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YOUTH SPORTS PARTICIPATION, DEMOGRAPHY AND IMPACT OF LOCAL POLICIES IN THE PREVALENCE OF CARDIOVASCULAR DISEASE

Dissertação de Mestrado na área científica de Ciências do Desporto, especialidade Treino Desportivo para Crianças e Jovens, orientada pelo Professor Doutor João Valente dos Santos e Professor Doutor Manuel J. Coelho-e-Silva e apresentada à Faculdade de Ciências do desporto e Educação Física da Universidade de Coimbra

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Faculdade de Ciências do Desporto e Educação Física

Youth sports participation, demography and impact of local policies in the prevalence of cardiovascular disease

Dissertação de Mestrado apresentada a Faculdade de Ciências do Desporto e Educação Física da Universidade de Coimbra com vista à obtenção do grau de Mestre em Treino Desportivo para Crianças e Jovens.

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Abstract

A sedentary lifestyle, especially among young people, is a very important risk factor for the development of many chronic diseases, including cardiovascular disease (CVD). The aging population, combined with the lack of sports practice among the youth has contributed to the emergence of these diseases as the main cause of death in modern societies. Therefore, the prescription of physical activity is becoming crucial in most strategies for treatment and prevention for CVD. By its close relationship with the communities, municipalities are in an excellent position to create favourable conditions for sport practice among population, especially among youth.

This work is an empirical exercise that seeks to verify if there is any statistical relationship between the effort of Portuguese municipalities in the implementation of sports policies and the quality of life of their respective communities, particularly in terms of the prevalence of CVD and life expectancy. Our exploratory spatial analysis confirms the presence of strong spatial autocorrelation in almost all variables, confirming the strong spatial dependence between neighbouring municipalities. The estimation of the spatial error model confirms the existence of a slight impact of local sports policies on mortality rate from CVD.

Keywords: Youth · Sport Policies · Physical Activity · Cardiovascular Diseases · Spatial Autocorrelation

Resumo

Um estilo de vida sedentário, especialmente entre os jovens, representa um fator de risco muito importante para o desenvolvimento de diversas doenças crónicas, incluindo doenças cardiovasculares. O envelhecimento da população, conjugado com a falta de prática desportiva no seio da juventude tem contribuído para a emergência destas doenças como causa principal de mortalidade nas sociedades modernas. Desta forma, a prescrição de atividade física constitui um elemento crucial na maioria das estratégias de tratamento e prevenção de doenças cardiovasculares. Tendo em conta a sua relação de grande proximidade com as comunidades, os municípios ocupam uma posição privilegiada para criar condições propícias à prática desportiva entre a população em geral e no segmento infanto-juvenil em particular.

Este trabalho constitui um exercício empírico que visa verificar a existência de associação estatística entre o esforço dos municípios portugueses na implementação de políticas desportivas e a qualidade de vida das suas respetivas comunidades, particularmente em termos de prevalência de doenças cardiovasculares e de esperança de vida. Os resultados da nossa análise espacial exploratória confirmam a presença de uma correlação espacial significativa em quase todas as variáveis. Com efeito, confirma-se a forte dependência espacial entre os municípios vizinhos. As estimativas do modelo de erro espacial confirmam, ainda, a existência de um ligeiro impacto das políticas desportivas a nível local sobre a taxa de mortalidade por doenças cardiovasculares.

Palavras-chave: Crianças e Jovens · Políticas Desportivas · Atividade Física · Doenças Cardiovasculares · Autocorrelação Espacial

Contents

List of Tables

List of Figures

List of Abbreviations

CVD – Cardiovascular diseases

EU – European Union

INE – National Institute of Statistics Portugal

WHO – World Health Organization

Chapter I

Introduction

1. Introduction

The increase in life expectancy on the one hand, but also the increasing mechanization of our daily lives, gave rise to the emergence of new diseases that goes side by side with the development of society and characterizes the modern world. Among the leading causes of death, some diseases, such as cardiovascular disease (CVD), cancer and other pathologies linked to new lifestyles, emerge as the most significant. The sedentary behaviour and new dietary habits are strongly associated with those diseases, especially in developed countries; with huge social and economic impact. As such health authorities must promote new preventive approaches, much more holistic, to prevent the spread of the so-called new epidemic diseases of modern times.

Thus, physical activity, or rather the lack of it, appears today as a major risk factor associated with the prevalence of CVD. Therefore, it is natural that organizations with responsibilities in population health care tend to include the prescription of physical activity in their treatment and prevention strategies. Scientific evidences indicate the beneficial effects of physical activity on health, reducing substantially the risk of most chronic diseases including CVD, overweight and obesity, type II diabetes and various types of cancer (Bouchard, Blair, & Haskell, 2006). In most developed countries, particularly in the European Union, all indicators point to the existence of a sports practice far short from the minimal level compatible with a good health, be that in its formal or informal component. Moreover, another aspect that is common to the various surveys on people's living habits is the inequality in terms of sports practice. Data survey indicates that access to sport is uneven throughout the population, usually depending on the socioeconomic status of individuals.

In this sense, the opportunity to put into practice sports policies aimed at promoting physical activity among all sectors of the population is certainly evident and necessary. These policies arise as a key element in the strategy of prevention against CVD. Moreover they are also a fundamental mean to ensure fairness and equity criteria regarding the access of the entire population to physical activity, through a "sport for all" approach.

As part of a sports policy, the key role of local authorities has been widely recognized. Indeed, by its proximity to the people and local actors, whether of private or associative nature, local authorities are in excellent position to mobilize and involve wide sectors of society in sports development plans leading to exciting dynamics and practical results.

The statistical association between physical activity and the prevalence of CVD is clear and consistent and has been demonstrated by numerous empirical studies. However, regarding the connection between local sports policies and population health indicators, the literature is scarce and very heterogeneous, at both theoretical and empirical levels.

Portugal, when compared to other European countries, has a high degree of centralization regarding the distribution of public resources. Despite this, Portuguese local authorities are endorsed with many responsibilities related to sport and physical activities and play a very active role in terms of sports policies. They support sports clubs and manage their own infrastructure with appropriate strategies to promote its use in a regular basis. Moreover, local authorities are the main responsible for policy choices concerning mobility, land use and public space organization. As such, local authorities are a key partner for any strategy aimed at raising the level of physical activity among the population, especially at youth levels.

Given this role, we think that it is of great importance to carry out empirical studies to assess and confirm possible effects of these policies on health indicators among the population. To fill this gap in literature, we lead on with a spatial econometric exercise, based on data disaggregated by Portugal's continental municipalities.[1] The use of spatial econometrics is fully justified since the effects of policies in a given municipality may in many cases generate externalities to neighbouring territories. The spatial econometrics, beyond measuring and incorporating these potential external and spatial effects, also gives more consistency to the estimators since the presence of spatial autocorrelation violates the assumption of independence of observations. Thus, the dissertation is organized as follows: after this introduction, follows a section with a theoretical exposition of the whole subject under discussion. In the third chapter, we explain the data and methodology. The results are described in the fourth chapter followed by the conclusion in the fifth chapter.

[1] Once we use here the criterion of geographical contiguity between municipalities to integrate eventual effects of spatial correlation, it would make no sense to use the data of the archipelagos.

Chapter II

From heart disease to local sport policies

2. From heart disease to local sport policies

2.1. Impact of cardiovascular disease

Cardiovascular diseases are a major cause of death in Europe. Each year, they cause the death of more than 4 million people in Europe and more than 1.9 million in the European Union (Nichols et al., 2012). In a comparative analysis, CVD accounted for 47% of deaths recorded in Europe and 40% of deaths occurred in the EU while in Portugal this average is slightly lower, with 32% (Nichols, et al., 2012).

This preponderance is a relatively recent phenomenon and can be interpreted in the light of the concept of “epidemiological transition” introduced by Omran (Omran, 1971). According to this author, the main drive of epidemiological transition is the downward trend in deaths caused by infectious diseases. Societies moved from the "age of pestilence and famine" to the "Age of Degenerative and Man-Made Diseases" (Omran, 1971). The increased importance of CVD in industrialized countries is often interpreted as a problem of adaptation of the human race to this new model of society (Lamm, 1984). Indeed, the world in general and Europe in particular exhibits, from the late nineteenth century, a change in the typology of causes of death. Degenerative diseases (CVD and cancer) began to assume a dominant role over infectious and parasitic diseases (Nizard, 1997). Two orders of factors contribute to explain this trend. On the one hand, the economic and social development raised the standard of living in most Western countries, improving hygiene, food and sanitation (Maffenini, 1984). This allowed to reduce dramatically the importance of many infectious and parasitic diseases and significantly increase life expectancy at birth, thus contributing to an aging population and a greater exposure to degenerative diseases and in particular CVD (Maffenini, 1984).

On the other hand, the new consumer habits, the mechanization of production and the increase of sedentary habits among vast sections of the population induced the so-called "man-made disease" in which the CVD plays a major role (Omran, 1971).

Cardiovascular diseases have a significant economic impact on society estimated at 196 billion euros per year in the EU countries (Nichols, et al., 2012). The direct cost of health care accounts for 54% of the total cost (212 euros per capita per year) and remains as the most significant (Nichols, et al., 2012). However the economic impact goes far beyond the treatment costs. Indeed, we have to account for the loss of productivity and the cost of informal care. Productivity losses arise from premature death and temporary or permanent disability resulting from disease. Together the productivity losses represent 25% of the total cost of CVD, about 27 billion euros a year in the European Union (Nichols, et al., 2012). The cost of informal care consists of the opportunity cost of unpaid care, that is, the income losses of people who are mobilized to informal care, usually to the respective family members. They represent 22% of the total cost, i.e. 43.5 billion euros a year in the European Union (Nichols, et al., 2012).

Health indicators do not present a homogeneous distribution among the European population. Indeed, life expectancy at birth exhibits a 19-year gap within the European male population and a 15-year gap on female (World-Health-Organization, 2009a). Inequality is also significant between countries. For example, in relation to the number of deaths from CVD, the northern European countries present much better results compared with some countries in the South and East (Mackenbach, 2006). Moreover, differences larger than 10 years are also found in life expectancy between low and high socioeconomic group levels (Mackenbach, 2006). Finally, the prevalence of CVD decreases with the educational level (Mackenbach, 2006).

2.2. Risk factors

Several risk factors compete for the occurrence of CVD in humans. These factors can be of genetic or environmental nature. In the present case, diet and physical activity represent key factors. According to a World Health Organization (WHO) study (World-Health-Organization, 2009b) 8 key factors explain 61% of deaths from CVD: alcohol consumption, smoking, hypertension, overweight, high cholesterol, hyperglycaemia, low consumption of fruits and vegetables and physical inactivity. Five of these factors are directly or indirectly related to physical activity. A simple reading of these factors allows us to understand the importance of prevention in the management of these diseases.

According to Capewell and O'Flaherty (2011), a small change in the level of any of these risk factors can reduce dramatically the deaths and disabilities caused by CVD. The same authors state that these effects can be seen within a relatively short period of time. However, to have tangible results, prevention strategies should address the whole population and not only some segment of risk populations or individuals with clinical signs (Jørgensen et al., 2013). Calculations carried out in the UK estimate a real possibility of saving 7.7 billion euros in two years with an appropriate prevention strategy geared to improve diet and increase physical activity (Scarborough et al., 2011).

2.3. The importance of physical activity

There are already sufficiently convincing empirical evidence on the relationship between physical activity and CVD.[2] The empirical evidence points to insufficient physical activity as a risk factor associated with CVD, in particular to coronary heart diseases and cerebrovascular accidents (Do Lee, Folsom, & Blair, 2003; Sofi, Capalbo, Cesari, Abbate, & Gensini, 2008). Epidemiological evidence points to the fact that effective preventive actions can be achieved with moderate levels of physical activity which are perfectly achievable for all population (Bouchard, et al., 2006). Thus, the WHO recommendations, also followed by the European Heart Network, point to a minimum of 150 minutes of moderate aerobic activity per week (World-Health-Organization, 2010). For moderate activity, it is meant a walk with a moderate speed around 4-6 km per hour. An almost daily practice of 60 minutes of physical activity (300 minutes per week) can be even more beneficial for the cardiovascular system also helping to control excess weight (World-Health-Organization, 2010). The long-term objectives of WHO indicate a recommended level of 60 minutes of daily physical activity. Note that this level of physical activity has a broader impact on other areas of human health, helping to preserve other functional abilities of human body (cognition, mobility etc.) and to prevent other chronic diseases (World-Health-Organization, 2003).

Data on physical activity are based in most cases on subjective measures that should always be interpreted with caution. Despite this fact, most studies estimate that about two-thirds of adults do not practice the minimum levels of physical activity consistent with optimum health (Branca, Nikogosian, & Lobstein, 2007).

[2] For a comprehensive literature review we followed Nocon, M., Hiemann, T., Müller-Riemenschneider, F., Thalau, F., Roll, S., & Willich, S. N. (2008). Association of physical activity with all-cause and cardiovascular mortality: a systematic review and meta-analysis. *European Journal of Cardiovascular Prevention & Rehabilitation, 15*(3), 239-246.

According to the results of the Eurobarometer survey on sport and physical activity (European-Commission, 2014) there is a high sedentary rate among European population pretty far from the WHO recommendations. Indeed, this survey conducted between November and December 2013 and covering a population of 27,919 people chosen among the 28 Member States of the European Union, shows that 59% of Europeans rarely, if ever, practice a physical activity or sport. The same survey also shows that 41% do so at least once a week. For exercise the investigation means any form of activity practiced in a sport context like swimming, training in a gym, jogging in a park, etc. As for frequency, a regular practice involves a minimum of 5 sessions per week while a practice is considered rare when the frequency is below the level of three sessions per month (European-Commission, 2014). The northern countries show higher activity levels compared to southern countries. In Sweden, 70% of respondents revealed a sport practice at least once a week compared to 28% in Portugal. The percentage of respondents who reveal to never have any sport practice was for those two countries respectively 9% and 64% (European-Commission, 2014). The connection between physical activity and heart disease is straightforward through the direct stimulus on the myocardium. However, there is also an indirect impact of physical activity through other risk factors, including the control of obesity or overweight (Nocon, et al., 2008). As for the distribution of sport among the population and among the countries of the European Union, the Eurobarometer study points to the educational level and socioeconomic status as the main discriminating factors concerning sports practice (European-Commission, 2014).

Sport has high social relevance and is a primary context for physical activity for the majority of youth. Reasonably regular participation in sport is characteristic of youth in many European countries (Adelino, Vieira, & Coelho, 2005; Seabra, Mendonça, Thomis, & Malina, 2007; Telama & Yang, 2000). Active lifestyles, however, vary between different geographic communities (Barreto, 2000).

Factors that influence physical activity levels of a population may be of individual (Edwards & Tsouros, 2006) or social nature. They also may be related to the physical environment that surrounds the individual (Dahlgren, 1994). From the individual point of view, there are several determinants that influence the participation in physical activities including sex, age, physical skills and motivation (World-Health-Organization, 2002).

Socio-economic status strongly determines the level of physical activity. Due to absence of financial capacity, lack of free time or simply due to the embedded culture in which physical activity is socially devalued, disadvantaged social groups tend to practice less sport (McNeill, Kreuter, & Subramanian, 2006). The built environment is another key factor that may induce or inhibit physical activity. By physical activity it is meant "any force exerted by skeletal muscles which results in an energy expenditure level above the resting level" (Caspersen, Powell, & Christenson, 1985). The built environment is used in a very broad sense including the type and quality of spatial planning. A city with a good pedestrian or cycling network, properly organized with a good mobility policy which discourages individual motorized transport will surely promote greater physical activity levels. Also, good equipments, green areas and well maintained sports facilities combined with sports animation policies are key factors to ensure wide access to sport and increase the numbers of assiduous practitioners (Edwards & Tsouros, 2006). According to (Baker, 2006), creating accessible sport facilities can increase by 25% the number of people who exercise at least three times a week. This effect can be more pronounced if the presence of the equipment is accompanied by information about its correct use and the health benefits of physical exercise (Baker, 2006). Sports policies aimed at youth in combination with schools, linking sport in schools to more competitive activities, and helping to build bridges between schools and clubs represent several paths in order to create permanent habits of physical activity and sport (Rees et al., 2006).

Local governments can play a crucial role in creating an environment that fosters a regular sport and physical activity within the population. Empirical evidence tends to show that policies to increase physical activity will be more successful if directed to improving the built and social environment of communities (Spence, 2001). Local elected officials have in this respect an excellent opportunity to use their democratic legitimacy to integrate the best urban planning practices with public health policies.

By its direct action on urban planning, particularly in the management of public space and mobility policies, local governments can significantly stimulate physical activity (Edwards & Tsouros, 2006). Due to the proximity of people and sports agents, municipalities are in a crucial position to put into practice local strategies that promote physical activity from a comprehensive logic aligned with the concept of “sport for all”. These local strategies should encourage the practice of physical exercise in areas with high population density, with green spaces and quality equipment, all kept in good condition (Sallis & Glanz, 2006). They should promote a safe environment and seek to involve the people and the local clubs in partnerships to facilitate access to sport across all population and without any kind of exclusion (Sallis & Glanz, 2006).

As we have said above the prevalence of chronic diseases and CVD is higher among lower socio-economic strata. This higher prevalence is strongly associated with different behavioural patterns in terms of mobility and dietary habits (Frank, Engelke, & Initiative, 2001). Indeed, the most vulnerable members of society may not have the means necessary to have access to sport facilities. In addition, they live in disadvantaged areas with lack of equipment. Moreover the street itself may not have safety conditions, thereby inhibiting the mobility of people and preventing children from playing (Gordon-Larsen, Nelson, Page, & Popkin, 2006; McNeill, et al., 2006).

In this sense, a sport policy aimed at strengthening physical activity among the population must be strongly committed to the concept of "sport for all". The "sport for all" concept means the provision of affordable sport activity for the whole population (Baumann, 2010). Sports policies promoted by local authorities should articulate measures to promote all kind of physical activity, be that more formal or organized initiatives in clubs and under sportive federation or informal activities practised in public spaces. Regardless of the size of budgets, it is important that the aim of these policies is as broad as possible and with a particular focus on disadvantaged social levels.

A good sports policy which encourages physical activity for the entire population may require significant resources. The funds are normally divided between the construction and maintenance of physical infrastructure, the support of clubs and the remuneration of the municipalities' staff who implement these policies on a daily basis.

Cost benefits analysis available in literature points to the positive effects of these policies and their impact on health and quality of life of populations. According to studies conducted in the United States of America, active individuals have lower direct medical costs compared to inactive (United-States, 1996). Promoting moderate levels of physical activity among the inactive population may generate a decrease in direct medical costs of many billions of dollars annually (United-States, 1996). Companies can also benefit from these policies with a healthier workforce, less absenteeism and higher productivity (Pratt, Macera, & Wang, 2000). Finally, it is noted that cities with a favourable environment for smooth travel means (pedestrian and cycling), with good sports and leisure infrastructure, attract more people and have a higher income from tourism (Daniels & Norman, 2003).

Chapter III

Data and analytical framework

3. Data and analytical framework

This study, based on data disaggregated at the municipalities level intends to conduct an empirical assessment of the role of local governments in the promotion of sport activity and the respective impact on several health indicators. More particularly, we aim to assess the extent to which municipal expenditures in sport (total, current and capital) contribute to the improvement of cardiovascular mortality rate and also of longevity index.

Thus we estimate two models, using successively as endogenous variables the mortality rate from CVD (‰) and the longevity index. As for the explanatory variables we use the municipal expenditure on sports and culture, with various levels of disaggregation (total, current and capital expenditure). In the same equation we will also use a set of control variables in order to strengthen the coefficients estimations. As such, we add a demographic variable represented by the aging index, a variable of human capital, represented by the gross rate of schooling and finally two socioeconomic variables by including the average monthly earning (€) and the gross value added of private sector companies.

All data used in this empirical study were taken from the Portuguese National Statistics Institute and are disaggregated at the level of the 278 Portuguese mainland municipalities, for the period between 2004 and 2012. The mortality rate from CVD corresponds to the number of deaths during a year, divided by the average population in the same period. The longevity index is the relationship between the aging population and the elderly, usually defined as the ratio between the number of people with 75 or more years and the number of people aged 65 years or more (usually expressed in percentage of people aged 65 and over). It is used as a proxy for the life expectancy. The aging index is defined by the relationship between the elderly and young people, usually defined as the ratio between the number of people aged 65 years or more and the number of people aged between 0 and 14 years (usually expressed in percentage of people from 0 to 14 years).

The gross rate of schooling corresponds to the proportion of resident population that is attending an education degree, relative to the total resident population of the relevant age group to the normal age of frequency of that level of education. Finally the average monthly earning and gross the value added corresponds to the typical settings at any statistical base. In order to avoid scale effects, private value added is divided by the local population and municipality expenditures are expressed in percentage of total expenditure.

Our baseline model is represented by the following equation:

$$y_i = \alpha_0 + \alpha_1 expenditure_i + \beta \ln x_i + \varepsilon_i \qquad \varepsilon_i \rightarrow i.i.d\left(0, \sigma_\varepsilon^2\right) \tag{1}$$

y_i represents the depended variable as defined above, in municipality i. In the explanatory side, expenditure represents the several dimensions of the municipality spending in sport and culture. X represents the vector of control variables and ε, the error term.

Cross-section studies are normally considered the most fruitful estimation procedure of that kind of statistical relationship. However, those procedures ignore that cross-regional data are frequently affected by spatial dependence leading to potential multicollinearity, endogeneity and specification errors (Islam, 2003). These problems affect the robustness of the coefficients and may produce misleading interpretations (Caselli, Esquivel, & Lefort, 1996; Evans, 1996; Quah, 1993). In order to solve this problem, Anselin (1988) and LeSage & Pace (2008) among other, state that the introduction of the geographical dimension, namely in the presence of spatial autocorrelation not only captures the spatial effect, but also improves the estimation and prevision outcomes since spatial dependence violates some of the Gauss-Markov assumptions of the OLS estimation (cross-section observations are no longer independent) producing inefficient estimators.

The spatial covariance, exists when occurrences in one specific geographical unit have an impact on its neighborhood. More particularly, the occurrence of spatial autocorrelation implies a correlation between spatial proximity and similarity among several geographical units. Two measures are known in literature: Index Geary (Geary, 1954) and Moran index (Moran, 1950). The first measures the ratio between the variance of neighboring regions and the total variance. The second emphasizes the differences in values between pairs of compared observations rather than the co-variation between the pairs, and typically varies between 0 and 2. In this paper we will use the Moran index, which is the most commonly observed in literature, represented by the following expression:

$$I = \frac{n}{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}} \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(x_i - \bar{x})(x_j - \bar{x})}{\sum_{i=1}^{n}\sum_{j=1}^{n} x_{it}x_{jt}} \quad \textbf{(2)}$$

Where n, represents the number of observations, x_i, the value of variable in region *i*, $\bar{x}$, the average variable and $w_{i,j}$ the proximity criterion between locations *i* and *j*. The set of weights, $w_{i,j}$ form the weight matrix *W* which can be constructed with different proximity criteria. We can distinguish in literature three types of proximity criteria. The simplest corresponds to the contiguity or neighborhood of first order, which determines that weight $w_{i,j}$ takes 1 if the locations are contiguous and 0 otherwise. A second possibility consists of extending the concept of contiguity to a higher order of neighborhood. In a third possibility, we can use the inverse of the distance between the locations *i* and *j*. As a benchmark level we use the normalized first order contiguity spatial weights matrix. A representation of it can be seen in Appendix III.

Formally we define our weight matrix as follows:

$$\boldsymbol{W(k)} = \begin{cases} \boldsymbol{w_{ij}(k) = 0 \; if \; i = j} \\ \boldsymbol{w_{ij}(k) = 1 \; if \; d_{ij} = 0} \\ \boldsymbol{w_{ij}(k) = 0 \; if \; d_{ij} > 0} \end{cases} \quad \textbf{(3)}$$

Associated to Moran's I statistic is the Moran Scatterplot, to detect the existence of spatial clusters, outliers and non-stationarity. In general terms, a given x-variable is standardized and plotted on the horizontal axis and the weighted average of x for the neighbors on the vertical axis. The scatterplot contains four quadrants: one represents clusters of high-high values (top-right quadrant); another one shows low-low values (bottom-left); and the remaining illustrate low-high and high-low values (top-left and bottom-right, respectively) (Florax & Nijkamp, 2003).

Two categories of spatial effects are pointed out in literature, namely: (*i*) spatial autocorrelation, exploring the spillover effects between contiguous regions and (*ii*) spatial heterogeneity, revealing the necessity of different functional forms for different regions. Spatial autocorrelation, in turn, can be of two types: the spatial autoregressive dependence, in which the dependence is attached to contiguous economic variables and the spatial autocorrelation in the disturbance term, in which the spatial dependence is captured in the error term due to omitted variables or deficient functional form.[3] The first model (with the lag dependent variable) is known as the spatial lag model (equation 4) while the second as the spatial error model (equation 5):

$$\mathbf{y} = \boldsymbol{\alpha} + \boldsymbol{\rho}\mathbf{W}\mathbf{y} + \boldsymbol{\beta}\mathbf{X} + \boldsymbol{\varepsilon} \tag{4}$$

$$\mathbf{y} = \boldsymbol{\alpha} + \boldsymbol{\beta}\mathbf{X} + \mathbf{u} \text{ with } \mathbf{u} = \boldsymbol{\lambda}\mathbf{W}\mathbf{u} + \boldsymbol{\varepsilon} \tag{5}$$

where *y* corresponds to the dependent variable, and X, a vector containing the explanatory variables. ρ, λ, α and β are respectively the spatially lag autoregressive parameters, the spatial correlation term in the errors, the constant term parameter and the vector of parameters of the explanatory variables, ε an *i.i.d.* error terms and W the spatial weights matrix.

[3] For comprehensive references about spatial econometric see for instance Anselin, L. (1988). Spatial econometrics: methods and models (Vol. 4): Springer; Le Gallo, J. (2002). Econométrie spatiale: l'autocorrélation spatiale dans les modèles de régression linéaire. Economie & prévision(4), 139-157; LeSage, J., & Pace, R. K. (2008). Introduction to spatial econometrics: CRC press.

Chapter IV

Empirical analysis

4. Empirical analysis

4.1. Agglomeration effects

Figures 1 to 3 show the geographical distribution of the main variables across the 278 municipalities of Portugal mainland.[4] The mortality rate from CVD (Figure 1, left) shows a slight gradient from the coast to the interior and in a lesser extent from north to south. This distribution is similar to that observed for longevity (Figure 1, right). This apparent association was already mentioned. It reflects the higher degree of exposure to CVD of more aging groups.

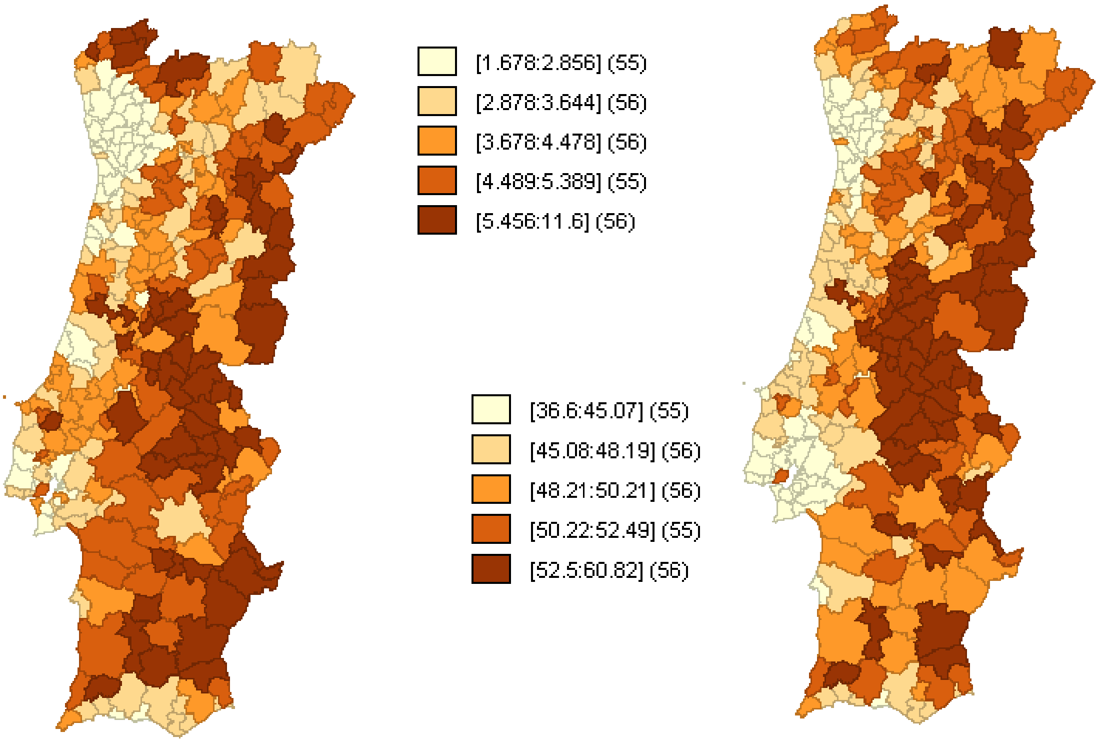


Figure 1. Mortality rate for cardiovascular diseases (left) and the longevity index (right) (source: INE).

[4] All calculations and maps were made using the software, geoda (http://geodacenter.asu.edu/).

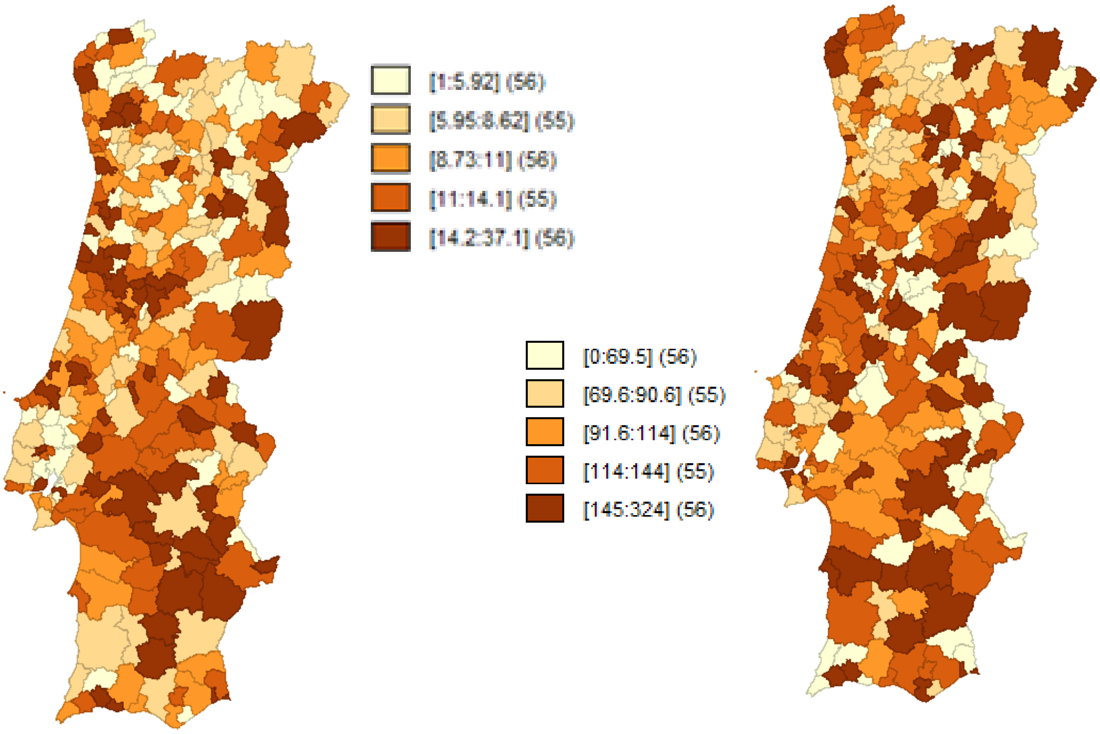


Figure 2. Municipal expenditure on sports and culture (left) and gross rate of schooling (right) (source: INE).

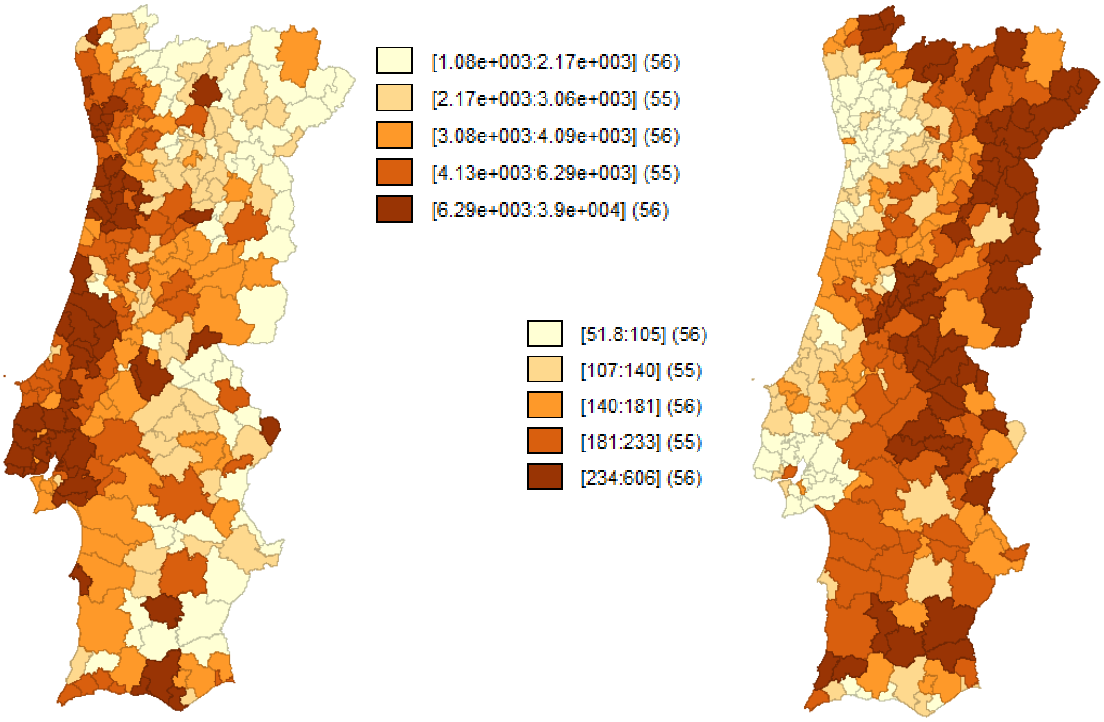


Figure 3. Gross value added of private sector companies (left) and aging index (right) (source: INE).

The total expenditure on culture and sports, as a percentage of the overall expenditure of the municipality, is intended to illustrate the efforts of the municipality to support the promotion of physical activity policies among population. In practice it is not easy to isolate these expenditures related to the promotion of physical activity in general and sport in particular. Indeed, these expenditures are normally distributed or shared by various departments which makes it very difficult to disaggregate.

The data presented are those available in the Portuguese Statistical Institute (www.ine.pt). They have the merit of providing a uniform basis for data collection that allows comparison between municipalities and the observation of possible trends over time. Unfortunately they do not separate culture and sport expenditures. One last important note has to do with the fact that in Portugal public resources are not uniformly distributed across the different levels of administration. Comparing with the remaining EU countries, Portugal presents a lower degree of decentralization as the most part of the national budget is spent at the central government level.[5] This means that the financial means put at the service of the Portuguese municipalities by the central government are relatively scarce. The average data for the period 2004-2012 shows that municipalities have devoted about 10% of its budget on culture and sport. This represents an annual average of 75 euros per inhabitant, equally distributed between current and capital expenditures, i.e. far below what can be observed in other EU countries. For example, the public decentralized funding through local governments in Finland represents a sum of 685 million euros per year, i.e. about 140 euros per inhabitant (Chaker, 2004). With regard to the geographical distribution of the municipality effort, the map on the left of Figure 2 does not seem to indicate any regular pattern, with municipalities spending more and less on sports and cultural activities coexisting throughout all territory.

Figure 2 right map shows the distribution of the gross rate of schooling across the territory. The map does not present any regularity, as would be expected in

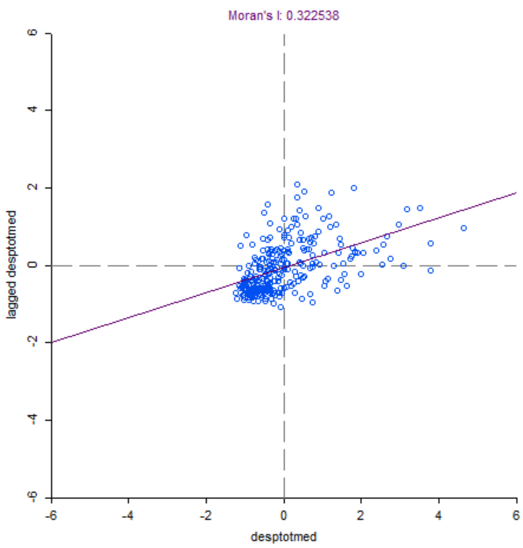
[5] For a comprehensive study of political, fiscal and budgetary decentralization, see Ivanyna Ivanyna, M., & Shah, A. (2012). How close is your government to its people? Worldwide indicators on localization and decentralization. *Worldwide Indicators on Localization and Decentralization (July 1, 2012). World Bank Policy Research Working Paper* (6138).

a country where the education sector continues to be predominantly public. The gross value added exhibits a different pattern. The left map in Figure 3 confirms a trend of concentration of productive activity on the coast compared to the interior. This agglomeration is particularly marked around the two main cities, Lisbon (south) and Oporto (north). Finally, the right map of Figure 3 illustrates the distribution of aging rate. Like the longevity rate, the map shows that the inland municipalities have more aged populations. This phenomenon stems from the exodus of young people to the large cities near the coast where they are more likely to find employment.

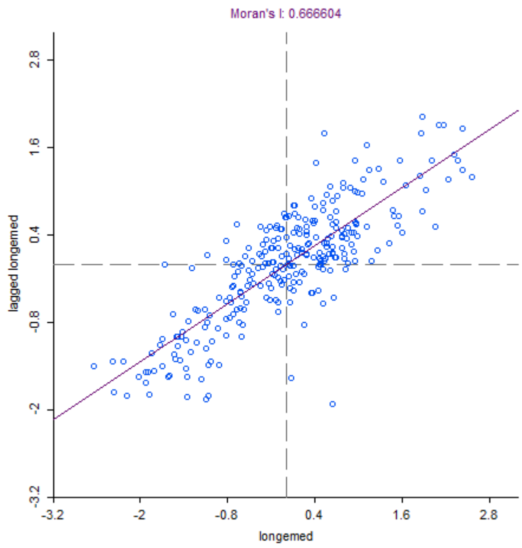
Table 1. Spatial Autocorrelation (Moran's I Statistic).

Variables	Moran'I	*P*-value
Total municipal expenditures in sport	0.3225	0.0010
Cardiovascular mortality rate	0.5173	0.0000
Longevity index	0.6666	0.0000
Aging index	0.5346	0.0142
Gross rate of schooling	-0.1228	0.6834
Gross value added of private companies	0.2647	0.0000
Average monthly earning	0.4504	0.0000

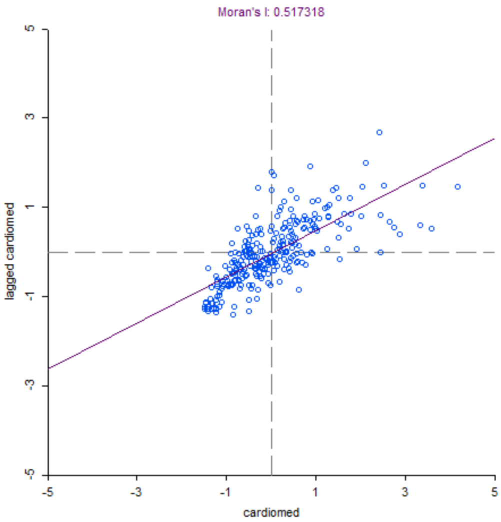
After checking the geographical distribution of all variables, we proceed studying the presence of spatial correlation, in order to verify if similar municipalities tend to cluster in more or less extensive agglomerations. There is a vast literature about spill-over effects and the tendency of economic and social activities to concentrate on specific areas of the territory. Examples of geographical concentration of economic activities has aroused a great interest in the academic community, following many famous examples like Silicon Valley (California), Route 128 (Boston), Cambridge (UK), the federal state of Baden Wurttemberg (Germany). Paul Krugman, describing the arbitration process between increasing returns and transaction costs (Krugman, 1980, 1991), contributed decisively to the recognition of the role of agglomeration economies, representing the main contribution for the New Economic Geography (Clark, Gertler, & Feldman, 2003). Since the early contributions of (Thunen, 1826) about the location of agricultural activities, many other authors, like (Fujita, Krugman, & Venables, 1999; Marshall, 1919; Porter, 1998), have explored social phenomena that feed external effects connecting contiguous geographic units and explain their interdependence relationship.



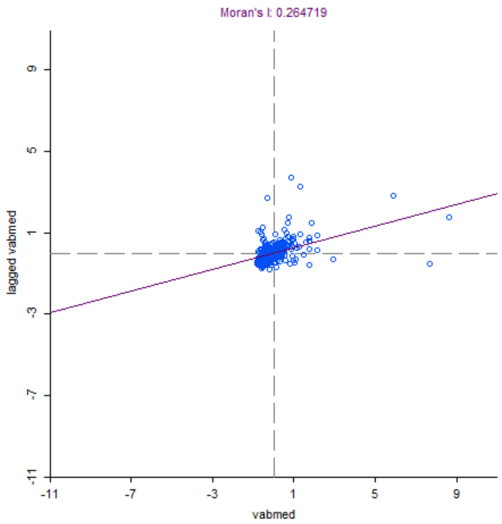
a) Total municipal expenditures in sport



b) Longevity index

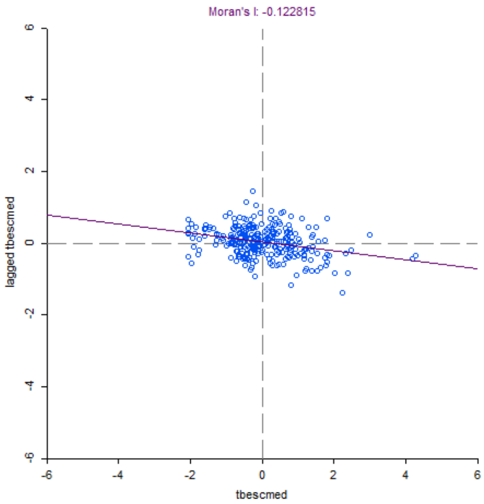


c) Cardiovascular mortality rate

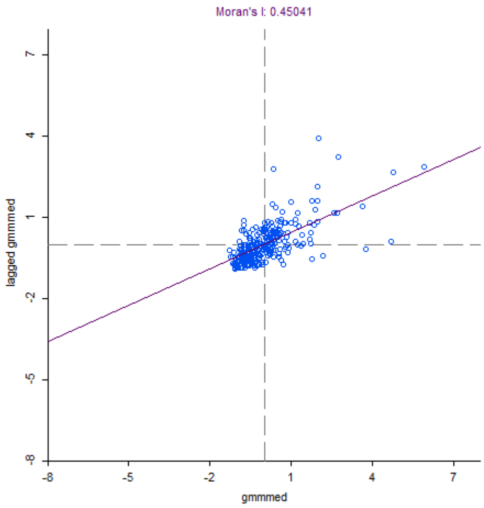


d) Gross value added of private sector companies

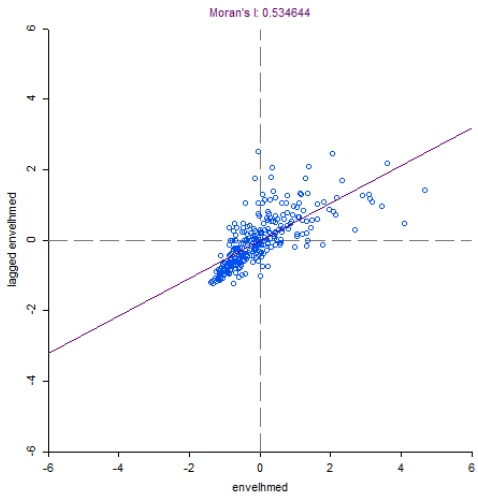
Figure 4. Moran Scatter Plots (continues).



e) Gross rate of schooling



f) Average monthly earning



g) Aging index

Figure 4. Moran Scatter Plots (continuation).

Table 1 shows the Moran's I values and the respective p-values. All variables with the exception of human capital exhibit statistically significant spatial autocorrelation. The values vary from 0.26 to 0.66. Another way to identify the presence of spatial autocorrelation is through the Moran Scatter Plots in Figure 4. As stated above, Moran Scatter Plots exhibits the position of each municipality with the value of the variable in the x-axis against the average of the neighbouring municipalities in the y-axis. The predominance of municipalities in the south-west and northeast quadrants represents a strong indication of the presence of autocorrelation. Moreover, the Moran's index corresponds to the slope of the regression line of the chart. We can see for example, the Moran Scatter Plot of the longevity index and confirm the massive presence of municipalities in the quadrants mentioned above and a positive slope of the regression line. The schooling Moran Scatter Plot, on the contrary exhibits a random distribution across all quadrants. Literature also refers the importance of the southeast quadrant, indicating the presence of shadowing effects. The shadow effect means that cumulative processes of concentration in one region contribute to empty its surroundings of economic or social activities (Krugman, 1993).

4.2. The exploratory spatial analysis

The use of spatial econometrics to estimate our model is fully justified after confirming the strong presence of spatial autocorrelation in most variables. We proceed with the estimation of two models applied successively to the cardiovascular mortality rate and to the longevity index. As a first step we apply the classic OLS estimation, using the residual to identify the spatial model that best fits the data. Secondly, we estimate the appropriate model found in the previous step and discuss the results. In a third and final step we test the robustness of the results re-estimating the same equations with other spatial weight matrix specifications.

Cardiovascular mortality rate

Table 2 shows the results of the model estimation where we use the cardiovascular mortality rate as the dependent variable. In the first column, we can see the results of the OLS version of the model. We observe an adjusted coefficient of determination (R^2) around 70%. Regarding the explanatory variables the estimation exhibits two that are statistically significant: the current expenditure in sport and the aging index. The former appears, however, with the wrong sign while the latter exhibits positive correlation with the dependent variable, as expected. Note that the full OLS version of the model showed strong evidence of multicollinearity with a condition number slightly above 30. As such we had to remove the Gross value added of private companies in order to preserve the stability of the regression results.

As expected, the OLS version presents several problems arising from the strong presence of spatial autocorrelation across the various variables, which violates the OLS assumptions and undermines the statistical inference. Indeed, the regression diagnostics reveal considerable non-normality and heteroscedasticity, as well as high spatial autocorrelation. The Jarque Bera test rejects the null hypothesis of normality for the residuals distribution. The Breusch-Pagan test, the Koenker-Bassett test as well as the White test indicate that the variance is correlated with the error term, signalling the presence of heteroscedasticity. Finally the global Moran's I statistic is significant indicating the presence of spatial autocorrelation.

Table 2. Estimation results for cardiovascular mortality rate (p-value in parentheses).

Dependent Variable: Cardiovascular mortality rate				
	OLS (1)	**SEM W1 (2)**	**SEM W2 (3)**	**SEM W3 (4)**
n	278	278	278	278
R^2 (adjusted)	0.71	0.77	0.74	0.73
Intercept	1.6024 (0.0015)	2.8781 (0.0000)	2.7896 (0.0000)	2.6689 (0.0000)
ρ	-	-	-	-
Current expenditures	0.0133 (0.0031)	-0.0075 (0.0707)	-0.0065 (0.1254)	-0.0084 (0.0526)
Capital expenditures	0.0027 (0.2941)	0.0023 (0.2718)	0.0033 (0.1538)	0.0024 (0.3128)
Gross rate of schooling	-0.0001 (0.9080)	0.0004 (0.6542)	0.0001 (0.9256)	0.0000 (0.9821)
Average monthly earning	-0.0004 (0.6029)	-0.0018 (0.0111)	-0.0017 (0.0109)	-0.0017 (0.0141)
Gross value added of private companies		0.0000 (0.2155)	0.0000 (0.2345)	0.0000 (0.4835)
Aging index	0.0150 (0.0000)	0.0142 (0.0000)	0.0148 (0.0000)	0.0151 (0.0000)
λ		0.5589 (0.0000)	0.5654 (0.0000)	0.5308 (0.0000)
Log likelihood	-378.001	-352.568	-364.054	-369.664
Akaike info criterion	770.003	719.135	742.107	753.328
Schwarz criterion	795.396	744.530	767.501	778.721
Moran's I (error)	7.8604 (0.0000)			
Robust LM (lag)	0.0011 (0.9736)			
Robust LM (error)	37.1478 (0.0000)			

Once we detected the presence of spatial autocorrelation, we can proceed to the second step which consists of modelling the spatial autocorrelation effect. Table 2 reports several tests to detect spatial autocorrelation. While the Moran statistic is highly significant, suggesting a problem with spatial autocorrelation, it is useless in suggesting the correct specification. To this end, several Lagrange Multiplier tests are used to determine the type of spatial dependence and the most appropriate model to be applied. In the present exercise we apply the robust LM-tests described in (Elhorst, 2003).[6] According to the results the null hypothesis of no spatially lagged dependent variable cannot be rejected ($p=0.9736$) while the null hypothesis of no spatially auto correlated error term is clearly rejected ($p<0.05$). As such, the test results point to the spatial error specification as the most appropriate model.

In the presence of spatial autocorrelation, OLS estimators are no longer convergent (autoregressive variable). Moreover, they are inefficient (spatial autocorrelation of errors). Convergent and asymptotically efficient estimators should then be obtained by the Maximum Likelihood Method (Le Gallo, 2002). The Maximum Likelihood estimation of the Spatial Error Model results with the first order contiguity spatial matrix (W_1, our baseline model) can be analysed in column (2) of Table 2. Note that the R^2 listed is a so-called pseudo-R2, which is not directly comparable with the measure given for OLS results (Anselin, Syabri, & Kho, 2006). The proper measures of fit are the Log-Likelihood, AIC and Schwarz criteria. If we compare the values in column (1) and (2) of Table 2 we notice an increase in the Log-Likelihood from -378.001 (for OLS) to -352.568. Moreover both AIC and SC criteria decrease relatively to OLS, again suggesting an improvement of fit for the spatial error specification.

The spatial autocorrelation parameter of the error is highly significant as expected ($\lambda=0.5589$ with $p<0.0000$). Moreover, the estimation results indicate a significant effect of current expenditure on sport by the municipalities as well as the average monthly earning and the aging index. The effect of current expenditure of municipalities is statistically significant, but only at a 10% significance level.

[6] We previously use the classic LM tests (Anselin, L. (1988). *Spatial econometrics: methods and models* (Vol. 4): Springer.) They rejects both the absence of spatially lagged and error dependence.

However, the effect is not very impressive. *Ceteris paribus*, an increase of 1 euro in the *per capita* current expenditure of municipality in sport will reduce cardiovascular mortality rate by 0.0075 percentage points. We can thus conclude that the current expenditure makes a slight contribution to lower mortality indicators from CVD. The same cannot be concluded in relation to capital expenditure whose effect is not statistically significant (p=0.2718). Regarding the control variables, the results point to a significant effect of the average monthly earning and the aging index both with the expected sign.[7] This means that municipalities with higher average earnings exhibit lower cardiovascular mortality rates. Moreover, municipalities with an older population have higher mortality rates from CVD. In the presence of spatial dependence, the OLS coefficient overestimates the impact of variables. As such ML coefficient are in general smaller.

Finally, in order to test the robustness of our results, we considered several other spatial weight matrix specifications. The first order contiguity spatial matrix (W1) corresponds to our baseline case. For the second and third spatial matrixes (W2 and W3), respectively in column (3) and (4) we applied the same contiguity specification but considering respectively the 2 and 3 nearest neighbors of each municipality.

Results show that, except for the current expenditure, the results of the estimated parameters are robust with respect to the specification of the weights matrix used. Regarding the spatial autocorrelation parameter of the error, values range from 0.53 (W3) to 0.56 (W2), which do not represent a very important variation. Concerning the current expenditure the coefficient varies from -0.0065 (W2) to -0.0084 (W3) which is not negligible. Moreover, the effect ceases to be statistically significant with the second order matrix (p=0.1254). Thus, all interpretation of these results, particularly on the effect of current expenditure, should be made with caution.

[7] The results for Gross value added of private companies were obtained without the average monthly earning to avoid multicollinearity. Fit measures correspond to the equation with average monthly earning.

Finally the robustness check raises the question about the most suitable spatial weights matrix for our model. In this sense, all criteria available in Table 2 - the likelihood function and the Akaike info as well as the Schwarz criteria- point to the same direction, considering the first order contiguity matrix as the best model, reinforcing our conclusion about the positive, although small, effect of municipality in the decrease the mortality rate from CVD.

Longevity index

Table 3 replicates the same exercise for the longevity index. Once again, the column (1) represents the OLS version of the model. According to the estimation results, *per capita* current expenditure of municipality in sport increases the longevity index as well as the gross value added of private companies and the aging index. This time we had to remove the average monthly earning to avoid the presence of multicollinearity (we get a condition number around 9 in the reduced version). The tests for the normality distribution of the error and the presence of heteroscedasticity (not reported in the table) were not conclusive.

Table 3. Estimation results for longevity index (p-value in parentheses).

Dependent Variable: Longevity index				
	OLS (1)	**SEM W1 (2)**	**SEM W2 (3)**	**SEM W3 (4)**
n	278	278	278	278
R^2 (adjusted)	0.68	0.78	0.74	0.68
Intercept	49.4660 (0.0000)	50.9285 (0.0000)	50.7777 (0.0000)	50.1235 (0.0000)
ρ	-	-	-	-
Current expenditures	0.02757 (0.0290)	0.0030 (0.7837)	0.0088 (0.4490)	0.0210 (0.0919)
Capital expenditures	0.0065 (0.3670)	-0.0019 (0.7239)	0.0031 (0.6202)	0.0037 (0.5988)
Gross rate of schooling	0.0047 (0.1602)	0.0028 (0.2552)	0.0024 (0.4174)	0.0044 (0.1799)
Average monthly earning		0.0096 (0.0000)	0.0106 (0.0000)	0.0111 (0.0000)
Gross value added of private companies	0.0002 (0.0164)	0.0002 (0.0001)	0.0002 (0.0001)	0.0002 (0.0075)
Aging index	0.0354 (0.0000)	0.0256 (0.0000)	0.0283 (0.0000)	0.0329 (0.0000)
λ		0.6904 (0.0000)	0.7212 (0.0000)	0.3857 (0.0070)
Log likelihood	-665.244	-626.836	-645.090	-662.543
Akaike info criterion	1344.49	1267.67	1304.18	1339.09
Schwarz criterion	1369.88	1293.07	1329.57	1364.48
Moran's I (error)	7.8987 (0.0000)			
Robust LM (lag)	3.9913 (0.0457)			
Robust LM (error)	40.6070 (0.0000)			

However, the global Moran's I statistic is highly significant indicating the presence of spatial autocorrelation, calling into question the statistical validity of the OLS results. Results not reported in the Table shows that both LM-Lag and LM-Error statistics are highly significant. The rejection of the null hypothesis by both LM test statistics is a situation commonly encountered in practice (Anselin, 1988). In this case it requires the consideration of the robust forms of the statistics. Here, the Robust LM-Error statistic is more significant (with $p < 0.01$), compared to the Robust LM-Lag statistic (with $p = 0.0457$). This suggests that a spatial error specification should be chosen.

The ML estimation of the spatial error model (column 2) suggests an improvement of fit relatively to the OLS (column 1), as confirmed by the Log-Likelihood, AIC and SC measures. The Log-Likelihood function increases from -665.244 (for OLS) to -626.836, and the AIC and SC criteria decrease respectively from 1344.49 (for OLS) to 1267.67and from 1369.88 to 1293.07.

Thus, the spatial autoregressive coefficient is estimated as 0.6904, and is highly significant ($p<0.0000$). The positive impact of Total municipal expenditures in sport on longevity index is not confirmed. Its coefficient is no longer statistically significant ($p=0.7837$). In terms of the control variables, the results confirm the positive effects of average monthly earning, gross value added of private companies and the aging index.[8] Comparing to the OLS estimation, the coefficients are slightly less in absolute value, which is normal as, in the presence of spatial dependence, the OLS coefficient normally overestimates the impact of variables.

With the exception of municipal current expenditure and the autocorrelation parameter, the remaining coefficients of the model seem to resist well to the robustness test. Indeed, if we look at the municipal current expenditure coefficient, we see that it varies from 0.0039 to 0.0210. Furthermore, it is not significant for the matrices W_1 and W_2, respectively the first and second order contiguity spatial matrix ($p=0.7837$ and $p=0.4490$), but becomes moderately significant (with a significant level of 10%) with the third order contiguity spatial matrix, W_3 ($p=0.0919$).

[8] Likewise, the results for Gross value added of private companies and average monthly earning were obtained separately to avoid multicollinearity. Fit measures correspond to the equation with average monthly earning.

These results, associated with the robustness tests require us to interpret this second exercise with some care. In this sense, we cannot conclude a clear impact of municipal policies and in particular of current expenditure of municipalities in sport on the longevity index.

Chapter V

Conclusions

5. Conclusions

A sedentary lifestyle is a very important risk factor for the development of many chronic diseases, including CVD. Cardiovascular disease is a leading cause of death in the Western world. Their social and economic costs are substantial. Assessments of the European Heart Network estimate overall costs of more than 200 billion euros in an annual base.

To react to this disturbing reality, the WHO, in 2002, recommended the practice of at least 30 minutes of daily physical activity for the entire population. More recently and following guidance documents of the WHO, the European Union and its Member States recommended a minimum of 60 minutes a day of physical activity of moderate intensity, for children and youth, and a minimum of 30 minutes of moderate physical activity for adults, including the elderly (footnote: EU Physical Activity Guidelines, confirmed by EU Member State Sport Ministers in their meeting in Biarritz on 27-28 November 2008). Physical activity is defined herein as "any movement associated with muscular contraction that increases energy expenditure above resting levels". This definition includes all contexts of physical activity. It comprises physical activity in leisure time (sports, dance, etc.), occupational physical activity, physical activity at home or in the neighbourhood and physical activity related to everyday mobility.

The overall objective of a sport policy should be to increase participation in quality sports activities among all segments of society. To ensure a physically active life in a sustained manner over time, the existence of a national network of sports facilities with low entry barriers is mandatory, no matter the nature of these obstacles (economic, social or cultural). To ensure access of all sectors of the population to sport infrastructures, the state's role becomes crucial through the public financing of the construction, renovation, modernization and maintenance of sports equipment and facilities.

The concept of "Sport for All" seeks to encourage a wide and inclusive participation in physical and sport activities, according to the idea that sport is a human right, regardless of age, race, ethnicity, social class or gender.

Many groups of actors intervene in sports policies in different levels, from the central government to municipalities, on organized or more informal sport practices. Local authorities are responsible for the vast majority of sport public infrastructure. By its close relationship with the communities, municipalities are in an excellent position to create favorable conditions for sport practice for all.

This work is an empirical exercise that seeks to verify if there is any statistical relationship between the effort of Portuguese municipalities in the implementation of sports policies and the quality of life of the respective communities, particularly in terms of the prevalence of CVD and life expectancy. Considering the permeability of the city limits, we use the latest techniques in spatial econometrics, thus seeking to model the neighbourhood effects of municipal policies and to ensure the robustness of our estimates in a framework where the independence of observations is not guaranteed.

Our exploratory spatial analysis confirms the presence of strong spatial autocorrelation in almost all variables, confirming the strong spatial dependence between neighboring municipalities. In practical terms, this means that sports policy in a given municipality will impact on the neighboring municipalities. The estimation of the spatial error model, the one that best fits the pattern of spatial dependence, confirms the existence of a slight impact of local sports policies on mortality rate from CVD. This impact concerns only current expenditure, leaving out capital spending. The order of magnitude is reduced (an increase of 1 euro in the per capita current expenditure of municipality in sport will reduce cardiovascular mortality rate by 0.0075 percentage points) and the robustness analysis is not absolutely conclusive. In terms of life expectancy, the results do not allow us to conclude on any positive effect of local sports policies.

Portugal has a very centralized public budget, in which resources are concentrated at the central government level. This circumstance constrains the municipalities which have to work with reduced budgets compared to the European standard. In this sense it is natural that the impact of local sports policy is relatively modest. However, it is necessary to precise that local policies to promote physical activity go beyond the strictly sports policies. That is, using only the part of municipal budgets devoted to sports area (current and capital expenditure), we are obviously underestimating the local political effort to promote active living in the communities. Indeed, all the money spent on rehabilitation of public space or on the promotion of soft modes of transportation (walking and cycling) should be recorded to measure this effort.

These results thus stress the need to improve the quality and quantity of data collected in the field, both in terms of output and input. By input we mean all resources put at the service of policies promoting physical activity, or more broadly speaking, health-enhancing physical activity. By output, we mean not only the health indicator but also the measure of physical activity at the individual level. The European Union in its 2009 White Paper stresses the need to improve measurements of physical activity for population health surveillance in order to better assess the effects of physical activity programs (questionnaires, accelerometers, etc.). Moreover the same White Paper also recommends regular monitoring of political actions orientated to promote physical activity, with objective indicators such as human and financial means, capable of evaluate programs and policies.

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Appendixes

APPENDIX I. List of the municipalities

Municipalities		
Abrantes	Barcelos	Cuba
Águeda	Barrancos	Elvas
Aguiar da Beira	Barreiro	Entroncamento
Alandroal	Batalha	Espinho
Albergaria-a-Velha	Beja	Esposende
Albufeira	Belmonte	Estarreja
Alcácer do Sal	Benavente	Estremoz
Alcanena	Bombarral	Évora
Alcobaça	Borba	Fafe
Alcochete	Boticas	Faro
Alcoutim	Braga	Felgueiras
Alenquer	Bragança	Ferreira do Alentejo
Alfândega da Fé	Cabeceiras de Basto	Ferreira do Zêzere
Alijó	Cadaval	Figueira da Foz
Aljezur	Caldas da Rainha	Figueira de Castelo Rodrigo
Aljustrel	Caminha	Figueiró dos Vinhos
Almada	Campo Maior	Fornos de Algodres
Almeida	Cantanhede	Freixo de Espada à Cinta
Almeirim	Carrazeda de Ansiães	Fronteira
Almodôvar	Carregal do Sal	Fundão
Alpiarça	Cartaxo	Gavião
Alter do Chão	Cascais	Góis
Alvaiázere	Castanheira de Pêra	Golegã
Alvito	Castelo Branco	Gondomar
Amadora	Castelo de Paiva	Gouveia
Amarante	Castelo de Vide	Grândola
Amares	Castro Daire	Guarda
Anadia	Castro Marim	Guimarães
Ansião	Castro Verde	Idanha-a-Nova
Arcos de Valdevez	Celorico da Beira	Ílhavo
Arganil	Celorico de Basto	Lagoa
Armamar	Chamusca	Lagos
Arouca	Chaves	Lamego
Arraiolos	Cinfães	Leiria
Arronches	Coimbra	Lisboa
Arruda dos Vinhos	Condeixa-a-Nova	Loulé
Aveiro	Constância	Loures
Avis	Coruche	Lourinhã
Azambuja	Covilhã	Lousã
Baião	Crato	Lousada

Municipalities		
Mação	Odemira	Reguengos de Monsaraz
Macedo de Cavaleiros	Odivelas	Resende
Mafra	Oeiras	Ribeira de Pena
Maia	Oleiros	Rio Maior
Mangualde	Olhão	Sabrosa
Manteigas	Oliveira de Azeméis	Sabugal
Marco de Canaveses	Oliveira de Frades	Salvaterra de Magos
Marinha Grande	Oliveira do Bairro	Santa Comba Dão
Marvão	Oliveira do Hospital	Santa Maria da Feira
Matosinhos	Ourém	Santa Marta de Penaguião
Mealhada	Ourique	Santarém
Meda	Ovar	Santiago do Cacém
Melgaço	Paços de Ferreira	Santo Tirso
Mértola	Palmela	São Brás de Alportel
Mesão Frio	Pampilhosa da Serra	São João da Madeira
Mira	Paredes	São João da Pesqueira
Miranda do Corvo	Paredes de Coura	São Pedro do Sul
Miranda do Douro	Pedrógão Grande	Sardoal
Mirandela	Penacova	Sátão
Mogadouro	Penafiel	Seia
Moimenta da Beira	Penalva do Castelo	Seixal
Moita	Penamacor	Sernancelhe
Monção	Penedono	Serpa
Monchique	Penela	Sertã
Mondim de Basto	Peniche	Sesimbra
Monforte	Peso da Régua	Setúbal
Montalegre	Pinhel	Sever do Vouga
Montemor-o-Novo	Pombal	Silves
Montemor-o-Velho	Ponte da Barca	Sines
Montijo	Ponte de Lima	Sintra
Mora	Ponte de Sor	Sobral de Monte Agraço
Mortágua	Portalegre	Soure
Moura	Portel	Sousel
Mourão	Portimão	Tábua
Murça	Porto	Tabuaço
Murtosa	Porto de Mós	Tarouca
Nazaré	Póvoa de Lanhoso	Tavira
Nelas	Póvoa de Varzim	Terras de Bouro
Nisa	Proença-a-Nova	Tomar
Óbidos	Redondo	Tondela

Municipalities
Torre de Moncorvo
Torres Novas
Torres Vedras
Trancoso
Trofa
Vagos
Vale de Cambra
Valença
Valongo
Valpaços
Vendas Novas
Viana do Alentejo
Viana do Castelo
Vidigueira
Vieira do Minho
Vila de Rei
Vila do Bispo
Vila do Conde
Vila Flor
Vila Franca de Xira
Vila Nova da Barquinha
Vila Nova de Cerveira
Vila Nova de Famalicão
Vila Nova de Foz Côa
Vila Nova de Gaia
Vila Nova de Paiva
Vila Nova de Poiares
Vila Pouca de Aguiar
Vila Real
Vila Real de Santo António
Vila Velha de Ródão
Vila Verde
Vila Viçosa
Vimioso
Vinhais
Viseu
Vizela
Vouzela

APPENDIX II. Statistical tables

	2004	2005	2006	2007	2008
Total municipal expenditures in sport (1000 €)	762,322.00	874,782.00	767,985.00	758,107.00	824,743.00
Cardiovascular mortality rate	3.50	3.50	3.10	3.20	3.20
Longevity index	43.50	44.20	45.20	46.10	46.80
Aging index	110.10	111.80	114.10	116.40	119.10
Gross rate of schooling	105.20	108.30	99.40	102.60	101.20
Gross value added of private companies (Millions €)	73,810.85	75,465.75	79,269.65	86,218.60	87,667.91
Average monthly earning	879.62	909.17	935.97	965.25	1,010.38

	2009	2010	2011	2012
Total municipal expenditures in sport (1000 €)	959,954.00	685,883.00	649,880.00	607,317.00
Cardiovascular mortality rate	3.10	3.20	3.00	3.10
Longevity index	47.20	48.00	48.70	49.00
Aging index	122.00	126.70	130.50	134.00
Gross rate of schooling	149.20	148.40	136.30	126.10
Gross value added of private companies (Millions €)	84,325.44	85,309.15	79,572.04	73,573.77
Average monthly earning	1,036.44	1,076.26	1,084.55	1,086.67

APPENDIX III. Contiguity matrix