



Spatial dependence of per capita property tax income in South Africa

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Abstract

We investigate spatial dependence of per capita property tax income among South African municipalities. One original contribution of our study is the use of per capita property tax income, rather than the property tax rate, as the outcome variable. Per capita property tax income is indicative of tax burden on residents. In addition, whilst most studies focus on advanced countries that have had institutionalised fiscal decentralisation for many decades, this paper focuses on South Africa, which is a developing country and implemented fiscal decentralisation only 18 years ago. Using Bayesian spatial econometric approach, we establish the presence of spatial dependence.

Keywords: municipalities, per capita property tax income, spatial, spatial dependence, South Africa

JEL Classification: H70, H77, C31

1 Introduction

Property tax is the most significant tax income source assigned to municipalities in South Africa (Republic of South Africa, 1996). Local and metropolitan municipalities, particularly in urban areas, generate more than 20 percent of own income through property tax (Department of National Treasury, 2011). Therefore, while it is important to understand the determinants of property tax income, it is also important to examine whether the latter is characterised by spatial dependence. There is spatial dependence of property tax income when property tax income in a municipality is correlated with property tax income in other municipalities.

The spatial dependence of municipal finance (i.e. expenditure, fiscal policies) has been studied extensively in a growing body of literature, yet with very

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few empirical studies focusing on African countries. There is no empirical study on this topic for the case of South Africa, despite this country having implemented fiscal decentralisation more than eighteen years ago. In this regard, the contribution of this paper to the literature is twofold.

First, and most importantly, instead of using the property tax rate, as most studies do, we consider per capita property tax income as the dependent variable. This variable can also be considered as a local tax burden, and is a good candidate for assessing spatial dependence of municipal fiscal policies. It is important to note that the use of the property tax rate does not account for possible differences that may exist between municipalities in terms of property tax bases, property tax rebate or relief (reduction) policies, property valuation methods, and so forth. Assuming that spatial dependence occurs through the property tax rate may to some extent be misleading (Bocci et al. 2017).

Now, suppose that two neighbouring municipalities apply the same property tax rate, but have different valuation methods to determine the property tax base and different property tax rebate policies. In our view, it is plausible that property owners in these municipalities whose properties have similar characteristics will pay different amounts as actual property tax. This is mainly due to the fact that the assessed values (base) of their properties differ, or that one of the two municipalities applies a lenient rebate on property tax. In this sense, using the property tax rate disregards other, critical information that influences the actual property tax income collected by municipalities. Therefore, we believe that per capita property tax income is a good candidate in the sense that it is a normalised indicator that, in a sense, summarises fiscal choices made by municipalities regarding property tax. Per capita property tax income as a local tax burden is what matters for local property tax payers, who can also use it to evaluate their municipalities, for instance with yardstick competition.

Second, our study is an attempt to close a gap in the literature by providing empirical insight into the spatial dependence of per capita property tax income in South Africa, which is a developing country and has system of fiscal decentralisation that is relatively new compared to advanced countries. It is important to note the environment in which municipalities operate may be characterised by contextual factors such as the quality and strength of institutions, level of active citizenry, education and skills levels, degree of urbanisation and so forth. In terms of these factors, there are important disparities between developed and developing countries, and between countries whose fiscal decentralisation has been in existence for many decades and those that have implemented it just recently.

For instance, the ‘yardstick competition’ theory assumes that local residents use municipal budget information to compare the performance of their municipality to that of neighbouring municipalities. For this to happen, it requires that these residents are aware and actively involved in the affairs of their municipality. Because of the above-mentioned factors in developing countries, it may be that local residents will behave differently. Hence, the importance of gaining some insight regarding spatial dependence of per capita property tax income in a developing country settings.

We test the presence of spatial dependence of municipal per capita property tax income in South Africa, using information from municipalities' income statements for 2011/2012 and the 2011 population census. In this regard, we adopt a Bayesian approach to estimate and select the appropriate spatial econometric model, for three main reasons (LeSage, 1997, 1999, 2014a, 2014b; LeSage & Pace, 2009). First, Bayesian estimation is suitable for avoiding the influence of outliers, if any, in the data. Second, through Bayesian estimation we are able to compare the spatial lag model (SLM), the spatial error model (SEM), and the spatial Durbin model (SDM), and to select the appropriate spatial model using the probabilities of posterior estimates. Lastly, we compare and select the appropriate spatial weight matrix for our sample. We present a detailed discussion of the estimation procedure in the section on the methodology.

An understanding of the spatial dependence of per capita property tax income is especially relevant because of the critical role that municipalities are intended to fulfil in South Africa. For instance, the White Paper on Local Government (Republic of South Africa, 1998) sets out that municipalities should contribute to government efforts to promote socioeconomic development. Municipalities are therefore viewed as catalysts in the eradication of poverty and inequality through the provision of essential services, such as potable water, electricity, sanitation and refuse removal, to all South African, and through regulations and the planning of land uses.

The structure of this paper is as follows. We provide a brief discussion of property tax in South Africa in section 2, while the relevant literature is reviewed in section 3. Sections 4 and 5 discuss the methodology and data respectively. We present the empirical results in section 6, and section 7 concludes.

2 Context of property tax in South Africa

South Africa has three spheres of government: national, provincial, and local government. There are three categories of municipalities that constitute the local government sphere. Category A includes metropolitan municipalities, which have been established in major cities and perform all functions assigned, with no concurrent jurisdiction of other local government structures. Local and district municipalities constitute categories B and C respectively. A district municipality covers a large area and includes two or more local municipalities. Local municipalities that fall under a district share functions and fiscal powers with the relevant district municipality. Municipalities in South Africa provide services that directly affect the community and people's lives. They are responsible for functions such as the provision of water and sanitation services, refuse removal and electricity distribution.

Municipalities also mobilise resources to finance their expenditure responsibilities through fiscal transfers and own-income sources. With regard to fiscal transfers, it is important to note that municipalities receive conditional and unconditional fiscal transfers. In terms of section 214 of the Constitution, each municipality annually receives an equitable share of nationally raised revenue.

In other words, national government annually collects revenue (generally from income tax, value-added tax, general sales tax, and customs duties) that is divided vertically between the three spheres of government (national, provincial and local government) in terms of the Division of Revenue Act. The Local Government Equitable Share (LGES) refers to the share allocated to local government as a whole through the vertical division.

There is no specific formula for the vertical division of the nationally raised revenue between the three spheres of government. The vertical division, which is at the discretion of Parliament, is generally based on constitutional considerations, provision for public debt costs, and national government priorities. In addition, the vertical division is based on the fiscal powers that provinces and municipalities have to generate their own revenue. For instance, in addition to fiscal transfer, municipalities have the power to levy substantial own revenue through local taxes such as property tax and user fees for services provided.

After the vertical division, Parliament divides the determined LGES among 278 municipalities. This division is generally referred to as the “horizontal division”. Each municipality receives its equitable share (ES), which is unconditional. The horizontal division of LGES is formula based, taking into account municipal population size, income level, and assigned functions. The formula also takes into account that municipalities are adequately funded to finance the provision of public goods, such as municipal health care, municipal roads, cemeteries, street lighting and parks, which are essential for community development. It also takes into account the funding of municipal administration and governance to ensure that municipalities, particularly those with a limited economic base, are able to function and fulfil their constitutional mandate.

Municipalities in South Africa are also empowered to levy property tax, other local taxes, user fees (also referred to as service charges) and other fees. However, it is worth noting that only local and district municipalities have the power to impose property tax in their jurisdiction. Property tax, often referred to as property rates in South Africa, is a tax imposed on the market value of land and buildings by local and metropolitan municipalities. It is regulated by the Constitution and the Municipal Property Rates Act (Republic of South Africa, 2004). Beyond some limitations that may be determined by the national government with respect to the ratios of property tax rates to impose between categories of properties, South African municipalities have autonomy with respect to property tax. In other words, they have the discretion to determine, collect and allocate income from property to finance their expenditure responsibilities. Property tax is therefore an important budget tool, which we examine in the present paper to shed light on its spatial dependence characteristics.

It is important to note that property tax is levied on both residential and business properties (albeit at different rates). We argue that the level of receipt of property tax income in a municipality ultimately has four determinants. The first is total taxable property stock, which in turn is influenced by factors such as effectiveness of building plan approval processes, and municipal policy on land development incentive schemes. For instance, the existence of red-tapes regarding building plan approval processes may hamper land development, thus

preventing the municipality the opportunity to grow its property stock and subsequently its property tax base.

Second, receipt of property tax income depends on the total value of taxable properties, which is mainly influenced by property valuation method or technique employed and some expertise related to property valuation. These factors will differ across municipalities. The third determinant is the rates at which property tax is levied on property. These are set by a municipality, and tend to differ not only between residential and business properties, but also within these categories, for example by using a progressive sliding scale based on the value of residential properties. In setting these rates, a municipality is likely to take into account considerations such as its revenue needs, historical rates in the municipality, rates in other municipalities (especially neighbouring ones), and how the level of and change in business rates is likely to affect economic activity in the area (a steep increase could lead to businesses relocating to other municipalities), and similarly how the level of and change in residential property taxes could affect the governing party's electoral prospects, could instigate protests, or be a factor influencing the relocation of individuals out of the municipality.

Fourth, the ability of the municipality to actually collect the rates levied. This is particularly complex in the case of South Africa; the political history of non-payment of residential property taxes during the apartheid period as a form of resistance to the apartheid regime has contributed to a culture of non-payment of property taxes, even during the period of democracy.

There are clearly spatial dimensions to each of these, which could give rise to the spatial dependence of property tax income across South African municipalities. The next section set out the manner in which spatial dependence occurs.

3 Literature review

3.1 Theoretical background

The topic of the spatial dependence of municipalities' budgetary components is receiving increasing attention in the literature. Empirical studies use different approaches and methods in this regard. Some studies focus only on the revenue side (i.e. local tax levels) of municipalities or local governments, whereas others consider the expenditure side. Our discussion in this section is limited to studies focusing on the spatial dependence of municipal taxes (or income).¹

It is worth noting that theoretical thinking on the spatial dependence of municipal finance was sparked, amongst others, by Tiebout's (1956) work on local government. Using Tiebout's main idea as point of departure, theories such as yardstick competition, spillover effects and resource flow competition have been developed in the last few decades, and have been used to justify the occurrence of spatial dependence of property tax rates (for a detailed

¹See Brueckner (2003) for a fuller discussion, in particular of theories used to test the spatial dependence of either municipal revenue or expenditure.

discussion on these theories, see Brueckner (2003). For instance, using resource flow competition theory, one can assume that a municipality will strategically determine its property tax rate at a lower level than that of its neighbours in order to retain or attract potential taxpayers into its jurisdiction.

However, Bocci et al. (2017) have recently pointed out that the empirical findings of studies that use the property tax rate as the outcome variable can be misleading in the sense that this variable does not account for disparities that exist between municipalities in terms of tax bases, rebate or deductions, property valuation methods, and so forth. These authors further propose that the actual tax income could be a good variable to be considered when assessing spatial dependence as it is the outcome of local fiscal policies. Although Bocci et al. (2017) propose property tax income as a good indicator, they themselves do not use it in their analysis. Instead, they use the ratio of property tax income to total income generated by municipalities as the dependent variable.

In the present paper, we use per capita property tax income instead of property tax rate. First, the usage of property tax rate assumes homogeneity among municipalities in terms, for instance, of valuation methods, expertise, policy orientation and so forth. As discussed in the previous section, it is plausible to assume heterogeneity among municipalities in relation to these factors. Second, we hypothesise that per capita property tax income is spatially autocorrelated, mainly because of yardstick competition among South African municipalities. This is because residents (voters) in a municipality have imperfect information with respect to the costs of local public services and local taxes. They compare local public spending and per capita property tax in their municipality and other (neighbouring) jurisdictions, and use this as a tool to measure local politicians' performance. Municipal governments, in anticipation of such behaviour by residents, end up mimicking the fiscal policies of neighbouring municipalities, which in the end may lead to a systematic and positive (auto) correlation of per capita property tax income or property tax burden.

Putting aside the abovementioned theories or channels, spatial dependence of per capita property tax income can occur because of close proximity (geographically and/or otherwise) between municipalities. According to Tobler's (1970, p. 236) first law of geography, which states that "everything is related to everything else, but nearer things are more related than distant things", it is only logical for one to expect similarities of per capita property tax income in closely related municipalities. This is because municipalities that are in close proximity will be characterised by similar phenomena, which in the end have an influence on their fiscal policies. It is also important to note that it is often difficult to observe all of these phenomena in real life, although they exist. Hence, it can only be economically sound when modelling the relationship between a variable (i.e. per capita property tax income) and its predictors – as far as these they are related to geographical units (i.e. municipalities) – to also consider the influence of these phenomena. A model that does not account for these similar phenomena may be judged as mis-specified and its findings as spurious. Therefore, one can use spatial models to specifically investigate the spatial dependence of per capita property tax income.

3.2 Empirical studies

Although our paper uses per capita property income, as discussed in the introduction, the discussion provided in this section is related to studies that use the property tax rate as the outcome variable to assess the spatial dependence of municipal finance. To the best of our knowledge, there are no studies in the literature that use per capita property tax income as dependent variable.

Recent papers that have looked at the topic from municipalities' income side include, amongst others, Agrawal (2016), Baskaran (2014), Bocci et al. (2017), Buettner and Von Schwerin (2016), Lyytikäinen (2012), Sedmíhradský (2013), Van Malderen and Gerard (2013) and Gerard et al. (2010). Buettner and Von Schwerin (2016) find strong evidence of spatial dependence of municipal business tax in Germany. They conclude that this phenomenon is explained by coordination and by yardstick competition among municipalities. Bocci et al. (2017) emphasise the importance of political and socio-economic factors as determinants of municipal fiscal choices in Italy. They find that, for a given municipality, choices regarding the property tax rate are influenced by its neighbouring municipalities' choices on property tax rates.

Furthermore, we note that all these papers deal with municipalities in developed countries. Sedmíhradský (2013), however, focuses on the Czech Republic, which is a transition economy. This author tests the theory of yardstick competition through local coefficients of the property tax set by Czech municipalities. The evidence in this study points to the influence of neighbouring municipalities on a given municipality's choice with respect to the local coefficient. In other words, Sedmíhradský (2013) finds that municipalities that choose to apply the local coefficient of property tax are surrounded by neighbouring municipalities that also apply the local coefficient. Buettner (2003) examines the subject matter for German municipalities, and finds that an increase in the tax rate of neighbours positively affects the tax rate of a given municipality.

Interestingly, Cassette et al. (2012) have examined the spatial dependence of the local tax of municipalities belonging to different countries, notably France and Germany. Studies using this approach are rare in the literature. A possible explanation could be differences in the institutional arrangements according to which municipalities in these countries operate. Nevertheless, these authors found evidence of spatial dependence of the business taxes of municipalities belonging to the same countries, whereas neighbouring municipalities in the other country have no influence on a municipality's level of business tax.

As indicated above, many papers have examined this topic over the last two decades. For instance, Allers and Elhorst (2005) find evidence for the spatial dependence of property tax rates set by municipalities in the Netherlands. Using estimates from spatial autoregressive models, these authors confirm that the rate of property tax in a municipality increases by 3.5 percent due to an increase of 10 percent in the property tax rate in neighbouring municipalities. Brueckner and Saavedra (2001) rely on the tax competition literature as rationale for the spatial dependence of the property taxes of some municipalities in the United States of America. These authors' findings also confirm that its neighbours'

property tax levels influence a municipality's property tax.

The overwhelming majority of existing studies examine municipalities in developed countries. One contribution of our paper, as noted in the introduction, consists of testing the notion of the spatial dependence of per capita property tax in South Africa. Previous studies internationally have focused on the property tax rate. The focus of the present study is also important to empirically test the hypothesis of spatial dependence of per capita property tax income in a developing country setting, in which the system of fiscal decentralisation is relatively new. The environment in which South African municipalities operate is characterised by different factors than in advanced countries. For instance, the level of active citizenry in monitoring local public affairs may be different in South Africa to advanced countries, where the system of local government has been in existence for many decades. The relatively low level of education could constrain residents' ability to actively monitor the affairs of municipalities. For this reason, we believe that there are factors in South Africa that differ from those in most other countries as far as municipalities are concerned. The nature of residents' needs and expectations from municipalities are also different from advanced economies, in the sense that many residents are still without access to basic services such as water and sanitation, and look to municipalities to provide these.

Consequently, our aim is to test the spatial dependence of per capita property tax income in the context of South African local municipalities. Furthermore, and unlike in previous studies, in which there was reliance on frequentist approaches to estimate spatial autoregressive models, we follow the Bayesian approach in this study. This approach, as argued by LeSage and Pace (2009), is robust for model selection and comparison.

4 Methodology

We first discuss the specification of spatial econometric models and the manner in which each of them captures the spatial dependence of property tax income for a given municipality. This section also discusses the construction of the spatial weight matrices. Lastly, we present the procedure adopted to estimate these models, including the selection of an appropriate spatial econometric model.

4.1 *Specification of spatial models*

Case at al. (1993) and many other studies present a theoretical foundation with respect to the reaction function for *municipality i* in the determination of budget variables. They argue that one has to consider spatial interactions (also referred to as horizontal interactions) between neighbouring municipalities in explaining the behaviour of a municipal budget variable. Based on this theoretical background, we specify three spatial econometric models, as shown in Equations (1), (2) and (3) below, where each equation describes the reaction function of *municipality i* with respect to property tax income for the financial

year 2011/2012, following Case et al. (1993).

$$y = \rho W y + \beta X + \varepsilon \quad (1)$$

$$y = \beta X + \varepsilon, \quad \varepsilon_i = \lambda W \varepsilon + u \quad (2)$$

$$y = \rho W y + \beta_1 X + \beta_2 W X + \varepsilon \quad (3)$$

$$\varepsilon \sim N(0, \sigma^2 V)$$

$$V = \text{diag}(v_1, v_2, \dots, v_n)$$

$$\pi(\beta) \sim N(c, T)$$

$$\pi(\sigma) \sim (1/\sigma)$$

$$\pi(r/v_i) \sim ID_{\chi^2}(r)/r$$

$$\pi(r) \sim \Gamma(m, k)$$

$$\pi(\rho) \sim U(1, 1)$$

$$\pi(\lambda) \sim U(1, 1),$$

where y is a vector of per capita property tax income, X is the matrix of explanatory variables, and W is a row-standardised spatial weight matrix that indicates the connectivity between municipalities. The terms β , ρ , ε and μ are the parameters that we will estimate using the Bayesian approach, as discussed below. In addition, we assume that, for all three models, the error term follows a normal distribution with a non-constant variance.

The term π denotes a prior distribution. In this regard, we consider a normal prior for parameters β and a diffuse prior for σ , whereas prior distributions for ρ and λ are uniform at

$(-1, 1)$ respectively. Furthermore, we assume that the relative variance terms (v_1, v_2, \dots, v_n) , which are going to be estimated, are fixed and unknown. The prior for these relative variances has the form of an independent $\chi^2(r)/r$ distribution.

We provide a brief overview of each of the above-specified models. Equation (1) is referred to as the spatial lag model (SLM). It captures what Elhorst (2014) refers to as the endogenous interactions effects in property tax income. In other words, for the SLM, per capita property tax income in *municipality* i is explained by exogenous variables represented in matrix X , and by the weighted average of property tax income of neighbouring municipalities, symbolised by Wy . The parameter ρ in SLM measures the strength of the spatial dependence of per capita property tax income. It is interpreted as the change in per capita property tax income in *municipality* i induced by a change in per capita property tax income in neighbouring municipalities, all other things being equal. Theories such as tax competition, yardstick competition and benefit spillovers are put forward in the literature as reasons to estimate the SLM (Besley & Case, 1992; Brueckner, 1998; Case et al., 1993; Wilson, 1986; Zodrow & Mieszkowski, 1986). For instance, with regard to yardstick competition, it is often argued that voters have imperfect information with respect to the costs of local public

services and local taxes. Consequently, they compare public spending and tax levels in other jurisdictions with what their government is offering to help them assess government performance. Voters (residents) determine whether the incumbent politicians deserve to be voted into office again (Besley & Case, 1992). Consequently, municipal councils behave in a strategic way to counter voters' behaviour of comparing their performance with that of their neighbouring jurisdictions through local fiscal policies, including mimicking the tax levels or tax burden of their neighbours (Revelli, 2006).

Equation (2) is called the spatial error model (SEM). SEM captures interactions through the error terms. A distinctive feature of SEM is that there are two components in the error term, notably ε and u . The first component is multiplied by the spatial weight matrix to represent the average error due to neighbouring municipalities. In other words, these are unobserved shocks that affect neighbouring municipalities. These shocks are transmitted to a particular municipality through the error term. The second component is the idiosyncratic error for the municipality concerned. The parameter λ captures the interactions between municipalities with respect to property tax income. As Elhorst (2014) argues, SEM does not require a theoretical argument. However, it is consistent with the situation in which there could be some omitted explanatory variable in the specification, or a common shock that affects all neighbouring municipalities' per capita property tax income.

The last equation (Equation (3)) is referred to as the spatial Durbin model (SDM), which nests both SLM and SEM. The specification of the SDM is based on LeSage and Pace (2009). They argue that SDM provides unbiased estimates, even in the case of model misspecification due to omitted variables. Two important terms in SDM necessitate an explanation, notably Wy and WX . The first term is the weighted average of the per capita property tax income of municipalities that are neighbours to *municipality i*. This means that, in addition to the matrix X of independent variables, one has to determine W , which in the literature is exogenously constructed based on contiguity, distance or other connectivity criteria. Thus, the parameter ρ associated with Wy in the SDM specification measures the spatial dependence of per capita property tax income. In other words, it is the change in per capita property tax income of *municipality i* induced by an average change of property tax income in neighbouring municipalities, all else being equal.

The second term, WX , is the matrix of the spatial lags of the independent variables of neighbouring municipalities in respect to *municipality i*. This means there are k parameters β_2 for k spatial lags of independent variables. A parameter, β_2 , measures the degree and direction of a change in per capita property tax in *municipality i* resulting from a change in an independent variable in neighbouring municipalities, all other things being equal.

4.2 Construction of spatial weight matrices

The estimation of the SLM, SEM and SDM require the identification of each municipality's neighbours. This is critical in explaining the spatial dependence

or spillover effects of per capita property tax income. The literature proposes several criteria, such as geographical borders, distances and socioeconomic similarities, to determine neighbourliness between spatial units. In the present paper, we use geographical coordinates that indicate the position of each municipality in space, notably latitude and longitude, to construct three spatial weight matrices. Each of these spatial weight matrices is alternatively used to estimate each of SLM, SEM and SDM.

The first spatial weight matrix is based on contiguity, according to which two municipalities are neighbours if and only if they have a common border, as shown below:

$$w_{ij} = \begin{cases} 1, & i \neq j \\ 0, & i = j' \end{cases} \quad (4)$$

where w_{ij} is a spatial weight that also shows whether two municipalities are neighbours or not. The spatial weight shows the influence of *municipality j* on *municipality i*. Equation (4) shows that w_{ij} can take two values: zero where *municipality i* and *municipality j* are not neighbours, and the value one where the two municipalities are neighbours. The bottom part of the equation shows that a municipality cannot be a neighbour to itself. Hence, in all cases where $i = j$, the value is always zero. We then arrange elements w_{ij} to form a symmetric matrix of n -by- n dimension (where n is the number of municipalities). It is important to note that, according to Equation (4), the diagonal elements of the spatial weight matrix are zero. This matrix needs to be row-normalised so that the sum of a row is equal to one.

The second and third spatial weight matrices are based on Euclidean distance, with thresholds of two and three nearest neighbours respectively. Let d_{ij} be a centroid distance between municipalities i and j , which is calculated using information on latitude and longitude following the Euclidean approach. For n spatial units (i.e. municipalities), we calculate $n^2 - n$ times d_{ij} , which can be ranked as follows: $d_{ij(1)} \leq d_{ij(2)} \leq \dots \leq d_{ij(n-1)}$. Then $k = 2$ or $k = 3$ (two or three nearest neighbours), and the set $N_k(i) = \{j(1), j(2), \dots, j(k)\}$ contains the k nearest municipalities to *municipality i*. Consequently, for two or three nearest neighbours, the spatial weight matrix is constituted with elements as follows:

$$w_{ij} = \begin{cases} 1, & j \in N_k(i) \\ 0, & \text{otherwise} \end{cases} \quad (5)$$

As with Equation (4), the spatial weight matrices based on k nearest neighbours are symmetric and row-normalised, with diagonal elements each equal to zero.

4.3 Estimation procedure

In our view, the process of selecting the appropriate spatial model, after confirming the possibility of spatial dependence through Moran's I test, is data driven. In this regard, two main estimation procedures are proposed in the literature to estimate and test spatial models: the "specific-to-general" and the "general-to-specific" procedures (see LeSage & Pace (2009 for a detailed discussion). The "general-to-specific" approach consists of estimating a spatial model

that simultaneously encompasses spatial interactions in the outcome variable, error terms and/or in the independent variables. This model is referred to as the general model. Thereafter, one has to test for the significance of each spatial variable in the model. The essence of the testing is to conclude whether the general model is appropriate. The “specific-to-general” approach is the opposite of the “general-to-specific” approach in the sense that models that incorporate only one type of spatial interaction are estimated and tested separately under the null that general spatial model is not suitable.

Elhorst (2014) points out that the “specific-to-general” approach is common in most empirical studies in this field. Unlike in the frequentist approach, the Bayesian approach does not follow neither of the abovementioned procedures, but rather consists of estimating all three models, as discussed above, and selecting the appropriate one based on a comparison of their probabilities (LeSage, 1997, 1999, 2014a, 2014b); LeSage & Pace, 2009). One advantage of the Bayesian approach is its ability to compare not only different spatial models (i.e. SLM vs. SEM), but, most importantly, to compare one type of spatial model estimated with different spatial weight matrices (i.e. SLM estimated with a spatial weight matrix based on contiguity vs. SLM estimated with a spatial weight matrix based on two nearest neighbours). To the best of our knowledge, this capability is not yet available in the frequentist approach.

It is common in spatial econometrics to first estimate a non-spatial model, shown in Equation (6) below, which is used as a benchmark to detect the presence of spatial autocorrelation in the residuals. In this respect, we apply the Moran statistic to test for spatial autocorrelation after estimating Equation (6) through the ordinary least squares method (OLS).

$$\begin{aligned} y &= \beta X + \varepsilon \\ \varepsilon &\sim N(0, \sigma^2) \end{aligned} \tag{6}$$

Under the null hypothesis of the Moran test, there is no autocorrelation in the residuals of the estimated non-spatial model. We also use the Lagrange multiplier tests (LMsar, LMerror, robust LMsar and LMerror), as the Moran test does not have an alternative hypothesis, as pointed out by Arbia (2014). The null hypothesis for LMsar and LMerror states that there is no spatial dependence in the residuals of the estimated SLM and SEM respectively. Lagrange multiplier tests are often used to select the appropriate models. Nevertheless, we use these tests only to detect the presence of spatial autocorrelation with respect to property tax income, and rely on the probabilities of posterior estimates to select the appropriate model for our sample data.

Equations (1), (2) and (3) are estimated with Bayesian MCMC estimation, for three reasons (LeSage, 2014a; LeSage & Pace, 2009). First, the assumption of constant variance over space and the normal distribution of the error terms is relaxed. Second, this approach is suitable even in the presence of outliers in the data. Lastly, with this approach we are able to compare models based on different spatial weight matrices and/or specifications.²

²We use Matlab codes provided by LeSage to estimate the Bayesian spatial models. Avail-

If either SLM or SDM is adopted and SEM is rejected, LeSage and Pace (2009) argue that it is important to extract the direct and indirect effects of the independent variables from the standard posterior point estimates in the SLM and SDM. These authors demonstrate that the use of the posterior point estimates of independent variables to interpret their impact on property tax income in SLM and SDM is misleading. They propose a partial derivative interpretation to test the impact of independent variables on the dependent variable, taking into account that there are strategic interactions between spatial units (municipalities in this case). In this regard, they provide a framework that allows for the extraction of (summary) partial derivatives for cross-sectional spatial models.

The direct effect estimates of the SLM or SDM measure the change in the dependent variable in *municipality i* as a result of a change in individual independent variables in that municipality. Also, direct effect estimates include feedback effects, that is, the impact passing through neighbouring municipalities and back to the municipality that instigated the change (Elhorst, 2010). The indirect effect estimates are the changes in the dependent variable of neighbouring municipalities because of the change in independent variables in *municipality i*.³

5 Data

The sample excludes districts, because this category of municipality does not levy property tax income. In this regard, the analysis considers 232 out of 234 local and metropolitan municipalities that existed in the 2011/2012 financial year. Two local municipalities are thus dropped from the analysis due to missing data.

Table 1 in the Appendix lists the data used in the analysis. The dependent variable is per capita property tax income (“income”), and we purposely select independent variables to ensure that our models include fiscal, demographic, socioeconomic, structural and political characteristics as determinants of municipal property tax income.

Per capita operating fiscal transfers (“grant”) is the first independent variable selected to explain per capita property tax income. Therefore, the relationship between “grant” and “income” could be either positive or negative. In the context of a nonspatial model or SEM, a positive coefficient on “grant” would be an indication that fiscal transfer crowds in per capita property tax income, whereas there is crowding out if the coefficient of “grant” is negative.

Number of households (“house”) represents relevant municipal demographic characteristics. By intuition, the relationship between “house” and “income” should be positive. The population aged 20 years and over with at least a university degree as a proportion of population aged 20 years and over (“edu”), per

able at: <https://www.spatial-econometrics.com/>

³Further discussion and mathematical demonstration of direct and indirect effects are presented in Elhorst (2010) and LeSage and Pace (2009) for cross-section spatial econometric models.

capita gross value added (“GVA”) in South African rand, and the percentage of population aged 15 years that is unemployed (“unempl”), represent socioeconomic characteristics. The relationship between “income” and “edu” is expected to be positive because educated individuals have a greater chance to earn an income and therefore to own property (especially higher valued property), and to pay municipal taxes and tariffs. In contrast, we expect “unempl” to be inversely related to property tax income. Municipal area (“area”) in kilometres is a structural characteristic. A positive coefficient of “area” could indicate that the provision of the composite local public good is costlier in geographically large municipalities.

The proportion of seats in a municipal council that are held by the ANC political party (“ANC”) is used to capture the political characteristics of municipalities. Previous studies, including that by Foucault, Madies and Paty (2008), have captured political characteristics using various variables, depending on data availability. Since democratisation in 1994, and up to and including the period of analysis for this study, the ANC has been the dominant political party and has governed in most municipal councils across South Africa. The proportion of seats held by the ANC in a council is a good indicator of the political characteristics of a municipality. The ANC has a range of pro-poor policies, such as exempting some households from paying property tax or providing a reduction in property tax. Thus, we a priori assume a negative relationship between per capita property tax income and the ANC, all other things being equal.

Data is collected from three different sources. The fiscal characteristics (“grant” and “income”) are obtained from the municipalities’ audited income statements for the 2011/2012 municipal financial year (which spans from July 2011 to June 2012) published on the National Treasury website.⁴ Other variables, excluding “GVA” and “ANC”, are obtained from the 2011 Population Census (Statistics South Africa, 2011). The GVA information is collected from Quantec (2018), while the ANC variable is constructed based on information collected from the Independent Electoral Commission of South Africa (2011). Data on the geographical locations of municipalities that is used to build the spatial weight matrices is collected from the Global Administrative Areas website.⁵ We report the summary statistics in Table 2 in the Appendix. It can be observed that South African municipalities are characterised by significant disparities.

We considered collecting and using property tax rate as the dependent variable, as do most studies in the literature, as a robustness check. However, this information is not publicly available across municipalities, so it was not feasible to pursue this option.

⁴<https://municipaldata.treasury.gov.za/> (Accessed 23 June 2018).

⁵ Available at <https://gadm.org/>

6 Results

To illuminate relevant aspects of the data, we show the distribution of per capita property tax income for 2011 and 2017 in Figures 1 and 2 respectively. These maps are constructed by clustering municipalities according to natural breaks (Jenks, 1967). For each map, we cluster municipalities into nine groups. We can observe that adjacent municipalities have a similar value of per capita property tax income, which, to a certain degree, may be considered indicative of possible spatial dependence.

Furthermore, we show in Figures 3 to 5 that per capita property tax income is indeed spatially autocorrelated using the Moran’s I scatterplots. On the horizontal axis is the distribution of standardised per capita property tax income, whereas the distribution of its spatial lag is on the vertical axis. The two dashed lines represent the mean of the per capita property income variable and its spatial lag respectively. For each figure, it can be seen that there are many points in the top-right and bottom-left quadrants. This is an indication of some sort of spatial clustering (or autocorrelation) of per capita property tax income. Points in the top-right quadrant show that municipalities with above-average per capita property tax income are surrounded by municipalities with above-average per capita property tax income. With regard to points in the bottom-left quadrant, they show that municipalities with below-average per capita property tax income are surrounded by municipalities with below-average per capita property tax income. The patterns are backed up by our findings after rigorous model estimation, as discussed below.

Table 3 in the Appendix shows the results of the Moran’s I statistic under randomisation for each of the three spatial weight matrices used in the analysis. It can be seen that the reported Moran’s I statistics are positive, and their probability values are less than five percent of significance level. These results point to the presence of positive spatial autocorrelation in the residuals of the estimated OLS model (Equation 6), in which per capita property tax income is explained by independent variables. The rejection of the null hypothesis of no spatial autocorrelation in the residuals of the estimated OLS model is an indication that we need to specify models that capture this spatial autocorrelation. These models correspond to the spatial models that we specified in Equations (1), (2) and (3). A discussion of their findings is presented in the next section.

Before discussing the results of the Bayesian spatial models, it is worth noting that inferences from these models are based on Markov Chain Monte Carlo (MCMC) sampling, consisting of 10 000 iterations. We adopted a conservative approach in discarding 1 000 early samples for each of the models to ensure that the remaining samples are from the converged parts of the chain. Other MCMC draws (i.e. 3 000, 20 000 and 5 000) were also used as robustness checks, and the posterior estimates are consistent throughout.

We estimate, for each specified equation (SLM, SEM and SDM) and each spatial weight matrix (e.g. first-order contiguity), a regression based on the assumption of homoscedasticity on the one hand and heteroscedasticity on the other. A three-step estimation process is followed to compare these models,

with the aim of selecting a combination of spatial model and spatial weight matrix that is suitable for the sample data. First, we compute probabilities for all estimated 18 spatial models (three spatial models by three spatial weight matrices by two assumptions, homoscedastic and heteroscedastic models) to decide if we should consider heteroscedasticity or homoscedasticity with respect to the residuals. Table 4 in the Appendix shows the probabilities of these models and should be read as follows: for each spatial weight matrix (in rows), we show the results of each spatial model (i.e. SLM) estimated under the assumption of homoscedasticity and heteroscedasticity respectively. These results show that, irrespective of the spatial weight matrix used, heteroscedastic SLM, SEM and SDM have the highest probabilities, which is an indication that we should discard the homoscedastic models. Technically, this also means that we keep nine out of 18 estimated spatial models, which are considered in the second step of this process, as discussed below.

Second, we compare the heteroscedastic spatial models to decide whether SLM, SEM or SDM is appropriate using the model probabilities. The results in Table 5 in the Appendix indicate that SLM performs better than SEM and SDM because of high probabilities. It means we select the SLM for each spatial weight matrix. Lastly, we compare the three SLM selected in the preceding step, as shown in Table 6 in the Appendix. In this regard, the SLM estimated with the spatial weight matrix based on the first-order contiguity criterion is selected as suitable for the sample data.

In Table 7 in the Appendix we report the posterior means of the SLM, estimated with the spatial weight matrix based on the first-order contiguity criterion. As can be seen, the posterior mean of ρ is positive and statistically significant at the one percent level. This is an indication of the spatial dependence of per capita property tax income among municipalities in South Africa, as already confirmed by the Moran's I statistic. It also means that an average change in per capita property tax income of R100 in contiguous municipalities corresponds to a positive change equivalent to R28 of per capita tax income in a given municipality, all other things being equal.

In our view, a space variable " ρ " is an indication of mimicking behaviour shown by South African municipalities as a strategy to counter residents from comparing their tax burden with those of neighbouring municipalities. This finding suggests that, when designing municipal finance-related policies, one has to consider this important aspect. This is because South African municipalities are influenced by their neighbours in one way or the other that results in a positive relationship between per capita property tax income.

Furthermore, the positive space variable is a confirmation of Tobler's first law of geography. Simply put, our findings show that municipalities in the same vicinity, in terms of contiguity and distance, exhibit similarities regarding per capita property tax income. It also means that there are some underpinning common factors that have an influence on municipal property tax policies in general.

The posterior means of some independent variables, except for "house", "unempl" and "area", and the constant terms are statistically significant. However,

as discussed in the preceding section on the methodology, we do not use the coefficients of the independent variables to interpret the impacts on the per capita property tax income. Instead, we use the results shown in Table 8 in the Appendix, in which we report posterior means of direct, indirect and total effects of independent variables on per capita property tax income. For ease of reference, we just refer to these as direct, indirect and total effects. Starting with direct effects, we observe that all but “grant”, “house”, “unempl” and “area” are statistically significant. In the case of “grant”, we note that per capita property tax income in a municipality increases (decreases) as a result of an increase (decrease) in the per capita grant. This finding could also mean that the per capita grant crowds in per capita property tax income.

In addition to it being positive and different from zero, we observe that the direct effect of “edu” is larger in magnitude than the other effects. This shows the relevance of education as an important determinant of per capita property tax income. As discussed in the preceding section, education is related to property tax income through the revenue earned by educated individuals, which makes them more likely to own and invest in higher value property and to pay municipal taxes and tariffs. The direct effect of GVA on per capita property tax income is intuitive, as shown by its positive sign. In other words, this result shows that an increase in per capita GVA corresponds with an increase in per capita property, all other things being equal.

We also note a negative direct effect of ANC, which implies that an increase (decrease) in the number of ANC seats in a municipal council will result in a decrease (increase) in per capita property tax income. This could be explained by the fact that ANC-dominated councils are in favour of policies that lead to lower per capita property tax income.

Turning now to indirect effects, we observe that only “edu” and “ANC” are statistically significant. This means that a change in any of these two variables in *municipality i* affects the per capita property tax income of municipalities that are neighbours to *municipality i*. Simply put, there are spillovers from “edu” and “ANC” in *municipality i* to neighbouring municipalities’ property tax income. Indirect effects occur because any change in an independent variable (e.g. “edu”) in *municipality i* first affects per capita property tax income in that municipality, which also affects the per capita property tax income of neighbouring municipalities, as confirmed by parameter ρ .

As discussed in the section on methodology, the total effect is a summary measure of the average impact on per capita property tax income in *municipality i* caused by a change in an explanatory variable in proportion of ANC seats in all neighbouring municipalities leads to a decrease in per capita property tax income of R4 in *municipality i*, all other things being equal.

7 Conclusion

The theory has established the plausible notion that local governments or municipalities directly or indirectly influence each other’s income and/or revenue

(Brueckner, 2003; Tiebout, 1956). With the advancements made in spatial econometric techniques, many studies have empirically tested this assertion using spatial autoregressive models. Empirical findings have been mixed, with some but not all studies confirming the existence of spatial dependence of municipal finance, including revenue.

However, the present study is the first to empirically test the validity of the spatial dependence of per capita property tax income, whilst most studies have used the property tax rate as the dependent variable. We also focus on South Africa, which is a developing country and has a relatively new decentralised fiscal system. In this regard, we also estimate the Bayesian spatial autoregressive models, as proposed by LeSage (1997, 1999, 2014a, 2014b). First, we find strong evidence of autocorrelation of per capita property tax income. We also find that this spatial dependence is well represented in the SLM specification. Indeed, per capita property tax income in *municipality i* changes because of a change in per capita property tax income in neighbouring municipalities. Second, our findings also demonstrate that, taking into account the interdependence of property tax income among municipalities, per capita grant, education, per capita GVA, and the proportion of ANC seats in council are the key determinants that explain property tax income for a given municipality in South Africa. Of these determinants, education is the most significant in terms of magnitude.

Third, we also observe the spillover effects of some determinants in neighbouring municipalities to per capita property tax income in a given municipality. This is mainly because the per capita property tax incomes of neighbouring municipalities influence one another.

Despite the fact that this paper draws important conclusions with regard to the spatial dependence of per capita property tax income in South Africa, these conclusions cannot be used to infer similar behaviour for other municipal revenue sources (e.g. service charges, surcharges, etc.). It would be wise to consider each of these revenue sources individually because they differ in nature.

We can conclude, based on the empirical results in this paper, that it is important for policymakers to recognise that any (i.e. financial) policy measure or action targeting one or a group of municipalities has the potential to affect other neighbouring municipalities in one way or the other. This is because of strong spatial interactions that exist among South African municipalities.

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Appendix

Figure 1: Spatial distribution of per capita property tax income, 2011

Distribution of per capita property tax income in 2011

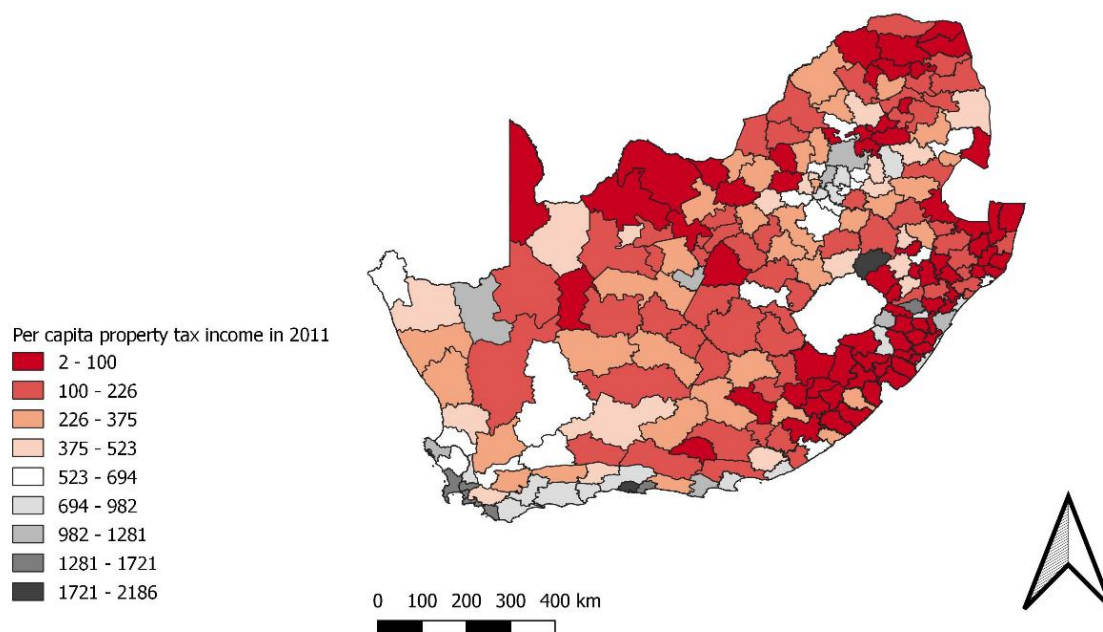


Figure 2: Spatial distribution of per capita property tax income, 2017

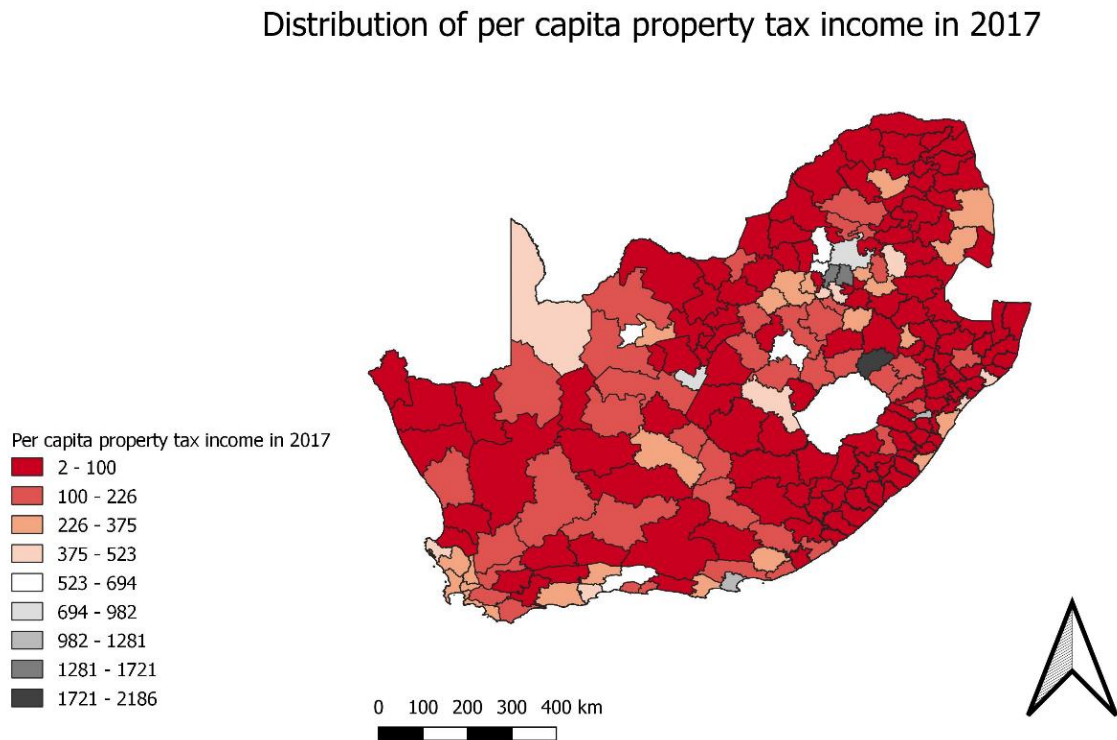


Figure 3: Univariate Moran's I for per capita property tax income in 2011: Contiguity spatial weight matrix

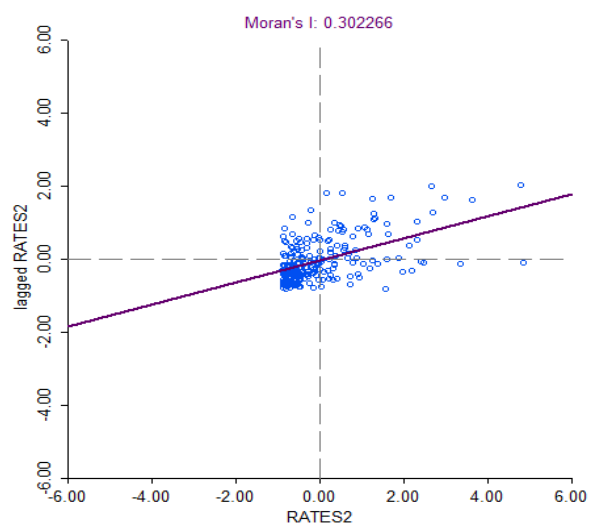


Figure 4: Univariate Moran's I for per capita property tax income in 2011: Two nearest neighbours spatial weight matrices

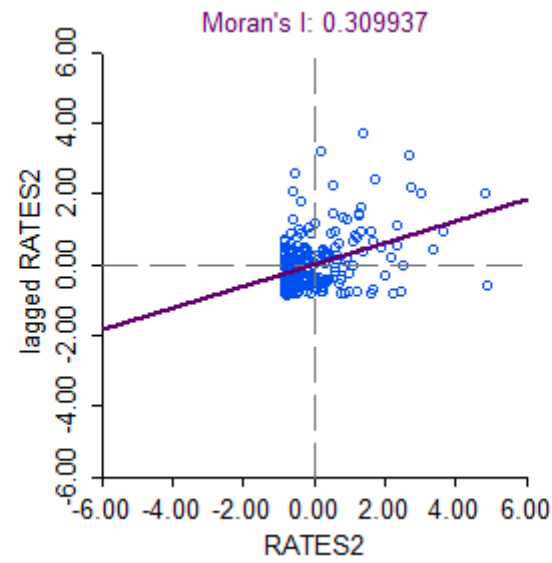


Figure 5: Univariate Moran's I for per capita property tax income in 2011: Three nearest neighbours spatial weight matrixes

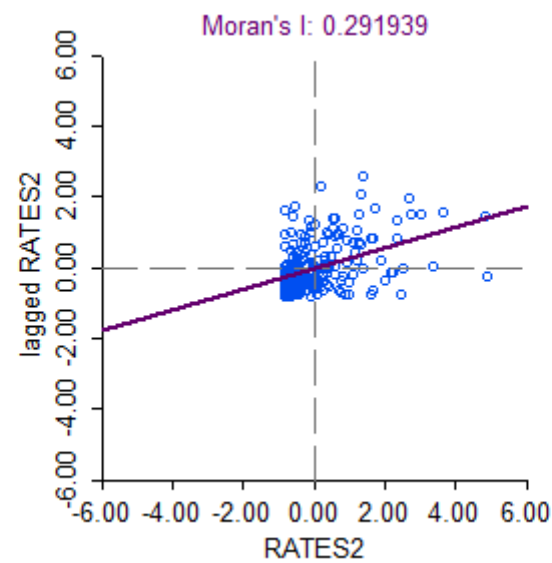


Table 1: List of variables

Variable	Description
Income	Income from property tax divided by total population in a municipality in South African rand (ZAR)
Grant	Per capita operating fiscal transfers in ZAR
House	Number of households
Edu	Population with higher degrees as percentage of population aged 20 and more
GVA	Per capita GVA of total industries at basic prices in ZAR (current prices)
Unempl	Population aged 15-64 unemployed as percentage of total population
Area	Area in square kilometre
ANC	Proportion of ANC seats in municipal council

Table 2: Summary of descriptive statistics

Variable	MAX	MIN	MEAN	STD
Income	2 186	2	336	381
Grant	2 157	51	764	370
House	1 493 936	1 735	63 107	163 809
Edu	22	2	7	3
GVA	338 394	5 320	38 420	30 706
Unempl	15	3	9	3
Area	36 127	252	5 249	5 438
ANC	96	13	64	17

Table 3: Spatial autocorrelation tests

Spatial weight matrix	Moran's I statistic	Probability
First-order contiguity	0.14	0.00
Two nearest neighbours	0.12	0.01
Three nearest neighbours	0.13	0.00

Table 4: Posterior probabilities of homoscedastic and heteroscedastic spatial models

	SLM		SEM		SDM	
	Homo.	Hetero.	Homo.	Hetero.	Homo.	Hetero.
Spatial weight matrix						
First-order contiguity	0.000	1.000	0.000	1.000	0.000	1.000
Two nearest neighbours	0.000	1.000	0.000	1.000	0.000	1.000
Three nearest neighbours	0.000	1.000	0.000	1.000	0.000	1.000

Table 5: Comparison of heteroscedastic spatial models

Model	First-order contiguity	Two nearest neighbours	Three nearest neighbours
SLM	1.000	1.000	1.000
SEM	0.000	0.000	0.000
SDM	0.000	0.000	0.000

Table 6: Selection of the appropriate spatial model

Model	Spatial weight matrix	Model probability
SDM	First-order contiguity	0.767
SLM	Two nearest neighbours	0.002
SDM	Three nearest neighbours	0.232

Table 7: Posterior estimates of SLM

Variable	Posterior mean	Z-probability
Constant	-58.448	0.290
Grant	0.046*	0.090
House	0.0001	0.270
Edu	53.779***	0.000
GVA	0.001*	0.070
Unempl	-1.672	0.730
Area	-0.0004	0.820
ANC	-3.061***	0.000
ρ	0.2870***	0.000
Adjusted R ²	0.5	
Number of draws	10000	
Burn-in	1000	

** and *** indicate statistically significant at 10 and 1 percent respectively*

Table 8: Posterior direct, indirect and total effects of independent variables

Variable	Posterior mean	Probability
<i>Direct</i>		
Grant	0.047*	0.094
House	0.000	0.277
Edu	54.683***	0.000
GVA	0.001*	0.080
Unempl	-1.6990	0.731
Area	-0.0004	0.820
ANC	-3.1130***	0.000
<i>Indirect</i>		
Grant	0.0180	0.1320
House	0.00003	0.3050
Edu	21.129***	0.0000
GVA	0.004	0.1020
Unempl	-0.640	0.7430
Area	-0.0001	0.8220
ANC	-1.204***	0.0020
<i>Total</i>		
Grant	0.065*	0.0980
House	0.0001	0.2800
Edu	75.813***	0.0000
GVA	0.001*	0.0800
Unempl	-2.340	0.7330
Area	-0.0006	0.8200
ANC	-4.317***	0.0000

* and *** indicate statistically significant at 10 and 1 percent respectively