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Regional disparities in income-independent quality of life in South African municipalities: convergence or divergence?

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Abstract

The purpose of this study is to add to the empirical literature regarding quality of life convergence dynamics. It achieves this by analysing and comparing income and income-independent quality of life (IIQoL) convergence dynamics across South Africa's 234 municipalities for the period 1996-2014. The study tested for convergence and utilised dynamic panel methods (systems GMM). The results indicate unconditional convergence in both income and IIQoL but at different rates. IIQoL is converging at a faster rate, which echoes the fact that poorer regions can achieve more than one would expect given their levels of per capita income. The significant conditions for growth in IIQoL, is found to be policy regarding poverty alleviation, level of human capital, level of income inequality and spare capacity. Policy should lean towards those municipalities, which are not able to translate their income growth into similar non-income quality of life gains.

1 Introduction

Barro and Sala-i-Martin (1992) stated that the most important economic concern to be addressed was the convergence between poor countries and their rich counterparts. This need, to understand different patterns, either between or with-in countries are more urgent today since there has been a tendency for income disparities to increase and be persistent over the last few decades (see Shorrocks and Wan 2004 and Kanbur and Venables 2005). These disparities in income and non-income quality of life is often deemed the catalyst to political and social instability.

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Non-income measures of quality of life has been in the spotlight since the 1970s when various social indicators were reported as a complement to the traditional Gross Domestic Product (GDP) (Sumner 2003). Rossouw and Naudé (2008) put forth a case arguing that non-income indicators of quality of life could be seen as more useful than income indicators when a medium or long-run evaluation was required. This could be because these type of measures more directly addressed the outcomes of policy for the development of human life in as much that people were seen as 'the ends rather than the means' or simply the inputs to these policies. Given that social indicators are slower to react, they have the additional benefit of being adaptable to disaggregation, making them instructive for distributional impacts of policy changes.

However, there has been critique (see Drèze and Sen 1991) against the usage of non-income (social) indicators as they are closely correlated with income indicators and therefore a pure income indicator could be seen as a sufficient measure of quality of life. In saying that, a seminal report compiled by Stiglitz, Sen and Fitoussi (2010) has put any such argument against the usage of social indicators to rest. They clearly demonstrate that quality of life is multidimensional and we simply must look beyond the traditional measure of real GDP per capita as an indicator for economic- and therefore overall quality of life. Research is therefore now focused on analysing the convergence dynamics of quality of life rather than merely analysing real income per capita.

With this being said, the research on the convergence of quality of life indicators mainly analyses the convergence patterns of individual social indicators and therefore are often strongly correlated with real GDP (see Giannias et al. 1999; Giles and Feng 2005; Liargovas and Fotopoulos 2009; Royuela and García 2015) or utilise composite indices that contains an income measure itself (Marchante and Ortega 2006; Hobijn and Franses 2001; Jordá and Sarabia 2015; Marchante et al. 2006; Martínez 2012; O'Leary 2001; and Rodríguez- Pose and Tselios 2015). This has led to a need for the development of an income-independent quality of life measure. To this end, the first contribution of this study is to address this caveat by developing an income-independent composite quality of life (IIQoL). This will allow us to determine whether additional information to that obtained from the traditional income perspective, can be extracted from using such a measure.

In the aforementioned studies pertaining to quality of life convergence, the method of analysis, depending on the type of data, was either Ordinary Least Square (OLS), three Stage Least Squares (3SLS) or fixed effects estimations. Therefore, this study's second contribution to the current literature is to estimate convergence by making use of systems GMM, found to be the most appropriate method to estimate growth models using panel data and which has not been utilised before in quality of life convergence.

A third contribution of the current study lies within the country of interest, South Africa. All of the previously mentioned studies determine and analyse quality of life convergence dynamics either between developed nations, members of the European Union or regions within developed countries such as Spain, Italy and Ireland. This study is the first known study to analyse regional convergence dynamics in a developing country. By applying this methodology to South Africa, we gain additional insight into convergence patterns in a country suffering from wide disparities in both income and income-independent quality of life, which might not always be present in more developed nations.

Lastly, the study's fourth contribution lies within the analysis of IIQoL convergence dynamics on a sub-national level through investigating 234 South African municipalities. This level of analysis makes a significant contribution to the current quality of life convergence literature, as it allows more focused policy interventions targeted at those regions at sub-national level, which are struggling to translate income growth into similar gains in income-independent quality of life.

In order to achieve these contributions, the study will therefore focus on answering the following research questions. First, the study will construct a composite IIQoL measure and test for unconditional $\beta-$ convergence on a sub-national level in a developing country. This convergence rate will be compared to that obtained from the traditional real GDP per capita in order to analyse the level of misrepresentation reported by past studies that only focused on income measures. Second, the study will focus on determining the specific conditions needed for conditional $\beta-$convergence in IIQoL.

The rest of the paper is structured as follows. The next section contains the outline of the methodology used whereas section 3, provides information regarding South Africa, describes the data and empirical models. The results and analysis will follow in section 4, whilst the study will conclude and provide avenues for future research in section 5.

2 Approach

In the empirical analysis, various stages and methodologies were utilised and as such, this section is divided into two parts;

(i) composition of the IIQoL index and;

(ii) testing for unconditional β- convergence in real GDP per capita and IIQoL as well as conditional β- convergence in IIQoL.

2.1 *Methodology followed for the composite IIQoL index*

For a complete discussion on the methodology followed to construct the IIQoL, see McGillivray (2005). However, what is important to note here, is that the underlying justification for separating income and non-income indicators comes from the ideology made famous by Drèze and Sen (1991).

As a first step in constructing the IIQoL index for South Africa's 234 municipalities, we utilise PCA and extract a single composite non-income quality of life index[1]. A regression analysis against the natural log of per capita income

[1] See also Rossouw and Naudé (2008), Naudé, Krugell and Rossouw (2009), Rossouw and Pacheco (2012), Pacheco, Rossouw and Lewer (2013) and Greyling and Rossouw (2017).

is run and the residual term, μ_i, which we interpret, as the variation not accounted for by per capita income, is seen as *income-independent quality of life.* We standardise the index using the minimum maximum method[2].

The abovementioned regression on the single composite non-income quality of life index can be expressed as:

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

Where Q_{it} is the single composite non-income quality of life index in the municipality i in period t (t =1996 to 2014); and lny_{it} is the natural log of per capita income in municipality i in period t, with μ_{it} the residual term. The residual term μ_{it} is central to our analysis and by definition orthogonal with respect to lny_{it}. We coin it the *income-independent quality of life index (IIQoL)* and is used as such in further analyses.

To validate the index we correlate it with the HDI, a measure for economic quality of life. In order to render it comparable to our IIQoL index, we adjust the HDI in the same manner as our own, i.e. by removing the variance explained by income from the index. The result is therefore a derived income-independent HDI. A statistically significant and positive relationship between these two indices is an indication that our newly constructed measure is a valid representation of objectively measured *income-independent quality of life* in South Africa.

2.2 *Methodology followed to test for unconditional and conditional $\beta-$convergence*

We start our investigation into convergence by examining the convergence dynamics for IIQoL and real GDP per capita, through deriving the coefficient of variance (CV), which measures convergence relative to the mean for the period 1996 – 2014. If the CV is less in 2014 than it was in 1996 it is evidence of convergence.

Secondly, we test for unconditional $\beta-$convergence, which means that we do not include any conditions to control for the differences in the structure of the municipalities. Lastly, we control for the structural differences since these suggest that each municipality might have a different steady-state, and thus conditional $\beta-$ convergence applies.

To test for $\beta-$ convergence we follow the proposed method of Baumol (1986) and Barro and Sala-i-Martin (1992).

1. To test for unconditional $\beta-$ convergence we estimate the following function;

$$lnY_{it} - lnY_{it-1} = blnY_{it-1} + \mu_{it} \tag{2}$$

[2] The Min-Max method standardises an index to have an identical range [0, 1] by subtracting the minimum value and dividing by the range (OECD 2008).

1. To test for the conditional $\beta-$ convergence in IIQoL we estimate the following function;

$$lnY_{it} - lnY_{it-1} = blnY_{it-1} + \beta_2 X_{it} + \mu_{it} \quad (3)$$

Where Y represents IIQoL or GDP per capita respectively, i is the municipality and t is the time period ranging from 1996 to 2014. In this expression, b captures the effect of the initial level of IIQoL or GDP per capita per year on its rate of growth. Since the structure of the municipalities are different in many respects, we control for these structural differences by including, in equation 3, a vector X_{it} of exogenous/endogenous controls. The structural differences suggest that each municipality might have a different steady-state path as is assumed under conditional $\beta-$ convergence. μ_{it} is the error term, which captures any unmeasured attributes that might affect a municipality's growth rate. Consequently, it is assumed that if $b < 0$, municipalities converge, that is municipalities with lower levels of real GDP or IIQoL are catching up with their leading counterparts. The opposite is true if $b > 0$.

From the coefficient of lnY_{it-1} (b) in equation 3, the speed of convergence (β) can be derived as follows:

$$b = -(1 - e^{-\beta})^3 \quad (4)$$

Thus β is a measure of the rate of convergence of municipalities to a common equilibrium or in the event of conditional $\beta-$ convergence to their own steady-state level.

We also calculate the half-life, which accounts for the time, in years, required for a municipality to cover half the distance between the initial real GDP per capita or IIQoL level respectively, and its steady-state level.

$$Half - life = \frac{-\ln 2}{\ln(1 - \beta)} \quad (5)$$

Where β, as previously stated, is the rate of convergence.

To estimate growth models a technique was derived by Arellano and Bond (1991) called first-differenced generalized method of moments (GMM) to overcome the unavailability of adequate instruments to instrument endogenous variables, a problem in growth models. In essence, the differenced GMM composes the regression equation as a dynamic panel data model and then takes first-differences to remove the unobserved time-invariant individual specific effects. The right-hand-side variables in the first-differenced equation are then instrumented using levels of the series lagged two or more periods (Bond et al. 2001).

In saying this, if the time series presents with relatively few time periods it is likely that the lagged variables are weak instruments for the subsequent first-difference and that the differenced GMM estimation performs poorly. In light of this shortcoming, Arellano and Bover (1995) developed an augmented version

[3] Equation 4 in terms of $\beta = -\ln(b + 1)$

of the model, which was later extended by Blundell and Bond (1998), called the system estimator. This system estimator (Blundell and Bond 1998) uses additional moment conditions and is designed for datasets with a large number of observations but relatively few time periods. Seeing as this accurately describes our dataset we are of the opinion that this system estimator is appropriate for the estimation of the growth models constructed in this study.

The system GMM estimation can be divided into one-step and two-step estimations. However, following Teixeira and Queirós (2016), we interpret the two-step system GMM estimator, as it is more adapt in the estimation of a large number of observations (municipalities) relative to the time periods. In all estimations, we made use of robust standard errors and the Windmeijer correction and by doing so, addressed heteroscedasticity.

For lagged endogenous – and weak exogenous variables to be valid instruments, the transient disturbances in the base model, ε_it , should be free of autocorrelation (Blundell and Bond 1998). Therefore, in all estimations we use the Arellano–Bond (1991) test in order to determine first-order (AR(1)) and second-order (AR(2)) serial correlation in the first-differenced residuals. Added to this, we utilise the Hansen-test to check for over identifying restrictions, which is the preferred test when the system GMM with robust standard errors is used. If the test statistic is significant it might indicate that the instruments are not valid.

To test the robustness of the system GMM estimations, we also estimate models making use of a 3-year interval time period and compare the beta coefficients. If the sign and the significance levels of the beta coefficients are similar we assume our results to be robust (Bonnefond 2014).

3 Data and variables

3.1 Data

All data analysed was obtained from IHS' Regional Economic Focus (REF) (2014) and can be accessed from their Regional eXplorer (ReX) database. Various information sources available on a sub-national level are used to compile ReX; they include but are not limited to; Statistics South Africa, South African Reserve Bank, South African Revenue Service, Council for Scientific and Industrial Research etc.

The data show that South Africa's HDI is 0.63 pointing to medium development and the Gini coefficient 0.64 – which indicates large income inequality. Of its total population (53,781,908 million), 45.4 per cent was deemed to fall below the upper poverty line[4] and 13 per cent of all households were located in informal settlements (Statistics South Africa 2015)[5]. This highly unequal dis-

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

[5] The detrimental effects which living in informal settlements in South Africa has on self-worth, sense of belonging and social cohesion is a well-established area of study (see Zaker-

tribution provides us with a unique opportunity to test for regional convergence pertaining to both income and non-income quality of life.

Our focus is on convergence at the sub-regional level, namely the municipalities of South Africa. The municipalities are divided into two main groups namely; metropolitan- and district municipalities. The district municipalities are further subdivided into local municipalities. According to the 2011 boundary demarcations, there were 8 metropolitan and 226 local municipalities (MDB 2016). To compile our panel dataset we merged the municipality data and appended it for the years 1996 to 2014.

Since this is the first study that analyses convergence dynamics of income-independent quality of life on a sub-national level in any geographical region, including South Africa, we are forced to rely on studies focusing purely on economic (real per capita income) convergence for comparison purposes. Results concerning income convergence patterns in South Africa has varied in that studies have shown both evidence of conditional convergence (Naudé and Krugell 2003), slow medium-term convergence (Naudé and Krugell 2006) or even divergence (Krugell et al. 2005).

3.2 Variables included in the IIQoL Index

As discussed in section 2.1 we construct an income-independent quality of life (IIQoL) index and we interpret this as such since it is independent of per capita income. The IIQoL index includes the ratio of the population over the age of 75 years as a sign of longevity and thus a suitable proxy for life expectancy, the proportion of people over the age of 15 who have a functional ability of reading and writing (proxy for adult literacy rate) and the proportion of people residing in formal housing (a measure of basic infrastructure).

The rationale for selecting these indicators lies first and foremost with the importance that both the United Nations (UN) as well as the World Bank (WB) (United Nations publication, Series F, No. 49 (1989), Series F, No. 18 (1975 and (2015)) has placed on health, education and developing infrastructure pertaining to housing, water and sanitation as breakthrough policy areas needed to achieve higher non-income quality of life[6] . These three domains also reflect the South African Government's investment priorities as stipulated in the 2017/2018 budget (National Treasury 2017) and forms an integral part of their National Development Plan (NDP) (National Planning Commission 2012), which mandates that social reforms such as housing, water and electricity, primary health care and education should be at the forefront driving increases in quality of life for all South Africans[7] .

haghighi, Khanian and Gheitarani (2015) and Richards, O'Leary and Mutsonziwa (2007).

[6] Also see Land et al. (2011), Reading and Wien (2009) and Rahman et al. (2005)

[7] In considering these variables, we found that water, electricity and housing are closely correlated and as consequence we opted to use the formal housing variable (see section 2.1 for the role and importance of informal housing in South Africa).

Table 1 shows the descriptions, sources and descriptive statistics across the 234 municipalities for the selected variables included in the IIQoL index.

3.3 Variables included in the $\beta-$ nvergence estimations

The selection of the explanatory variables included in the estimated model is based on the variables from the endogenous growth models of Barro and Sala-i-Martin (1992), an extensive literature review (see section 1) as well as the availability of data.

These variables, which are presented in table 2, are:

(i) the growth rate of real GDP per capita and IIQoL;

(ii) the natural log of the initial level of real GDP per capita and IIQoL;

(iii) the Gini coefficient for a measure of inequality since higher levels of inequality results in a lower perception of quality of life (see Kanbur and Venables 2005; Giles and Feng 2005);

(iv) the poverty rate (a proxy for government spending on poverty alleviation) seeing as a significant proportion of the South African budget is allocated towards social welfare payments (see Diener and Diener 1995; Giannias, Liargovas and Manolas 1999);

(v) the unemployment rate, which is an indication of the spare capacity in a municipality and the potential for labour intensive production (see Naudé and Krugell 2003);

(vi) the proportion of people that successfully completed a postgraduate degree (a proxy for human capital) (see Neumayer 2003; Giles and Feng 2005) and;

(vii) the population growth rate (a proxy for urbanisation) (see Royuela and García 2015).

4 Results

The results section reports on (i) the IIQoL index derived through PCA; (ii) a comparison of the unconditional $\beta-$ convergence of the growth in real GDP per capita and IIQoL, respectively and (iii) testing for conditional convergence in IIQoL.

4.1 Principal Component Analysis

To construct our IIQoL index, we followed the methodology as outlined in section 2.1. First, we applied PCA to our selected variables; life expectancy, adult literacy rate and formal housing and extracted the first component in accordance to McGillivray's (2005) methodology[8] . Extracting the first component is in line with the Kaiser rule (Kaiser and Rice 1974) which states that only the components with an eigenvalue greater than 1 should be extracted. The first component has an eigenvalue of 1.71 and explains 57 per cent of the variance in the data, which is deemed an acceptable level of explained variance to represent data (see comparative studies such as Vyas and Kumaranayake 2006; Rossouw and Pacheco 2012; and Greyling and Tregenna 2017). Second, we regress the non-income quality of life index on the natural log of per capita income to derive the residual, which we deem to be our objectively measured IIQoL (McGillivray 2005).

To validate the index we correlate it with the adjusted HDI (income-independent HDI). We find that IIQoL and the income-independent HDI of the municipalities are statistically significant and positively correlated (*Pearson's r =0.88*). In light of this result, we are confident that our newly constructed index is a valid reflection of objectively measured *income-independent quality* of life in South Africa.

4.2 Coefficient of variance (CV)

As an initial investigation into convergence, we calculated the CV for IIQoL and real GDP per capita. We found that in 1996 the variation to the mean in the IIQoL (0.112 to 0.105) and real GDP per capita (84.2 to 66.79) was greater than in 2014 (see figures 1 and 2), indicating convergence over the specific time period. This result is further investigated in the next sections using $\beta-$convergence estimations.

4.3 Unconditional convergence of the growth in real GDP per capita and IIQoL

The estimation results, pertaining to the first research question, show that the models are statistically significant (p=0.000). The estimated coefficients' levels of statistically significance and their accompanying signs, using an annual – and 3 – year interval time period are similar therefore we conclude our results to be robust (Bonnefond 2014)[9]. Through applying the Arellano-Bond (1991) test, we reject the null hypotheses of "no first-order serial correlation" (p=0.010 and p=0.012, respectively). The test statistics for the second-order serial correlation (p=0.397 and p=0.366, respectively) cannot permit us to reject the null hypotheses and the Hansen-test statistic of over identification allowed us to deem the estimations to be robust[10].

[8] As a validation method, we also used equal weighting as an alternative to weight the IIQoL. The two composite indices are statistically significant and positively correlated (Pearson's r= 0.92).

[9] To test the robustness of our results we also estimated all models using Instrumental Variable Regressions for panel data (available upon request from the authors). We obtained similar results for both the signs as well as the significance of the estimated coefficients.

[10] However the test statistic was weakened by the number of instruments.

The results reported in table 4 show that both IIQoL and real GDP per capita are unconditionally converging, though at different rates of 7.8 and 7.15 per cent per annum, respectively. These findings are in line with Marchante and Ortega's (2006) study. The calculated half-life for IIQoL and real GDP per capita are 8.5 years and 9.4 years, respectively.

These results indicate, notwithstanding structural differences, that municipalities with lower levels of IIQoL are catching up with those characterised by higher levels. Therefore, a case can be made that if real development of a region is to be measured, one should rather use IIQoL measures as pure income indicators could provide a skewed and biased representation in developing countries.

4.4 Conditional $\beta-$ convergence of the growth in IIQoL

The results on the estimation of the conditional $\beta-$ convergence in IIQoL, addressing the second research question, are presented in table 5. The results show that the model is well specified and statistically significant (p=0.000). As found previously, our estimated coefficients' levels of statistically significance and their accompanying signs, using the system GMM, for annual – and 3 –year interval time periods are similar, therefore we conclude our results to be robust (Bonnefond 2014). The test statistic for the second-order serial correlation is not statistically significant (p=0.366), indicating that there is no second-order serial correlation and as such we can reject the null hypothesis of order serial correlation. Furthermore, the Hansen-test statistic of over identification finds the instruments to be robust.

Considering the conditional $\beta-$ convergence rate, we find an implied speed of 10.9 per cent per annum, which is higher than the convergence rate obtained without controlling for other conditions (7.8 per cent per annum). This implies that all municipalities' IIQoL converge at a rate of 10.9 per cent controlling for both its previous levels as well as other determinants of growth for a specific municipality. Estimating the half-life, we find that it will take 6.03 years for each municipality to eliminate 50 per cent of the distance between its initial – and its steady-state level compared to 8.5 years under unconditional $\beta-$ convergence. We find this to be in line with the works of Mathur (2004) testing the convergence in real GDP per capita across countries.

Human capital (proxied by people with a postgraduate degree) is positively related to the growth of IIQoL. Considering the standardised coefficients[11], it seems that the percentage of people in a municipality that has a postgraduate degree is the biggest contributor (1.4 per cent), ceteris paribus, relative to the other independent variables (less than 1 per cent) in explaining the growth rate of IIQoL. Therefore, we can conclude that investment in human capital can improve the IIQoL for all people. This finding is in line with the work done by Ferrara and Nisticò (2015) where they concluded that higher-quality education leads to better public health care, greater respect for the environment,

[11] Derived from standardised variables with a mean of 0 and a variance of 1.

an acknowledgement of fellow citizens' civil rights and a general increased social cohesion. Policy regarding education should therefore not only focus on basic literacy skills but also on higher levels of education as this can make a significant contribution to the growth in non-income quality of life.

Government spending on poverty alleviation at municipal level (proxied by poverty rate) is statistically significant and positively related to IIQoL. Local government policy interventions such as grants, free healthcare and education, basic services and housing increase IIQoL growth for these municipalities relative to their counterparts.

The Gini coefficient is statistically significant and negatively related to the growth in IIQoL as is expected. This is in line with the findings from Alesina et al. (2004) where they concluded that inequality is perceived as a social evil and that it does not merely affect the poor but the rich as well since it negatively influences their sense of fairness and decreases their overall quality of life.

The unemployment rate is statistically significant and positively related to the growth in IIQoL. This is reflective of the work done by Naudé and Krugell (2003) and implies that there is spare capacity, which is positively related to growth in IIQoL. This signals that investment is needed in human capital to utilise said spare capacity and increase the productivity of the municipality.

In this model the population growth rate is not statistically significant, although it is found to be negatively related to the growth in IIQoL. This finding is in line with the work of Greyling and Rossouw (2017), in that they found higher population density to be negatively related to non-economic quality of life. They explain this as higher population numbers increase the burden on education –, health –and housing infrastructure.

5 Conclusions, recommendations and avenues for future research

The study contributes to the existing quality of life convergence literature through i) developing a composite income-independent quality of life measure on any geographical level; ii) being the first known study to utilise GMM in analysing quality of life convergence; iii) applying this methodology to a developing country which provides additional insight into convergence patterns and; iv) analysing convergence dynamics on a sub-national level in a country suffering from wide disparity in both income and non-income quality of life, which might not always be present in more developed nations.

It was found that IIQoL converged at a higher speed than real GDP per capita, which implied that there were municipalities, which were able to convert their income gains into higher non-income quality of life, and as such were indeed catching up with their affluent counterparts. The significant conditions contributing to IIQoL convergence were found to be human capital, the poverty rate, the Gini-coefficient, and the unemployment rate. Unfortunately, it seemed that the convergence rate was still relatively slow and that it would take approximately 6 years to eliminate 50 per cent of the distance between municipalities' initial – and steady-state levels.

These findings will assist in formulating policy directed towards those municipalities that are not able to convert income into non-income gains and elevate the level of government-subsidised amenities. Given the half-life result of 6 years, the question of whether this convergence rate is deemed fast enough to address the huge inequalities plaguing South Africa needs to be asked?

The one caveat of this study is the exclusion of the spatial dimension. Future research will incorporate spatial autocorrelation since it is a well-established fact that socio-economic variables have a spillover effect on its neighbouring regions. This implies that policy directed towards convergence needs to have a spatial dimension, and can be articulated into two simple groups. First, areas may suffer from low levels of non-income quality of life because they are distinctly different from other areas, including those areas, which are contiguous. In this case, the policy will need to be area-specific and designed to improve the non-income quality of life of the area in isolation. Second, areas may suffer low levels of non-income quality of life because they are influenced by spatial spillovers. In this case, the appropriate policy will need to be targeted towards not simply the specific area but also the group of contiguous areas.

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Table 1: Descriptive statistics of the variables used to construct the IIQoL Index

Variable	Description	Source	Mean	Std. Dev	Min	Max
Over 75 years of age rate	Proportion of people over 75 years of age	Census data from StatsSA	0.017	0.007	0.002	0.048
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	0.663	0.114	0.310	0.925
Formal housing rate	Proportion of people residing in formal housing	Census data from StatsSA	0.715	0.202	0.116	0.979
Real GDP per capita	The rand value of the real GDP per capita per year	Census data from StatsSA	37 696*	28 056	3 577	266 556

Source: Authors' own calculation using data derived from IHS Regional Economic Explorer (2014).
*Note: R37 696 = $2 696.43 at an exchange rate of R13.98=$1 (17 November 2017)

Table 2: Descriptive statistics of variables included in the $\beta -$ convergence estimations

Variable	Description	Source	Mean	Std. Dev	Min	Max
IIQoL Growth	IIQoL growth rate %	Authors' own based on ReX	1.91	.0.28	-1.09.	2.66
GDP Growth	Real GDP growth rate %	Authors' own based on ReX	3.40	.325	2.55	4.38
Ln Initial IIQoL	The natural log of the initial IIQoL	Authors' own based on ReX	1.909	.278	1.087	2.663
Ln Initial GDP	The natural log of the initial real GDP	Authors' own based on ReX	10.295	.7134	8.182	12.493
Education	% of population that has a postgraduate degree	Census data StatsSA	0.416	0.431	0.004	3.590
Poverty Rate	% of population that are poor	Census data StatsSA	51.5	18.0	11.8 .	89.9
Gini	A measure of inequality of the distribution of income	Regional Economic Focus data	.588	.035	.474	.691
Unemployment rate	% of the EAP population that is unemployed	Census data StatsSA	27.4	11.0	3.80	7.06
Population growth rate	The rate at which the population grow per year	Authors' own	.739	2.329	-.936	18.914

Source: Authors' own calculation using data derived from IHS Regional Economic Explorer (2014).

Table 3: Correlation Matrix IIQoL and income-independent HDI

	IIQoL	Income-independent HDI
IIQoL	1.00	
HDI(income-independent)	0.88	1.000

Source: Authors' own calculation using data derived from IHS Regional Economic Explorer (2014).

Table 4: Unconditional β −convergence estimates for IIQoL and real GDP per capita for 1996 – 2014

Variable	Dependent: IIQoL	Dependent: Real GDP per capita
Lagged growth rates	0.122**(0.040)	0.0304***(0.001)
Ln Initial IIQoL/real LnGDP	-0.075***(0.011)	-0.069***(0.001)
N	4211	4211
Number of instruments	172	172
Wald $chi^2(5)$	52.74	3914.16
Probability of chi^2	0.000	0.000
Arellano-Bond test	Order 1: *p*=0.010 Order 2: *p*=0.397	Order 1: *p*=0.012 Order 2: *p*=0.366
Unconditional β-convergence rate	7.796	7.150
Half-life	8.546	9.357

Source: Authors' own calculation using data derived from IHS Regional Economic Explorer 2014.
Note: ***Indicates significance at 0.1 % confidence level, **indicates significance at 1 % confidence level and * indicates significance at 5 % confidence level. Standard errors in parentheses.

Table 5: Conditional β −convergence estimates for IIQoL for 1996 to 2014

Variable	Dynamic panel-data estimation, two-step system GMM	Dynamic panel-data estimation, two-step system GMM – Standardised Coefficients
IIQoL Growth lagged	0.114** (0.040)	-
Ln Initial IIQoL	-0.103*** (0.008)	-0.980***(0.008)
Education	11.040***(1.743)	1.375***(1.748)
Poverty rate	0.144***(0.014)	0.755***(0.025)
Gini	-0.597***(0.090)	-0.725***(0.090)
Unemployment rate	0.310**(0.109)	0.275**(0.109)
Population growth rate	-0.003(0.007)	-0.253(0.007)
N	4211	4211
Number of instruments	177	177
Wald $chi^2(5)$	473.73	473.73
Probability of chi^2	0.000	0.000
Arellano-Bond test	Order 1: p=0.012 Order 2: p=0.366	Order 1:p=0.012 Order 2:p=0.366
Conditional β-convergence rate	10.869	10.869
Half-life	6.029	6.029

Source: Authors' own calculation using data derived from IHS Regional Economic Explorer 2014.
Note: Dependent variable = IIQoL growth. ***Indicates significance at 0.1 % confidence level, **indicates significance at 1 % confidence level and * indicates significance at 5% confidence level. Standard errors in parentheses

Fig. 1 CV for IIQoL (1996-2014)

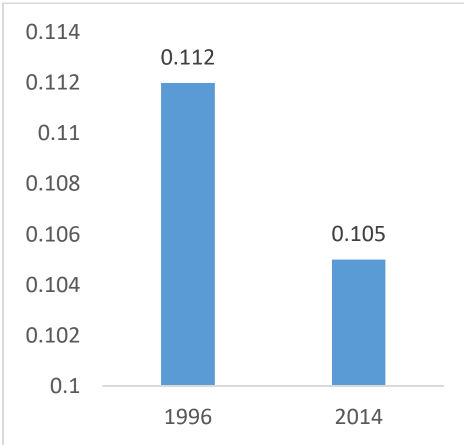
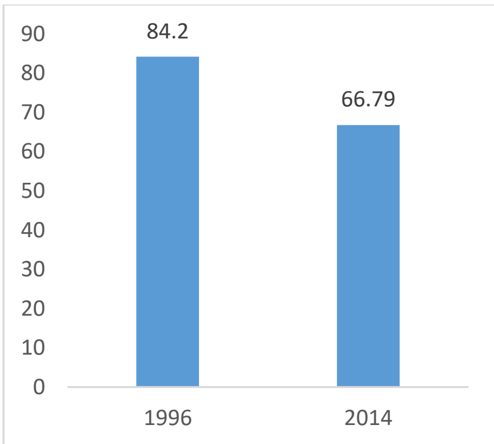


Fig. 2 CV for real GDP per capita (1996-2014



Appendix A

Table 6: Total Variance explained by the eigenvalues of the extracted components

Component	Eigenvalues of extracted components Initial Eigenvalues		
	Total	% of Variance	Cumulative %
1	1.713	57.09	57.09
2	0.714	23.79	80.87
3	0.574	19.13	100.00

Extraction Method: Principal Component Analysis
Source: Author's own calculations

Table 7 Factor loadings on the extracted components

Variables	Factor loadings on components		
	1	2	3
Over 75 years of age	0.54	0.77	0.30
Adult literacy rate	0.61	-0.12	-1.78
Formal housing rate	0.57	-0.61	0.54

Extraction Method: Principal Component Analysis
Source: Author's own calculations