatsSA 2015). HIV does not only affect the non-economic quality of life of the people suffering from HIV but also their wider support system consisting out of family, friends and health professionals. The limited life expectancy of HIV sufferers has dire consequences for households. If the parents pass away the households are often headed by children with limited access to income, health or education services.

5 Conclusions and recommendations

The main aims of this paper have been to develop composite indices to measure non-economic quality of life within the eight metropolitan areas in South Africa and then to estimate the relationship between these measures of non-economic quality of life and population density.

Quality of life is a multidimensional concept encompassing both economic and non-economic components. If policy makers on behalf of the people are driven by the achievement of a higher standard of living and wellbeing, understanding and analysing the determinants of quality of life over a population, society or region seems a necessary condition to understand human behaviour.

Worldwide the phenomenon 'urban resurgence' is taking place which shows that many urban areas are experiencing a massive influx of internal migrants (Glaeser and Gottlieb 2006). This higher population density can be seen as beneficial for growth, as it allows specialisation, increasing returns to scale and positive externalities. This will ultimately lead to greater productivity, greater incomes and higher levels of quality of life. Whilst acknowledging the advantages of population density, new evidence tends to suggest that increasing returns to scale is not always the outcome or result of higher population densities. More importantly, increases in productivity and therefore higher incomes are not always translated into better quality of life as this phenomenon can create various disamenities (Glaeser and Gottlieb 2006).

Most of the research to date pertaining to the relationship between quality of life and population density have been (i) subjective in nature or (ii) objective but in these studies a measure of income was included and we know because of the work done by McGillivray (1991) that any of these quality of life measure will be deemed 'redundant' as the income component will dominate. Research has also mainly focused on relatively small samples groups, not on a wider sun-national level and these studies were conducted primarily in developed countries.

In this study, our main contributions have been to (i) construct an index for South Africa's eight metropolitan cities that measures objective non-economic quality of life (see McGillivray, 2005); (ii) to investigate the relationship between non-economic quality of life and population density on this sub-national level; (iii) utilise panel data modelling techniques, not previously used in this area of research, which controls for unobserved heterogeneity; (iv) utilise panel data as it has the additional advantage that by testing for endogeneity that spreads from simultaneity the causal relationship between population density and non-economic can be determined and lastly (v) conduct research on the aforementioned relationship in a developing country (South Africa) since the majority of studies found were conducted in developed countries. We found the following:

When we investigated non-economic quality of life on a whole we found that our composite index ranked the eight metropolitan cities different than those obtained from the HDI and GDP per capita measures. Metropolitans with relatively high levels of economic quality of life such as the City of Johannesburg's and the City of Tshwane's ranking changed compared to the those obtained through our non-economic quality of life index. The City of Johannesburg and the City of Tshwane was found to be almost at the bottom of our non-economic quality of life rankings. This indicates that economic quality of life does not necessarily translate into non-economic quality of life. Evidence of this can be seen in both the Cities of Johannesburg and Tshwane which has large slum areas and high poverty rates. In the City of Johannesburg 19 per cent and in the City of Tshwane 20 per cent of their residents stay in informal housing which is characteristic of slum populations (Global Insight Regional Economic Explorer 2014). In these slum areas people have limited access to water, electricity, plumbing, food and employment opportunities (Davis 2003). These factors all contribute to lower levels of non-economic quality of life.

The regression analysis between population density and our objectively measured non-economic quality of life index revealed the following: first and most important, population density is negatively related to objective non-economic quality of life and statistically significant at the 1 per cent level. No evidence of reversed causality between population density and non-economic quality of life was found suggesting the causality flows from population density to non-economic quality of life. The causality between population density and non-economic quality of life has not previously been tested and this result contribute further to our understanding of the causal relationships that influence non-economic quality of life. The implication of these findings strongly suggests that future policy makers has to take into account that changes to population density as a direct result of policy changes will have an impact on non-economic quality of life.

Second, the control variables used in our regression analysis were all statistically significant at either the 1 or 5 per cent level. The variables with the expected signs were: the natural log of GDP, Gini-coefficient, crime rate, HIV prevalence rate, poverty rate, unemployment rate and the formal housing rate. From the standardised estimation results of the FE model it was found that the Gini-coefficient- and the HIV variables had the largest coefficients, relative to other estimated coefficients and therefore the largest impact on South Africa's non-economic quality of life. These two variables are very distinct to the South African scenario as South Africa is classified as the fourth worst country in terms of income inequality and the country with the highest number of people living with HIV (StatsSA 2015).

Interestingly, the education rate (proportion of people with grade 12) was only statistically significant at the 10 per cent level and revealed a negative sign. This indicates that if a higher proportion of all people have matric (the highest level of high school education) non-economic quality of life will decrease. We explain this with the rationale that people with only matric education level is not sufficient to ensure them employment, therefore it is likely that they stay at home in less than desirable surroundings.

These findings have significant implications for policy formulation as it states in the South African Constitution that the aim of the South African Government is to improve the quality of life for all people in the country (RSA 1998). A concerted effort should be made to address the push factors that leads to internal migration thereby uplifting and developing non-urban and rural areas. Furthermore, for those people living in densely populated areas the emphasis should be on improving amenities such as better access to education, employment opportunities, health, service delivery and housing.

Annexure A

Validation of estimation results

In annexure A we include the estimation results with NEQoLe and adult literacy rate as dependent variables to test the validity of our regression results in which NEQoLg is our preferred dependent variable (see section 4.2). The results regressing NEQoLe and adult literacy rate on our independent variables were very similar to those found on NEQoLg. Therefore, we can conclude that our results are valid.

Table 7 Estimation results NEQoLe as the dependent variable

Variable	FE	IVR(2SLS)
LnPopulation density SE	-0.500*** (-3.91)	-0.166* (-1.13)
Lngdp SE	0.189** (3.19)	0.066 (1.01)
Gini SE	-1.680** (-2.76)	-1.617** (-2.66)
Crime SE	-0.124*** (-4.38)	-0.093** (-3.23)
HIV_rat SE	-0.005 (0.01)	-0.627 (1.02)
Povrat SE	-0.704** (-2.94)	-1.074** (-4.28)
Unempl_rat SE	-0.938*** (-4.77)	-1.021** (-5.21)
Ed_matric SE	-4.077*** (-5.38)	-3.645** (-4.80)
hhfor_rat SE	0.585*** (3.48)	0.469** (2.78)
Cons SE	2.460 (4.29)	
R-sq. within/ between/overall	0.754	0.742
F/ Wald Chi^2	F(7.134)=46.04	Chi2(9) = 10383.20
Probability	0.000	0.000

Source: Authors' own calculation using data derived from Global Insight Regional Economic Explorer 2014.

Note: ***Indicates significance at 1 % confidence level, **indicates significance at 5 % confidence level and * indicates significance at 10 per cent confidence level using two-tailed tests. Instrument = ln (number of households).

Table 8 Estimation results Adult Literacy Rate as the dependent variable

Variable	FE	IVR(2SLS)
LnPopulation density SE	-0.083*** (-5.79)	-0.028* (-1.66)
LnGDP SE	0.078*** (11.70)	0.057** (7.69)
Gini-coefficient SE	-0.208** (-3.05)	-0.197** (-2.83)
Crime rate SE	-0.013*** (-3.96)	-0.007* (-2.26)
HIV rate SE	-0.147* (-2.19)	-0.045 (-0.64)
Poverty rate SE	-0.109*** (-4.07)	-0.169** (-5.88)
Unemployment rate SE	-0.039 (-1.77)	-0.052* (-2.33)
Education matric rate SE	-0.020 (-0.24)	0.050 (0.58)
Formal housing rate	0.112*** (5.98)	0.093** (4.82)
Constant SE	0.150* (2.34)	
R-sq. within/ between/overall	0.984	0.982
F/ Wald Chi^2	F(9.135)=935.86	Chi2(9) = 273
Probability	0.000	0.000

Source: Authors' own calculation using data derived from Global Insight Regional Economic Explorer 2014.

Note: ***Indicates significance at 1 % confidence level, **indicates significance at 5 % confidence level and * indicates significance at 10 per cent confidence level using two-tailed tests. Instrument = ln (number of households).

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