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Strategic Interaction on Public Expenditure: Evidence from Portuguese Local Governments

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STRATEGIC INTERACTION ON PUBLIC EXPENDITURE: EVIDENCE FROM PORTUGUESE LOCAL GOVERNMENTS

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Abstract

This research investigates the strategic interactions among Portuguese mainland municipalities, focusing on the expenditure side, a relatively underexplored aspect in the literature compared to the revenue side. The study addresses critical gaps in empirical evidence, seeking to assess the existence of expenditure strategic interactions and what drives linkages between local spending behaviours using updated data. Drawing on three theoretical frameworks – expenditure spillovers, tax competition, and yardstick competition – the research aims to comprehensively understand the phenomenon. Employing an econometric approach with panel data analysis covering the 2003-2022 period for all 278 mainland municipalities, the study employs a spatial weights matrix to assess spatial interdependencies. The study aims at assisting policy decision-makers in developing an effective institutional framework. The study's results reveal the existence of strategic interaction in expenditure among Portuguese municipalities, with the spillover effects theory being the source of this interaction in total and current expenditures. Additionally, yardstick competition is identified in capital expenditures, with the overall magnitude of capital acquisition proving more significant to this theoretical framework than its specific composition.

JEL codes: C23, H72, H73, R12

Keywords: strategic interaction, local public expenditures, local governments, spatial econometrics, Portugal

Resumo

Este estudo analisa as interações estratégicas entre os municípios do continente português, com ênfase no lado da despesa, um aspeto relativamente menos explorado em comparação com o lado da receita. O estudo aborda lacunas críticas na evidência empírica, de modo a procurar avaliar a existência de interação estratégica do lado da despesa e os fatores que impulsionam as interações entre os comportamentos locais de despesa, recorrendo a dados atualizados. Com base em três quadros teóricos – efeitos externos, concorrência à Tiebout e imitação no comportamento – o estudo visa compreender de forma abrangente o fenómeno. Utilizando uma abordagem econométrica com dados em painel abrangendo o período de 2003 a 2022 para os 278 municípios do continente português, o estudo recorre a uma matriz de pesos espaciais para avaliar as interdependências espaciais. O objetivo do estudo é auxiliar os decisores políticos na formulação de um enquadramento institucional eficaz. Os resultados do estudo revelam que os municípios portugueses apresentam interação estratégica nas despesas, sendo a teoria dos efeitos externos a fonte dessa interação nas despesas totais e nas despesas correntes. Além disso, a imitação no comportamento é identificada nas despesas de capital, com a magnitude global da aquisição de capital a assumir maior importância para este enquadramento teórico do que as componentes específicas.

Códigos JEL: C23, H72, H73, R12

Palavras-chave: interação estratégica, despesas públicas locais, governos locais, econometria espacial, Portugal

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1. Introduction

Strategic interaction between local governments assumes significant relevance in academic areas such as Public Economics and Public Choice. In theoretical terms, the main mechanisms that explain the behaviour of local political decision-makers, who do not act independently and tend to exhibit strategic behaviour, include spillover effects, tax competition and yardstick competition. Regarding the empirical side, over the last few decades, there has been a significant increase in studies that focus on applying different econometric models to different countries.

In the specific case of Portugal, empirical studies on strategic interaction are notably scarce. To our knowledge, the focus on the expenditure side is particularly scarce compared to that on the revenue side; four studies address the expenditure side – Barreira (2011a), Barreira (2011b), Costa et al. (2015) and Silva et al. (2011).

Given the small number of works on public spending strategic interactions, this research explores a fundamental question: Is there a strategic interaction between the Portuguese mainland municipalities regarding expenditures? Another incentive for this research is to obtain insights about local government decision-making, namely inspecting what drives local spending behaviour. These contributions enhance the transparency and accountability of public institutions regarding the reasons behind decisions about local resources allocation.

Thus, the primary objective of this study is to assess the presence of strategic behaviour between Portuguese local governments and to provide the rationale for local public management on the expenditure side through a comprehensive literature review. Additionally, if strategic interaction between Portuguese municipalities is found, we aim at identifying which of the competing theories better explain this phenomenon. Moreover, expenditure strategic behaviour may differ across types of expenditure, since some may be complementary (e.g., transport network), substitutable (e.g., sports facilities), or independent (e.g., garbage collection) from those taken by neighbours. Relying on the economic classification of local public expenditure, we also aim at assessing how spatial interaction differs across expenditure items.

The analysis of the Portuguese case is interesting due to the uniformity in rules and legislation governing all municipalities, coupled with the shared political instruments (Costa et al., 2015). Consequently, this uniformity restricts their capacity for differentiation, prompting

municipalities to explore unique strategies to distinguish themselves. Furthermore, decentralization in Portugal, initiated with the 1977 Local Government Law, has empowered municipalities by assigning increased autonomy, i.e., with expanded rights and responsibilities. While central government transfers represent most of their revenue, municipalities have greater flexibility in managing expenditures, especially investments (Silva et al., 2011).

Moreover, spatial interaction with neighbours may also depend on political economy factors, such as ideology proximity, coalition governments, possibility of re-election, and sharing the ideology of the party in the central government. Thus, we also propose to assess strategic interaction controlling for these features.

We believe that the study holds additional relevance as it aims to identify the presence of strategic interaction within Portuguese municipalities. This endeavour besides providing insight into the dynamics between municipalities, also offers valuable guidance to policymakers in refining the existing institutional framework. Additionally, it is crucial to acknowledge the limitations of the available empirical evidence on the expenditure side of Portuguese municipalities, as the periods under study are now significantly outdated. Indeed, studies by Costa et al. (2015) and Silva et al. (2011) address all mainland municipalities from 1986 only up to 2006; in turn, the analysis in Barreira (2011a) only covers municipalities in the southern region – Algarve – from 1998 and only up to 2007, while the study by Barreira (2011b) focuses on the northern municipalities for the period spanning from 1998 just to 2008. We aim to address the existing gap in the literature by employing a spatial econometric approach. Our study uses an updated database from 2003 to 2022 and considers various spatial interaction models and specifications.

After this introduction, section 2 presents a literature review of the theories of strategic interaction, along with an overview of existing empirical studies on the expenditure side. Section 3 presents the legal and administrative Portuguese framework, while Section 4 systematises the empirical framework by detailing the general model used, the underlying econometric problems and the alternative models employed to address them. Section 5 presents an empirical application to Portuguese municipalities, outlining the constructed database and presenting the results and main findings. Finally, the conclusions drawn from the study are summarized, together with the identification of research gaps and of opportunities for future developments.

2. Literature review on jurisdictional strategic behaviour

Policy strategic interaction is grounded in the premise that policy decision-makers do not operate independently. Instead, they typically react to the decisions of policy-makers taken in the neighbouring jurisdictions, often adopting similar behaviours (Barreira, 2011b). However, these behaviours may also include efforts to differentiate themselves with a view to become more attractive (Revelli, 2002).

2.1. Explanations for strategic behaviour

Strategic interaction can be classified into three distinct types: expenditure spillovers, tax competition and yardstick competition (Revelli, 2005). Brueckner (2003) merges these perspectives into two general categories: the “spillover” model and the “resource-flow” model.

In the “spillover” model, each jurisdiction or local government independently sets the level of a strategic policy variable. The crucial point, however, lies in the fact that, even in making autonomous decisions, the jurisdiction is expected to take into account the decisions of the neighbouring jurisdictions concerning the same variable. An interconnected relationship emerges between jurisdictions, wherein the actions of one directly influence the decisions of the others.

As for the “resource-flow” model, the strategic variable in question relates to tax policy, and decisions made by a jurisdiction regarding this variable have implications for the flow of resources between jurisdictions. Since local resources are limited, each jurisdiction must strategically allocate these resources to optimize local benefits. A crucial aspect of these models is that, through policy decisions, jurisdictions might influence the number of resources available in the neighbouring jurisdictions. This dynamic results in strategic behaviour, where a jurisdiction's decision is shaped not only by its internal conditions but also by the competition for resources in its immediate surroundings.

Explanations related to expenditure spillovers and yardstick competition belong to the “spillover” model category, while the explanation related to tax competition is included in the “resource-flow” category.

Expenditure spillovers

The theory on expenditure spillovers emphasizes the interdependence between nearby jurisdictions, whereby the spending decisions of each local government exert influence and are reciprocally influenced by the choices of other local governments in the neighbourhood (Brueckner, 2003). These dynamics can either benefit or harm adjacent areas, depending on the complementarity or substitutability between public goods (Barreira, 2011b; Geys, 2006).

For instance, infrastructure investment such as roads within a given jurisdiction can positively impact nearby residents, leading to an increase in public expenditure within those jurisdictions (Case et al., 1993; Geys, 2006). This phenomenon may coincide with an imminent tax increase, especially when government officials share similar partisan affiliations or political ideologies (Barreira, 2011b; Baskaran, 2014). In competitive scenarios, the reduction of certain services within a jurisdiction makes the neighbourhood more attractive while simultaneously intensifying pressures on the local characteristics of the latter. This situation may result in inefficiencies in public goods provision in both jurisdictions and underscores the concept of a negative interaction in tax rates, wherein the jurisdiction benefiting from the expenditure of its neighbouring jurisdiction may decrease the tax rate to enhance attractiveness. Consequently, the neighbouring jurisdiction may need to follow suit to maintain its appeal (Baskaran, 2014).

Tax competition

The theory on tax competition, rooted in seminal contributions such as Tiebout (1956), Wilson (1986) and Zodrow and Mieszkowski (1986), underscores the interdependence of decisions regarding tax rates across different jurisdictions (Revelli, 2003).

In tax competition, as proposed by Tiebout (1956), individuals strategically choose a community size that best aligns with their preferences for taxes and public goods, fostering competition for a mobile tax base. The identification of ideal-size tax bases prompts jurisdictions to competitively adjust their policies to attract and retain mobile human and capital migration, creating indirect influences between neighbouring jurisdictions (Geys, 2006; Revelli, 2003, 2005). Higher tax rates compared to neighbouring regions lead individuals and firms to seek alternatives, resulting in the destruction of the tax base (Allers & Elhorst, 2005). This compels jurisdictions to reduce tax rates to retain economic agents, potentially leading to the under-provision of public services – a downside of competitiveness (Brueckner & Saavedra, 2001).

Complementary to the tax competition model is the concept of welfare competition, where local governments aim at repelling welfare recipients while retaining high-income taxpayers (Saavedra, 2000). The challenge lies in finding a balance between providing social assistance and preventing an influx of needy individuals from other jurisdictions (Case et al., 1993). Benefit levels are often set lower to mitigate migration concerns, with the possibility of offering higher social benefits if social security payments in other territories increase (Case et al., 1993; Saavedra, 2000).

In both tax and welfare competition models, the interdependence of decisions and competition for mobile resources contributes to strategic interactions, with a more pronounced impact in closer jurisdictions where information is more accessible and associated costs are lower (Barreira, 2011b).

Yardstick hypothesis

The yardstick competition model, initially introduced by Shleifer (1985) and Salmon (1987), and later developed by Case et al. (1993) and Besley and Case (1995), assumes aligned behaviours in establishing tax rates and configuring the electoral system (Bordignon et al., 2003).

The theory is based on the externalities resulting from asymmetric information between voters and politicians regarding the cost of providing local public services (Besley & Case, 1995; Revelli, 2003, 2005).

Opportunistic politicians attempt to withhold this information to implement tax rate increases beyond that required by the optimal provision of public goods, thereby maintaining additional tax revenue as political rents for personal gain (Pinho & Ribeiro, 2023). To fight against such undesirable behaviour, voters, by analysing the relationship between the provision of public goods, services and taxes in other jurisdictions, create a disciplinary benchmark to infer the competence and quality of their local government (Bordignon et al., 2003; Geys, 2006). Higher tax revenues compared to its neighbours may be perceived as rent extractions, judging politicians as bad and, consequently, this will lead to sanctions from voters, undermining support for re-election through the dismissal or replacement of the policy decision-maker in office (Allers & Elhorst, 2005; Brueckner, 2003; Geys, 2006).

However, policymakers are sensitive to how voters assess their fiscal performance relative to neighbouring jurisdictions and, therefore, there is a natural inclination for officeholders to

imitate or, at the very least, not to deviate significantly from policies adopted by neighbouring jurisdictions, creating a behaviour of tax mimicking (Revelli, 2002, 2005; Saavedra, 2000).

Strategic interaction is heightened in situations where policymakers aim to acquire short-term electoral support (Heyndels & Vuchelen, 1998), especially in locations with electoral uncertainty (Bordignon et al., 2003). The yardstick mechanism is less pronounced in political coalitions as it is more challenging to pinpoint responsibility (Allers & Elhorst, 2005). Moreover, in cases where seeking re-election is not possible, tax mimicking may even be absent, with ideology taking precedence over mimicry (Heyndels & Vuchelen, 1998).

To distinguish yardstick competition from other theories it is essential to examine whether the determination of tax rates is associated with incentives to gain votes (Bordignon et al., 2003; Geys, 2006), whereas tax competition, for example, occurs independently of re-election opportunities (Allers & Elhorst, 2005).

2.2. Overview of empirical studies on the expenditure side

Assessing strategic interaction in local public expenditure is essential for understanding the dynamics involving municipalities and their interdependence. This section aims at exploring empirical studies on the expenditure side, focusing on assessing if and how municipalities' local expenditures are interconnected and influence each other.

Regarding the expenditure spillover hypothesis, Ermini and Santolini (2010) validated the interdependence of expenditure decisions among the 246 Italian local councils for the year 2000, demonstrating that this interdependence is attributable to positive spillovers. Baicker (2005) also found support for positive spillover effects in the United States of America in the 1983-1992 period, where each dollar spent on healthcare by a certain state resulted in nearly 90 additional cents in spending by neighbouring states. This implies that states can be significantly influenced by the policies and decisions of their neighbouring states. This influence is particularly pronounced when residents of a state consider relocating to neighbouring states due to factors such as job opportunities, quality of life, or public services. As a result, states may feel compelled to adjust their own policies and practices to remain competitive and attractive to both current and potential residents.

Regarding tax competition, across the 435 counties in Germany not affiliated with city states, the finance of local government for the year 2002 was attached to mobile tax bases, mainly

derived from business activities (Borck et al., 2007). German counties aimed to lure and keep businesses, making it imperative to maintain a competitive tax burden and align public services with corporate interests. This strategy reflects an approach that involves expanding public expenditure as a strategy to establish a more appealing environment for businesses. This funding primarily originated from mobile tax bases, indicating that by providing companies with better conditions for their economic activity, counties could attract mobile factors and consequently enhance the tax base. Similarly, in 2006 the 205 municipalities of the Czech Republic endowed with extended powers, particularly larger cities with a dense concentration of businesses, demonstrated a confirmation of Tiebout's competition theory. In expenditures related to the environment, there was evidence that municipalities were spending more resources to establish a cleaner and more friendly environment for residents and businesses, with the underlying goal of enhancing the tax base (Štátná, 2009).

The yardstick theory, when examined in several countries, reveals interesting patterns in the strategic interaction for local public expenditures. In Switzerland, for the period between 1980 and 1998, the yardstick theory is corroborated by the identification of imitation effects between cantons, driven by comparisons made by competitors (Schaltegger & Küttel, 2002). However, when a canton has mechanisms like direct democracy and fiscal autonomy, the policymakers are less likely to adopt the same fiscal policies as their neighbouring regions. Furthermore, in the year 2000, the findings from Geys (2006) offered compelling evidence of the correlation between total expenditures and the provision of local public services in Flemish municipalities compared to neighbouring ones. However, there was no strong explanation for the theory that most accurately elucidated this behaviour. Nevertheless, given that strategic interaction was more prevalent in coalitions and when municipalities lacked a significant majority, this suggested that politicians were attempting to demonstrate comparable performance to their counterparts in neighbouring areas, resulting in a tendency for mimicking behaviour driven by electoral motives. The evidence, however, is not robust enough to assert that yardstick competition is the sole theory that explains the interdependence among Flemish local governments.

For the case of Portugal, and to the best of our knowledge, four studies were carried out, offering an enlightened perspective on strategic interaction in local public expenditure. The study conducted by Barreira (2011a) in the 16 municipalities of the Algarve region, spanning from 1998 to 2007, suggests that the influence exerted by one municipality on its

neighbouring regions, known as spillover effects, plays a significant role in spatial interaction. When there is the presence of central government grants, there is a statistically significant tendency for an increase in *per capita* public expenditure in the neighbouring municipalities, implying that the main explanation is the presence of positive spillover effects.

The work of Barreira (2011b), focusing on the Northern region of the Portuguese mainland, between 1998 and 2008, highlights the existence of external effects in the spatial autocorrelation of local public expenditure. Positive spillover effects are identified in total expenditures, primarily influenced by neighbouring local governments sharing similar political orientations. When considering expenditure segmentation by environmental protection and management, strategic interaction is less pronounced but is still attributed to positive spillover effects emerging from cooperative behaviour among incumbents with aligned ideology. Conversely, when examining cultural and sports expenditures, the tax competition effect combines with the positive spillover effect as strategic interaction becomes reinforced. This occurs because politicians use this category to attract new residents to their municipalities and thus increase spending.

The study by Costa et al. (2015), covering the 278 Portuguese mainland municipalities from 1986 to 2006, points to the presence of positive spillovers in the total expenditure of local public goods, highlighting the complementary characteristics of the provision of these goods. Regarding current expenditures, there is greater persistence in strategic interaction, as local governments face difficulties in making abrupt changes, whether due to legal obligations or high adjustment costs. On the other hand, capital expenditures are heavily dependent on intergovernmental grants, with investments revealing consistent and significant spillover effects. Within investment expenditures, there is evidence of positive spillovers in the categories of machinery and equipment and miscellaneous constructions. More specifically, when considering rural roads and sewage systems, the spillover arises from coordination among municipalities, while in investments in sports, recreational, and educational infrastructure, strategic interaction is attributed to mimicking behaviours, possibly aimed at attracting businesses and residences, aligning with the theory of tax competition, as political motivations were rejected.

Silva et al. (2011), analysing the same sample of 278 mainland municipalities over the same period, corroborates the existence of strong positive spillovers, especially in investment expenditures related to transport, material, machinery and equipment components, in

addition to construction expenditures that require complementary actions between municipalities' neighbours. Collectively, these Portuguese studies contribute to a comprehensive understanding of strategic interaction in local public expenditure, highlighting the prevalence of positive spillover effects in the national context.

3. The Portuguese local government institutional framework

The restoration of democracy in Portugal in 1974 marked the end of a 48-year dictatorship regime and the promulgation of a new constitution (Castro & Martins, 2013). This new Constitution, operational since April 25, 1976, laid down the foundations for local governments in Portugal, defining three main entities: civil parishes (*freguesias*), municipalities (*municípios*), and administrative regions (*regiões autónomas*) (Costa et al., 2015; Pinho & Veiga, 2005).

Currently, the institutional framework of Portuguese local government comprises 308 municipalities, with 278 located on the mainland and 30 in the autonomous regions of Madeira and Azores.¹ The autonomous regions exhibit a unique territorial organisation, specific resident needs, and the potential for additional European Union funds due to the categorization as ultra-peripheral regions (Costa et al., 2015).

Municipalities emerge as fundamental pillars within the context of Portuguese local government, playing a multifaceted and far-reaching role both in terms of policy decision-making and financially (Jorge et al., 2006). Under the analysis of Castro and Martins (2013) and Martins and Veiga (2013), their importance is undeniable, as they are primarily responsible for a wide range of assignments that directly impact citizens' lives. This comprehensive authority, as discussed by Veiga and Veiga (2007), gives them the ability to intervene in issues covering economic and social development, territorial organisation, and the provision of local public goods, reflecting the breadth of their influence on local daily life. Financially autonomous, municipalities own their assets, employ personnel, and have the autonomy to define their local budget and action plan without requiring approval from any superior authority (Veiga & Veiga, 2007). On the other hand, civil parishes, as mentioned by Costa et al. (2015) and Jorge et al. (2006), assume a more circumscribed role, often operating as extensions of municipalities. Their functions, although important, tend to be more specific and limited, often designated by municipalities to carry out smaller-scale tasks of lesser relevance compared to the broader assignments of municipalities.

The evolution of local governments in Portugal has been marked by a series of legislative enactments and reforms since the restoration of democracy (Silva et al., 2011). The initial milestone of this process was the enactment of the Local Government Law in 1977 (Law

¹ [Portal Autárquico - Municípios \(dgal.gov.pt\)](http://PortalAutarquico-Municipios.dgal.gov.pt)

79/77), subsequently followed by a series of legal amendments designed to incrementally expand the responsibilities and powers of municipalities. This legislative path reflected a clear trend towards decentralisation, aiming to strengthen local autonomy and promote governance that is more adjusted to the needs of citizens (Pinho & Veiga, 2005). However, Portugal's accession to the European Economic Community in 1986 decisively catalysed this decentralisation process. As pointed out by Costa et al. (2015), this integration provided municipalities with a significant influx of funding from the European Union. This substantial funding not only strengthened the financial capabilities of municipalities but also encouraged them to pursue more effective practices of management and locally driven developmental strategies aligned with European guidelines.

Although municipalities in Portugal benefit from a considerable degree of financial autonomy, as highlighted by Veiga and Veiga (2007), this autonomy is mitigated by a set of restrictions and oversight measures imposed by the central government. These regulatory measures, crafted to uphold stability and compliance with national policies, require Portuguese municipalities to adhere to budget rules, institutions, legislation, and uniform competencies (Costa et al., 2015; Silva et al., 2011). Ultimately, these regulations may limit municipalities' ability to exercise full discretion over financial decisions (Veiga & Veiga, 2007).

The financial sustainability of municipalities in Portugal depends on various sources, reflecting the complexity and diversity of the local fiscal structure. The main sources of municipal revenue, as emphasised by Costa et al. (2015), include transfers from the central government, local taxes, and other miscellaneous revenues. Transfers from the central government (national and European Union funds) represent a significant portion of municipal revenue and play a crucial role in redistributing resources among municipalities (Costa & Carvalho, 2013). These transfers, as elucidated by Veiga and Pinho (2007), can be conditional or unconditional. Conditional grants are regulated through contracts and specific program criteria, with the central government exercising tighter oversight over their use. On the other hand, unconditional grants are determined by a formula, providing municipalities with greater autonomy in their application. However, it is important to note that there exists a direct relationship between municipal development and fiscal revenue. It is notable that in economically more advanced municipalities, the contribution of municipal taxes and other fees to total revenue is substantially higher, often exceeding 60%. This indicates a greater

degree of financial autonomy and reliance on local revenue sources within these more developed areas. In contrast, on average, approximately 38% of municipal revenue is derived from taxes and other fiscal sources, thereby underscoring a significant disparity between various levels of municipal development (Coimbra et al., 2011). These economic imbalances sometimes manifest in the different financial capacities of municipalities to meet the needs and demands of their populations, posing significant challenges to balanced local development (Costa & Carvalho, 2013). Another important source of revenue are local taxes, which include property tax, property transfer tax, tax on the circulation of vehicles, and corporate income tax, among others. The property tax is highlighted as the main source of municipalities' revenue, giving them the autonomy to set their rates within a range established at national level (Costa et al., 2015). Finally, other revenues, such as fees, fines, property income, and financial liabilities, complement the revenue-side financial framework of municipalities. These additional revenues provide an additional source of funding for municipalities, allowing them to address specific needs and invest in priority development areas.

On the other hand, concerning expenditures, municipalities play a fundamental role in utilising the available financial resources to address the needs and demands of the local community. These expenditures are divided into current expenditures and capital expenditures. Current expenditures include personnel expenses, acquisition of goods and services, financial expenses, current transfers to parishes, subsidies and other current expenses. On the other hand, capital expenditures encompass the acquisition of capital goods, capital transfers to parishes, financial assets, financial liabilities, other capital expenses and off-budget operations. Despite the limitations imposed by restrictions on fiscal revenues and the dependence on transfers from the central government, Portuguese municipalities keep a degree of flexibility in allocating their expenditures, particularly in terms of investments (Barreira, 2011b). It is important to note that choices over current expenditures are often limited due to the rigidity of salaries, which are regulated by rigid employment contracts (Veiga & Veiga, 2007). This means that municipalities have less flexibility to quickly adjust their current expenditures in response to economic conditions or emerging needs, posing a significant challenge for local financial management.

The scarcity of infrastructure and equipment, coupled with the availability of unconditional transfers from the central government earmarked for capital expenditures, laid the

groundwork for a strategic orientation of local authorities towards public investment. This approach was reinforced by the heightened electoral visibility of the public investment, while other indicators of good management, such as the level of indebtedness, remained in the background (Coimbra et al., 2011).

Acquisition of capital goods in Portuguese municipalities are structured into three distinct components: investment expenditures, financial leases and public domain assets. The ability of local governments to adjust their financial allocations according to the specific needs and priorities of communities is crucial to drive local economic development (Costa et al., 2015; Pinho & Ribeiro, 2023). Such flexibility can result in significant impacts on the economic activity of local regions, as suggested by Costa et al. (2015). By investing in infrastructure, development programs, or other initiatives that promote economic growth, municipalities can stimulate the business environment and attract investments, firms and households, fostering popularity and competitiveness among municipalities (Costa et al., 2015; Pinho & Ribeiro, 2023).

4. Empirical framework

Spatial econometrics, a branch of econometrics aiming to integrate spatial aspects into econometric procedures, emerges as a fundamental domain for understanding complex interrelations within economic and social systems. These aspects, stemming from both the interdependence among different regions and the disparity in the distribution of resources and economic activities across locations, manifest in structures connected by location and physical proximity among diverse economic units (Anselin et al., 2008).

While traditional spatial econometrics historically confined itself to single-equation and cross-sectional setups, its scope has evolved to include panel data, consisting of observations collected over time for multiple units such as countries, regions, or firms (Anselin et al., 2008). This enables a more dynamic analysis and a fuller understanding of economic relationships. Panel data sets, by providing greater informational richness, reduce collinearity between variables, broaden degrees of freedom, and enhance analysis efficiency (Barreira, 2011b). Additionally, they allow for the specification of more complex behavioural hypotheses. This means that researchers can explore and identify the underlying reasons for strategic interactions among different economic units over time, which is not possible with cross-sectional data that captures only a specific moment in time (Bordignon et al., 2003).

The purpose of this study is to conduct a comprehensive empirical analysis spanning the period from 2003 to 2022 and focusing on the 278 municipalities of mainland Portugal. Interactions will be tested by estimating reaction functions, facilitating an understanding of how each jurisdiction responds to the choices of neighbouring jurisdictions regarding specific local government expenditure variables while taking into account characteristics of the jurisdictions.

The model employed in this research is a general reaction function adapted for panel data, as described by Brueckner (2003) in equation (4.1), and later explored by Belotti et al. (2017). The reaction function establishes a connection between the absolute or relative measure of public expenditure of each jurisdiction (i) at time t , (y_t), represented as an $n \times 1$ column vector, and its specific characteristics (X_t), which are captured in an $n \times k$ matrix of regressors. This function also considers decisions made by reference neighbouring jurisdictions (j) regarding the same strategic variable (y_t), also represented as an $n \times 1$ column

vector. An n by n matrix, denoted by $\mathbf{W}$, captures the spatial relationships between n units, with each entry w_{ij} in $\mathbf{W}$ representing the degree of spatial proximity between units (i) and (j).

$$y_t = \rho W y_t + X_t \beta + \epsilon_t \quad (4.1)$$

ρ is identified as the slope of the reaction function, while β is an unspecified vector of parameters, and ϵ_t is the error term.

The study employs a comprehensive approach to assess spatial interdependencies by comparing a baseline spillover specification with one that also controls for the influence of socioeconomic and political explanatory variables.

4.1. Neighbourhood definition

Understanding spatial interaction, which implies that observations at one location (i) depend on observations in other locations (j), arises from underlying regional interactions (LeSage, 1999). This comprehension requires a careful definition of neighbourhood, a fundamental concept in economic and geospatial analysis. This definition is translated into a spatial matrix, a representation that assigns non-negative weights to indicate the relevance of other jurisdictions in the interaction with a specific jurisdiction, referred to as (i) (Brueckner, 2003).

The relevance of this matrix goes beyond a mere representation of spatial connections. It determines not only the reference jurisdictions for each jurisdiction (i), but also the pattern of spatial interaction between them (Heyndels & Vuchelen, 1998; Saavedra, 2000). It should be noted that the data of the matrix must be specified *a priori*, as it cannot be estimated simultaneously with the other model parameters (Saavedra, 2000).

The construction of this matrix is a crucial step in the process. This process is generally based on geographical criteria, such as contiguity or distance (Anselin et al., 2008). Initially, to build the matrix, it is necessary to assign zeros to all elements and then change these zeros to ones when the jurisdictions are adjacent (contiguity) or meet the distance defined *a priori* as neighbours (distance).²

² Costa et al. (2015) apply the two geographical criteria (contiguity and distance).

To capture this connectivity between jurisdictions, approaches such as contiguity (Brueckner, 2003) are commonly used. The greater spatial proximity between municipalities corresponds to a heightened expected level of interaction (Pinho & Ribeiro, 2023). This variation implies that municipalities are assigned different weights depending on whether they share a geographic border with a reference jurisdiction or not (Heyndels & Vuchelen, 1998). There are various forms of contiguity, such as linear contiguity (when entities share borders to the right or left), rook contiguity (when they share sides), bishop contiguity (when they share vertices); double linear contiguity (when two entities are immediately to the left or right), double rook contiguity (when two entities are to the right, left, south or north), and queen contiguity (when they share vertices or sides) (LeSage, 1999).

It is important to emphasize that a transformation is necessary to standardise the matrix, ensuring that the sum of each row equals to one-unit (e.g., if municipality i shares borders with six municipalities, then $w_{ij} = 1/6$ for each of the j neighbouring municipalities). Another point to mention is that its main diagonal is composed of null elements to exclude self-neighbours, conveying the idea that it is an average matrix in which neighbouring municipalities are considered equally (Heyndels & Vuchelen, 1998; Saavedra, 2000).

This matrix plays a crucial role in interpreting model results, especially when considering the slope parameter of the reaction function, which conveys the response of a jurisdiction (i) to changes in the average level of the expenditure measure of neighbouring jurisdictions (given by $\bar{y}$) (Saavedra, 2000). As $\frac{\partial y_i}{\partial \bar{y}} = \rho W_{ij}$, the matrix has an impact on the magnitude of this effect.

4.2. Econometric issues

In spatial interaction models, it is crucial to consider that other jurisdictions may influence or be correlated with the variable of interest, along with other variables in the model (Brueckner, 2003). This influence can also arise through the correlation between the characteristics of jurisdictions and error terms. Indeed, these models admit that the values of an explanatory variable in a spatial unit are related to the values of the same variable in neighbouring spatial units (Anselin et al., 2008).

In this scenario, the estimation method most commonly used is Ordinary Least Squares (OLS); however, it is imperative to consider the endogeneity present in the model

(Brueckner, 2003; Soro et al., 2017). Endogeneity refers to the situation in which an independent variable in a regression model is correlated with the error term arising from simultaneity or from other relevant explanatory variables that are omitted in the model. When endogeneity is present, the coefficients of variables in the model, obtained by OLS, may be biased or inconsistent, failing to accurately reflect the real relationships between the variables (Greene, 2005).

Another crucial issue to consider is the dependence of the error term, which occurs when the error term of the model (represented by ϵ) incorporates characteristics of the jurisdictions that were not explicitly included in the model and that are spatially interrelated. This dependency implies that the error in one jurisdiction is correlated with the error in neighbouring jurisdictions, due to shared characteristics or spatial effects (Brueckner, 2003). For example, coastal jurisdictions often exhibit geographic proximity to each other, which may result in similarity in characteristics and economic performance. The presence of this dependency may require the use of specific estimation methods to avoid a loss of efficiency in estimating the model parameters by OLS (Greene, 2005).

Due to the inconsistency of OLS estimates, it is necessary to resort to another method to estimate the coefficients of the reaction function more reliably (Brueckner, 2003). Among the two possible solutions (Instrumental Variables and Maximum Likelihood), the method used in this research is the one suggested by Brueckner (2003), which addresses endogenous problems through Maximum Likelihood (ML) estimation. This method inverts the system to eliminate the dependent variables on the right-hand side of the estimated equation and uses a non-linear optimization routine to estimate the spatial coefficient. Moreover, incorporating panel data allows for the exclusion of the correlation between jurisdiction characteristics and the error terms.

4.3. Spatial interaction models

The general reaction function can be expanded to include strategic interactions arising from explanatory variables, the relationship between error terms, or even fixed effects groups. Following Belotti et al. (2017) perspective and using the Stata command *xsmle*, we proceeded to estimate five alternative spatial models for panel data.

In the spatial models presented below, $\mathbf{y}_t$ represents a 278 municipalities $\times$ 1 column vector of the dependent variable, and $\mathbf{X}_t$ denotes the 278 municipalities $\times$ k matrix of explanatory regressors, where $t = 1, \dots, T$ indicates time periods. For each cross-section, $\mathbf{W}$ is the 278 $\times$ 278 matrix that describes the spatial arrangement of the 278 units, with each entry $w_{ij} \in \mathbf{W}$ representing the spatial weight associated to units (i) and (j).

Spatial Autoregressive Model

The Spatial Autoregressive Model (SAR) analyses the spatial dependence among observations in adjacent units. Essentially, SAR incorporates the spatially-lagged dependent variable as explanatory variable, reflecting that the value of the dependent variable (in our case, public expenditure) is influenced not only by own characteristics of the jurisdiction but also by expenditures of neighbouring spatial units. This reflects the tendency of geographically proximate units to share similar characteristics due to unobserved spatial factors (Elhorst, 2010). The model is formalized by the equation (4.2),

$$\mathbf{y}_t = \rho \mathbf{W} \mathbf{y}_t + \mathbf{X}_t \boldsymbol{\beta} + \boldsymbol{\mu} + \boldsymbol{\varepsilon}_t \quad t=1, \dots, T \quad (4.2)$$

where ρ is the coefficient on the spatially-lagged dependent variable, $\boldsymbol{\beta}$ is a vector of unspecified parameters reflecting the influence of the explanatory variables on variation in the dependent variable and $\boldsymbol{\mu}$ is a vector of parameters to be estimated in the fixed-effects variant (Elhorst, 2014; LeSage, 1999). Additionally, the model operates under standard assumptions, including the independence of error terms across different spatial units $\varepsilon_{it} \varepsilon_{js} = 0$ for $i \neq j$ or $t \neq s$, and normality of errors, with mean zero and a constant variance $\varepsilon_{it} \sim N(0, \sigma^2)$ (Belotti et al., 2017).

Spatial Durbin Model

The distinction that the Spatial Durbin Model (SDM) holds in comparison to its predecessor, the SAR model, lies in the inclusion of spatially weighted independent variables as explanatory variables (LeSage & Pace, 2009). The equation can be formulated as follows (Belotti et al., 2017).

$$\mathbf{y}_t = \rho \mathbf{W} \mathbf{y}_t + \mathbf{X}_t \boldsymbol{\beta} + \mathbf{W} \mathbf{Z}_t \boldsymbol{\theta} + \boldsymbol{\mu} + \boldsymbol{\varepsilon}_t \quad (4.3)$$

The model incorporates an additional set of explanatory variables, denoted as $\mathbf{Z}_t$ (which may differ from or overlap with $\mathbf{X}_t$). The vector $\boldsymbol{\theta}$ indicates how these additional variables influence the dependent variable, accounting for spatial dependencies (LeSage, 1999).

Spatial Autocorrelation Model

The spatial autocorrelation model (SAC) represents an extension of the SAR model, as it also includes a spatial autoregressive process in error terms (Elhorst, 2010). The structure of the model is outlined as follows (Belotti et al., 2017),

$$\mathbf{y}_t = \boldsymbol{\alpha} \mathbf{W} \mathbf{y}_t + \mathbf{X}_t \boldsymbol{\beta} + \boldsymbol{\mu} + \mathbf{v}_t \quad (4.4)$$

$$\mathbf{v}_t = \lambda \mathbf{M} \mathbf{v}_t + \boldsymbol{\varepsilon}_t \quad (4.5)$$

where $\mathbf{v}_t$ represents the spatially autocorrelated error term, λ denotes the spatial autocorrelation coefficient and $\mathbf{M}$ is a matrix of spatial weights that may or may not be equal to $\mathbf{W}$.

In this specification, the assumption is that spatial autocorrelation is not limited solely to the variable of interest ($\mathbf{y}_t$), but is also present in the model's errors (LeSage & Pace, 2009). For the estimation of this model, the same matrix of spatial weights is used in both equations.

Spatial Error Model

The Spatial Error Model (SEM) is a special case of both SAC and SDM models, in which it is presumed that spatial dependence manifests exclusively in the model's errors, rather than in the explanatory variables. Consequently, the SEM incorporates a spatial autoregressive process into the error term (Elhorst, 2010). Thus, the structure of the model is delineated by the equation provided below (Belotti et al., 2017).

$$\mathbf{y}_t = \mathbf{X}_t \boldsymbol{\beta} + \boldsymbol{\mu} + \mathbf{v}_t \quad (4.6)$$

$$\mathbf{v}_t = \lambda \mathbf{M} \mathbf{v}_t + \boldsymbol{\varepsilon}_t \quad (4.7)$$

This approach assumes that observations are spatially interconnected, meaning that forecast errors in a particular location are likely to be influenced by errors in neighbouring locations (LeSage & Pace, 2009).

Generalized Spatial Random Effects Model

The Generalized Spatial Random Effects (GSPRE) model constitutes an extension of the SEM model, wherein the panel effects (μ) are assumed to be spatially correlated. To account for this type of spatial correlation, a spatial autoregressive process is modelled into the panel effects as well. The model equation is represented as follows (Belotti et al., 2017),

$$y_t = X_t\beta + \mu + v_t \quad (4.8)$$

$$v_t = \lambda M v_t + \epsilon_t \quad (4.9)$$

$$\mu = \phi W \mu + \eta \quad (4.10)$$

where ϕ is the spatial autocorrelation coefficient for the fixed effects, μ . This approach allows for both errors and panel effects to be considered as normally distributed and independent from each other, while capturing the spatial correlation present in panel data (Belotti et al., 2017).

Except for the last model, and since the sample represents the entire population, fixed effects estimation is employed as typically recommended in the literature (e.g., Elhorst, 2009).

5. An empirical application to the Portuguese municipalities

This chapter discusses the construction of the dataset, describing the processes involved in collecting and organising the data for the 278 Portuguese mainland municipalities from 2003 to 2022. We formulate expectations regarding the signs of coefficients of the explanatory variables, and present the results of alternative model specifications together with model tests. In addition, we provide theoretical and empirical explanations for the results, offering a comprehensive analysis based on the available data.

5.1. Dataset

To achieve the objective of this study, which aims to examine the presence of strategic interaction among Portuguese municipalities concerning public expenditure, an extensive dataset spanning the period from 2003 to 2022 and including all 278 municipalities of mainland Portugal was compiled. The data was obtained from various reliable sources, including the Directorate-General of Local Authorities (DGAL), Statistics of Portugal (INE), the National Electoral Commission (CNE), as well as the General Secretariat of the Ministry of Internal Affairs (SGMAI).

The general dependent variable in this study is nominal *per capita* expenditure. All expenditure data over the 2003-2022 period were obtained from DGAL. The data extraction process was carried out in two main stages. In the first phase, we collected the main categories of current expenditure and capital expenditure. We then disaggregated capital expenditure, specifically focussing on the acquisition of investment goods. This approach was adopted to allow for a more detailed analysis of this category of expenditure, which is often highlighted in empirical literature as the domain in which strategic interaction between municipalities is most evident.

All expenditure variables were divided by the total population, based on data obtained from Statistics of Portugal, in order to express them in *per capita* terms.

We also included the expenditure lagged variable in the models presented above as to capture the inertia of budget decisions. Expenditure often follows a pattern established in previous years, reflecting the continuity of government policies and priorities. However, this approach may not be as effective for more volatile spending categories, such as investment, which can be influenced by more recent data or emerging needs. Thus, the lagged variable helps to

understand how current decisions are influenced by the past, but its effectiveness varies depending on the type of expenditure. This defines dynamic models where the lagged (in time or space) dependent variable or the lagged (in both time and space) dependent variable may be included in the specifications.

The variable of central government grants, which corresponds to *per capita* transfers, was also included in the models. These grants are often used to finance a wide range of projects, such as road construction and maintenance, improvements to schools and the development of local infrastructure. Given the nature of these transfers, it is expected public spending to increase with grants, as the municipalities that benefit from these additional resources tend to invest in infrastructure and other public services to meet their specific local needs.

In addition to the lagged expenditure and central government grants, socioeconomic and demographic covariates were included as explanatory factors to control for fixed municipality characteristics. All these covariates are represented by matrix X in the models above. As described in Table 1, these regressors include population density, total dependency ratio and the *per capita* purchasing power index. These factors play a crucial role in understanding the socio-economic dynamics that influence municipal expenditure patterns.

Population density, which represents the number of individuals *per* square kilometre, is an important variable to understand the demographic and urbanisation dynamics of a specific geographical area. A high population density is typically associated with a greater demand for public services and infrastructures, which may affect the availability and quality of these services. As a proxy for urbanisation, population density indicates areas with a large concentration of people in a delimited space, which leads to two opposing effects on the provision of local public goods and services. On one hand, high population density can result in economies of scale, as the cost per unit of services such as transportation, healthcare, and education may decrease with a high proportion of people using them, leading to a decrease in per capita expenditure. On the other hand, densely populated regions may face heightened pressure on existing infrastructure and create new needs for public expenditure, mainly transport and environment-related one, which can strain public resources and increase per capita expenditure. Therefore, while there is a potential for economies of scale, the overloading effect might outweigh these benefits. Given this conflict, we ultimately expect the estimated coefficient of this variable to have a positive sign, as the impact of congestion likely compensates for the economies of scale.

Age group population distribution is also important; for example, the active age population (15 to 64 years old) is crucial in signalling the available workforce, which is essential for determining a municipality's ability to generate tax revenue, as this age group is typically employed and contributing to the local economy. Municipalities with a high proportion of the active age population may have more resources available to invest in public services and infrastructures, which can positively influence their spending decisions and willingness to compete or cooperate with other municipalities. Conversely, a higher proportion of elderly population have specific demands for public services, such as healthcare and social assistance, which can affect municipalities' spending priorities and their willingness to interact with other municipalities. Similarly, municipalities that have a significant proportion of children and adolescents (aged up to 14) also require adequate infrastructure, such as parks and daycare centres. Parks not only offer recreational and leisure spaces, promoting children's health and well-being, but also contribute to the social cohesion of communities, while daycare centres support working parents and foster early childhood development. The total dependency ratio, which considers the ratio of the number of dependents over the working-age population, is crucial for understanding the economic and social pressure on active population. Balancing these demands between the different age groups influences the financial allocations of municipalities and their interactions with neighbouring jurisdictions, with more socially vulnerable municipalities experiencing higher demand for specific services provided by local authorities, which suggests a predicted positive sign for this variable.

The *per capita* purchasing power variable demonstrates the economic prosperity of local residents and their ability to acquire goods and services (dynamism of local economic activity) and is therefore, through its impact on local government revenue, expected to have a positive influence on public expenditure. Since the variable extracted from the INE was only of biennial frequency, values for the missing years were replaced by interpolated/extrapolated values, specifically for 2006, 2008, 2010, 2012, 2014, 2016, 2018, 2020 the data were interpolated and extrapolated to the year 2022.³

The dataset also includes detailed information on selected political variables to better assess the existence of a yardstick mechanism. The political variables are dummies expressing the political inclination of local governments (right or left-wing), whether there is a majority in

³ The results were obtained using the Stata command *ipolate*, with the option *epolate*.

the municipal council, whether the incumbent had a close race with the main opponent in the last elections and whether the incumbent faces a binding term-limit.

After collecting all the variables, the dataset showed 18 missing values, which corresponds to 0.3% of the total observations. As the Stata command to be used does not allow unbalanced panels, we opted to impute these missing values. For this purpose, we calculated the average of the values from the previous two years to fill in the gaps, guaranteeing the integrity and functionality of the dataset for subsequent analyses.

To formulate the spatial weight matrix, the criterion of geographical proximity was used considering queen contiguity of type 1. To this end, the *Carta Administrativa Oficial de Portugal 2021* was used to construct the matrix.

Table 1 presents all variables and sources used to construct the study database. Annex 1 contains a comprehensive list of expenditure categories labelled with their corresponding descriptions.

Table 1: Description and sources of variables

Variable	Description	Source
Exp_pc	Total <i>per capita</i> expenditure and expenditures categories	DGAL
Grant_pc	Grants from the central government	DGAL
Pop	Total population	INE
PopD	Population density	INE
Dr	Total dependency ratio	INE
PPpc	<i>per capita</i> Purchasing Power Index	INE
dvRight	dummy variable right-wing political inclination of the winning list = 1; left-wing or independent = 0	SGMAI
dvAbMaj	dummy variable winning list has the absolute majority in the municipal executive (<i>câmara municipal</i>) = 1; 0, otherwise	SGMAI
dvCIRace	dummy variable vote share difference of the mayors' party < 5 % points than that of its main opponent (close race) = 1; 0, otherwise	SGMAI
dvTLimit	dummy variable mayor cannot run for re-election (term-limit restricted) = 1; 0, otherwise	SGMAI; CNE

Notes: The expenditure categories of financial assets/liabilities were omitted as they are deemed to be non-effective expenditure. Data was collected in April/May 2024 from the following data sources: [DGAL](#); [INE](#); [CNE](#); [SGMAI](#).

The descriptive statistics are presented in Table 2 (for more detailed statistics, see Annex 2). Over the period under analysis, Portuguese mainland municipalities spent a *per capita* average

of €1,038 on total expenses, with a standard deviation of €523. The municipality with the lowest *per capita* spending was Estremoz in 2007, while the municipality with the highest *per capita* spending was Fornos de Algodres in 2010. As shown in Annex 2, of the various expenditure categories, municipalities spend the most on personnel expenses (cod_01pc), with a *per capita* average of €336, followed by the acquisition of goods and services (cod_02pc) with €278, and lastly, the acquisition of capital goods (cod_07pc) with €277. Investments represent approximately 80.3% of the total acquisition of capital goods, with financial leasing representing 0.8% and public domain goods representing 18.9%.

Table 2: Descriptive statistics

Variable	Obs	Mean	Std. dev.	Min	Max
Exp pc	5,282	1,037.604	522.750	169.308	4,954.568
CurExp pc	5,282	722.859	378.938	89.139	3,067.965
CapExp pc	5,282	314.745	222.287	10.710	3,235.981
Grant pc	5,282	695.533	488.278	78.376	3,767.050
PopD	5,282	308.357	850.897	4.300	7,415.300
Dr	5,282	62.311	13.020	37.961	121.806
PPpc	5,282	78.884	20.948	41.770	277.930
dvRight	5,282	0.415	0.493	0.000	1.000
dvAbMaj	5,282	0.875	0.330	0.000	1.000
dvClRace	5,282	0.148	0.355	0.000	1.000
dvTLimit	5,282	0.197	0.398	0.000	1.000

Note: The descriptive statistics of the expenditure categories identified with the prefix ‘cod_’ are described in detail in Annex 2.

To mitigate the potentially distorting effects of highly correlated covariates in statistical models (see Annex 3), we have adopted a selection approach that prioritises variables from different domains (demographic, economic, and political) commonly recognised as relevant explanatory factors in the literature.

5.2. Results and discussion

Initially, we ran the Moran's I test for the dependent variable for each year under analysis. The results, which indicated a positive and significant spatial autocorrelation at 99% for all the years, are presented in Annex 4. This suggests that total expenditure *per capita* is similar in neighbouring municipalities, refuting the hypothesis that the dependent variable results

exclusively from random spatial processes. The rejection of the null hypothesis of no spatial dependence would indicate that the Ordinary Least Squares (OLS) estimation is not the most suitable for analysing the data, due to the need to integrate spatial effects into the sample (Soro et al., 2017).

Given the evidence of spatial dependence, we proceeded to estimate the spatial panel models described in section 4.3, applied to the 278 Portuguese mainland municipalities between 2003 and 2022. We used five different models, each with two specifications, labelled (1) and (2), as described in Table 3. The first specification (1) considers a baseline specification of the model with selected socio-economic controls; the second specification (2) also includes a combination of four political variables. The latter makes it possible to analyse the impact of political variables on the spatial dependence of total *per capita* expenditure. Robust standard errors were used in the regressions to ensure that statistical interpretations are more precise in the presence of possible heteroscedasticity and correlations in the data. The models were also extended to the dynamic version, including the lagged (time) dependent variable as explanatory.⁴

The results from Table 3 confirm the presence of significant spatial dependence, reinforcing the need to use techniques that take into account spatial effects (most of the coefficients reported in the bottom part of the table are significant). The covariates included to control for local socio-economic characteristics are, in their majority, statistically significant. Both lagged spending and central government grants have robust positive significant impacts on municipalities' total *per capita* spending across models, indicating the inertia of the dependent variable, but also the availability of additional revenue for municipal expenditure.

⁴ The spatial dependence of the lagged dependent variable was not statistically significant across models and specifications; thus, this was not included in the estimation. Adequate correction of bias is tackled through the option *dlag* in the command *xsmle* in Stata, that uses a QML estimator following Yu et al. (2008).

Table 3: Estimation results for total *per capita* expenditure

	SAR		SDM		SAC		SEM		GSPRE	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
lag_Exp_pc	0.174 (6.64)***	0.173 (6.69)***	0.172 (6.51)***	0.171 (6.53)***	0.128 (4.94)***	0.127 (4.96)***	0.128 (10.67)***	0.127 (10.63)***	0.181 (14.27)***	0.182 (14.34)***
Dr	-0.346 (-0.28)	-0.414 (-0.34)	1.118 (0.75)	1.016 (0.69)	-0.141 (-0.11)	-0.208 (-0.16)	-0.199 (-0.26)	-0.263 (-0.35)	1.857 (3.41)***	1.849 (3.40)***
PopD	-0.095 (-1.93)*	-0.085 (-1.70)*	-0.111 (-2.35)**	-0.105 (-2.28)**	-0.111 (-2.43)**	-0.101 (-2.14)**	-0.107 (-1.84)*	-0.098 (-1.67)*	-0.001 (-0.08)	-0.001 (-0.09)
PPpc	-0.541 (-0.97)	-0.537 (-0.97)	0.023 (0.03)	-0.028 (-0.04)	-0.221 (-0.38)	-0.228 (-0.39)	-0.306 (-0.67)	-0.304 (-0.67)	2.113 (6.32)***	2.184 (6.53)***
Grant_pc	0.826 (23.72)***	0.826 (23.86)***	0.846 (23.17)***	0.848 (23.36)***	0.870 (23.45)***	0.869 (23.41)***	0.863 (44.46)***	0.863 (44.50)***	0.840 (47.69)***	0.841 (47.75)***
dvAbMaj		13.131 (1.17)		13.511 (1.21)		12.539 (1.13)		12.855 (1.6)		13.236 (1.6)
dvRight		-5.062 (-0.48)		-4.842 (-0.47)		-4.164 (-0.40)		-4.381 (-0.62)		-1.128 (-0.16)
dvClRace		1.694 (0.21)		2.812 (0.34)		0.161 (0.02)		0.339 (0.05)		-0.412 (-0.06)
dvTLimit		-8.587 (-1.27)		-9.060 (-1.35)		-8.209 (-1.21)		-8.374 (-1.36)		-14.065 (-2.39)***
_cons									4.999 (0.11)	-10.129 (-0.22)

Spatial effects

Dr			-3.502 (-1.67)*	-3.855 (-1.86)*						
PopD			0.213 (1.83)*	0.249 (2.14)**						
PPpc			-1.388 (-1.34)	-1.420 (-1.38)						
Grant_pc			-0.087 (-1.70)*	-0.078 (-1.55)						
dvAbMaj				29.646 (1.43)						
dvRight				-19.842 (-1.08)						
dvClRace				25.168 (1.80)*						
dvTLimit				-9.332 (-0.54)						
rho (dependent variable)	0.043 (2.23)**	0.042 (2.20)**	0.074 (3.43)***	0.071 (3.36)***	-0.037 (-0.74)	-0.033 (-0.65)				
lambda (error term)					0.111 (1.98)**	0.105 (1.87)*	0.075 (3.44)***	0.728 (3.35)***	0.212 (10.40)***	0.208 (10.16)***
phi (fixed effects)									0.694 (12.40)***	0.698 (12.53)***

Panel Length (years)	19	19	19	19	19	19	19	19	19	19
Groups (municipalities)	278	278	278	278	278	278	278	278	278	278
Observations	5,282	5,282	5,282	5,282	5,282	5,282	5,282	5,282	5,282	5,282
Hausman χ^2										
Hausman <i>p</i> -value	(a)	(a)	(a)	(a)	-	-	(b)	(b)	-	-
Log-likelihood	-34,160	-34,160	-34,220	-34,230	-34,230	-34,230	-33,940	-33,940	-34,590	-34,590

Note: ***, **, * statistically significant at 99%, 95% and 90% levels, respectively; z-statistics in parentheses. (a) Hausman test is ignored, since the dynamic random effects model is not allowed; (b) Fitted models fail to meet the asymptotic assumptions of the Hausman test.

When analysing population density, used as a proxy for the degree of urbanisation, we found a negative impact on municipalities' *per capita* spending, contradicting initial expectations. The negative coefficient of population density suggests that, in the specific context of Portuguese municipalities, factors such as economies of scale and the overloading of existing infrastructure may result in lower *per capita* expenditure in more densely populated areas. In places with a high population density, the *per capita* cost of providing services such as sewage, public transport and education may be lower due to operational efficiency and better use of resources. Another factor worthy of consideration is that high population density can increase the need for infrastructure and, when this demand exceeds the capacity of the existing infrastructure, it can delay the need for any additional investment until the existing infrastructure capacity is increased. However, this effect is not statistically relevant for the GSPRE model.

In addition, the dependency ratio exerts a positive and significant influence on *per capita* expenditure (but only in the GSPRE model), implying that a higher proportion of dependent population (young and old) can significantly increase the demand for essential public services, such as education, healthcare and social assistance. As a consequence, *per capita* expenditure is higher in the municipalities analysed in order to meet the specific demands of these demographic groups.

The analysis does not provide evidence of tax competition. Although *per capita* purchasing power exhibits a significant positive correlation in the GSPRE model – generally reflecting a stronger local economy with a more robust fiscal base that allows municipalities to collect more revenue through taxes which, in turn, provides more resources to be spent on public services and infrastructure, thus increasing *per capita* spending – this fact alone is not enough to conclude robust dominant presence of tax competition.

As far as the political framework is concerned, variables such as having an absolute majority in the municipal executive, being a right-wing party and having a close race between the candidates in the last elections were not statistically significant, indicating weak evidence of yardstick competition. Only the inability to run for re-election, in the GSPRE model, displayed a negative coefficient with a high level of confidence, suggesting that politicians in their later mandates may have less incentive to increase public spending, by focusing their efforts on maintaining fiscal stability or by avoiding long-term projects that they will be unable to oversee. Therefore, the absence of re-election incentives suggests that ideological

considerations may override purely electoral behaviour, indicating that yardstick competition is not predominant.

As for the main variable of interest, capturing the spatial interdependence of *per capita* public expenditure, the results show that when the estimates are highly significant, they have the expected positive sign in the SAR and SDM models. This demonstrates the existence of spatial strategic interaction when municipalities define their total expenditure. However, this result does not hold for the SAC model. The SAC, SEM and GSPRE models indicate a positive spatial dependence in the errors, suggesting that the models might be under-specified and may potentially be omitting variables that affect *per capita* expenditure and exhibit spatial dependence.

The GSPRE model states that the spatial fixed effects are positively correlated between neighbouring municipalities, indicating the presence of spatial autocorrelation in the unobserved characteristics that affect municipalities' *per capita* expenditure. This result underlines the importance of considering spatial dependence when analysing municipal data and formulating public policies, as local decisions can have wider ramifications at a regional level.

From an overall perspective, the results on specification tests shown in Table 4 demonstrate that the SDM model is the better specification when compared to the SAR, SAC and GSPRE models. With respect to the SEM model, the chi-squared test does not provide sufficient evidence to state that the SDM model is preferable over the SEM. However, considering the penalty for model complexity, SAC has the lowest BIC criteria, suggesting that this model is slightly preferred to SDM when simplicity is prioritised. However, most of the results go for SDM over the remaining models.

Table 4: Model specification tests

	χ^2	p-value	AIC	BIC
SDM vs SAR				
Specification (1)	8.36	0.0392		
Specification (2)	13.30	0.0650		
SDM vs SEM				
Specification (1)	6.96	0.1383		
Specification (2)	12.18	0.1432		
SDM				
Specification (1)			67,885.83	67,958.13
Specification (2)			67,889.38	68,014.24
SAC				
Specification (1)			67,892.72	67,945.30
Specification (2)			67,896.17	67,975.03
GSPRE				
Specification (1)			69,204.31	69,270.03
Specification (2)			69,204.18	69,296.19

Note: AIC is the Akaike information criterion and BIC is the Bayesian information criterion.

In an interesting note, the SDM model reveals that circumstances and issues in neighbouring jurisdictions can significantly shape expenditure policies in a municipality. In particular, an increase in local spending is associated with situations in which neighbouring incumbents were in a close electoral race in the last election, suggesting that this fierce competition may motivate neighbouring local governments to increase spending in order to win or maintain voter support. If that is the case, positive effects on public expenditures in contiguity municipalities are expected, which may also justify, at least partially, spatial autocorrelation in error terms found in SAC, SEM and GSPRE. Also, the presence of high population density in neighbouring municipalities is also related to an increase in local spending, possibly because the needs of densely populated areas spill over into adjacent areas, creating similar pressures on nearby municipalities to increase their spending and address regional needs.

On the other hand, a high dependency ratio and the provision of central government grants by neighbouring municipalities negatively affect the dynamics of local spending. This can occur because these neighbouring municipalities, by receiving more grants, have a greater capacity to build infrastructure such as nursing homes and kindergartens, potentially resulting in a redirection of the local population to these adjacent municipalities, reducing the need for similar expenditure in the municipality in question. In this way, intergovernmental grants and high dependency on neighbouring municipalities relieve the pressure on the local municipality to invest in certain areas, influencing the distribution of expenditure.

In general, decisions regarding municipal spending seem to be more influenced by economic and demographic factors than by direct political comparisons between different jurisdictions. Thus, the mechanism of spillover effects seems to be the most prominent mechanism in the spending decisions of Portuguese municipalities.

We proceed to the analysis of the different models using the most comprehensive specification (2) for both current and capital expenditure, obtaining results that reveal important differences from those observed for total expenditure.

Looking at the first 5 columns of Table 5, the results on current expenditure confirm the main findings obtained for total expenditure. The only differentiating feature is that, for current expenditure, none of the political variables proved to be significant in any model. In addition, in terms of spatial effects, only the neighbour dependency ratio is statistically significant.

Moving to capital expenditure, which represents on average approximately 30% of total expenditure, the analysis revealed significant differences against total and current expenditure. The SDM model reveals a particularly interesting finding: the spatial dependency effect of grants to neighbouring municipalities produces a negative impact on capital expenditure in each municipality. This finding, coupled with the negative value of the ρ coefficient in the SAC model, suggests that municipalities exhibit substitutability when it comes to capital expenditure. In simpler terms, it appears to be a dynamic process in which municipalities strategically adjust their spending in response to neighbouring municipalities receiving grants. This behaviour reflects a potential interaction between geographical proximity and fiscal interdependence.

As for population density, although significant only in the GSPRE model, there is a positive correlation with capital expenditure, informing that in more densely populated areas the pressure for new investments in infrastructure is greater to cater for the dense population. In terms of the dependency ratio, the results suggest that a higher dependency ratio leads to a reduction in the capacity to invest in capital expenditure, probably due to the redirection of resources to prioritise the current expenditure on social services needed by dependent groups.

Table 5: Estimation results for current and capital *per capita* expenditures

	Current					Capital				
	SAR	SDM	SAC	SEM	GSPRE	SAR	SDM	SAC	SEM	GSPRE
lag_Cur_pc/lag_Cap_pc	0.611 (12.10)***	0.607 (11.97)***	0.495 (8.16)***	0.552 (45.93)***	0.820 (46.84)***	0.266 (9.23)***	0.252 (8.80)***	0.173 (6.17)***	0.203 (16.58)***	0.277 (20.41)***
Dr	0.590 (0.94)	1.253 (1.60)	0.386 (0.69)	0.824 (1.92)*	0.760 (2.89)***	-1.534 (-1.30)	-1.456 (-1.07)	-1.386 (-1.04)	-1.551 (-2.42)**	-4.254 (-8.59)***
PopD	-0.045 (-1.77)*	-0.051 (-2.08)**	-0.044 (-1.57)	-0.054 (-1.69)*	-0.006 (-2.15)**	-0.005 (-0.20)	-0.030 (-1.31)	-0.021 (-0.65)	-0.013 (-0.28)	0.017 (2.28)**
PPpc	0.758 (2.41)**	0.956 (2.50)**	0.592 (2.19)**	1.343 (5.16)***	0.923 (8.11)***	-3.009 (-7.14)***	-2.120 (-3.81)***	-2.342 (-4.63)***	-2.924 (-7.59)***	-0.511 (-1.98)**
Grant_pc	0.143 (6.86)***	0.141 (7.29)***	0.143 (8.24)***	0.183 (16.89)***	0.145 (14.35)***	0.485 (14.45)***	0.564 (14.24)***	0.553 (14.89)***	0.538 (34.34)***	0.344 (23.73)***
dvAbMaj	-6.698 (-1.31)	-6.327 (-1.27)	-6.364 (-1.29)	-6.916 (-1.56)	-0.887 (-0.21)	21.155 (2.80)***	20.839 (2.85)***	20.195 (2.97)***	21.844 (3.40)***	24.249 (3.70)***
dvRight	1.267 (0.24)	1.307 (0.25)	0.328 (0.06)	1.927 (0.49)	-3.102 (-1.05)	-8.455 (-0.86)	-7.823 (-0.82)	-5.772 (-0.64)	-7.794 (-1.37)	10.650 (2.01)**
dvClRace	-4.212 (-1.00)	-3.614 (-0.85)	-3.866 (-0.96)	-4.762 (-1.23)	1.374 (0.36)	11.011 (1.64)	11.233 (1.75)*	7.196 (1.20)	9.181 (1.64)	6.662 (1.16)
dvTLimit	-3.312 (-1.02)	-3.746 (-1.19)	-3.917 (-1.24)	-3.290 (-0.97)	-4.569 (-1.34)	-3.976 (-0.83)	-3.104 (-0.63)	-2.988 (-0.68)	-3.858 (-0.79)	-16.979 (-3.47)***
_cons					-61.164 (-3.51)***					261.729 (6.65)***

Spatial effects

Dr		-1.954 (-1.86)*					0.114 (0.06)			
PopD		0.101 (1.60)					-0.005 (-0.07)			
PPpc		-0.774 (-1.45)					-0.674 (-0.77)			
Grant_pc		0.029 (0.88)					-0.307 (-7.45)***			
dvAbMaj		15.068 (1.37)					-3.772 (-0.24)			
dvRight		-11.733 (-1.02)					-4.245 (-0.24)			
dvClRace		8.999 (1.06)					16.323 (1.22)			
dvTLimit		-4.344 (-0.52)					0.249 (0.02)			
rho (dependent variable)	0.176 (8.96)***	0.176 (10.49)***	0.359 (5.43)***			0.155 (7.67)***	0.220 (9.73)***	-0.403 (-5.49)***		
lambda (error term)			-0.317 (-3.12)***	0.154 (7.07)***	0.276 (148.23)**			0.544 (10.24)***	0.231 (11.59)***	0.350 (18.08)***
phi (fixed effects)					1.310 (14.21)***					0.670 (10.21)***

Panel Length (years)	19	19	19	19	19	19	19	19	19	19
Groups (municipalities)	278	278	278	278	278	278	278	278	278	278
Observations	5282	5282	5282	5282	5282	5282	5282	5282	5282	5282
Hausman χ^2										
Hausman <i>p</i> -value	(a)	(a)	-	(b)	-	(a)	(a)	-	(b)	-
Log-likelihood	-3,1090	-3,1150	-3,1150	-3,1150	-3,1150	-3,3180	-3,2970	-3,2970	-3,2970	-3,2970

Note: ***, **, * statistically significant at 99%, 95% and 90% levels, respectively; z-statistics in parentheses. (a) Hausman test is ignored, since the dynamic random effects model is not allowed; (b) Fitted models fail to meet the asymptotic assumptions of the Hausman test.

Another factor that has the opposite sign to the one associated with total expenditure is the municipal purchasing power, which is highly significant in all the models. In this case, municipalities with a higher purchasing power index may have less need to invest in basic infrastructure, since they already have an adequate installed base. Meanwhile, when we look at the political variables, we realised that the absolute majority on the city council is highly significant and positive, indicating that strong leadership can boost investment in infrastructure. Other variables, such as right-wing parties, close races and term limits, although not as strong in all the models, show some statistical significance in at least one of the models, suggesting that capital investment decisions can be used as instruments to gain political support or respond to electoral pressures, being more sensitive to the political context than current or overall expenditure.

While current expenditure is more influenced by demographic and economic factors, closely aligned with total expenditure and therefore better explained by the spillover effects theory, capital expenditure is more sensitive to the political context and infrastructure investment needs. Thus, the spillover effects theory seems to be the most consistent explanation for the current spending decisions of Portuguese municipalities, with yardstick competition elements also present in capital investment decisions.

We proceeded with a more detailed breakdown of expenditures into the main subcategories. These results can be seen in tables 6 and 7, for the most representative categories of current (personnel expenses and acquisition of goods and services) and capital expenditures (acquisition of capital goods), respectively.

Table 6: Estimation results for personnel expenses and acquisition of goods and services

	cod_01, personnel expenses					cod_02, acquisition of goods and services				
	SAR	SDM	SAC	SEM	GSPRE	SAR	SDM	SAC	SEM	GSPRE
lag_cod01_pc/ lag_cod02_pc	0.846 (18.81)***	0.845 (18.53)***	0.753 (15.95)***	0.768 (83.98)***	0.960 (202.77)* **	0.462 (10.88)***	0.459 (10.69)***	0.334 (8.10)***	0.397 (29.69)***	0.559 (35.26)***
Dr	0.476 (2.62)***	0.449 (1.99)**	0.513 (2.78)***	0.495 (3.51)***	0.044 (0.73)	0.419 (1.03)	0.795 (1.61)	0.137 (0.43)	0.669 (2.30)**	1.854 (8.50)***
PopD	0.002 (0.51)	0.000 (-0.01)	0.003 (0.76)	0.001 (0.12)	-0.001 (-0.86)	-0.006 (-0.47)	-0.004 (-0.30)	0.001 (0.06)	-0.012 (-0.58)	-0.011 (-3.11)***
PPpc	0.022 (0.25)	0.111 (0.94)	0.176 (2.04)**	0.243 (2.84)***	0.107 (3.35)***	0.647 (3.44)***	0.617 (2.87)***	0.343 (2.28)**	0.962 (5.50)***	0.938 (7.61)***
Grant_pc	0.040 (4.60)***	0.041 (4.73)***	0.055 (6.49)***	0.059 (16.49)***	0.030 (12.70)***	0.059 (5.40)***	0.052 (4.64)***	0.049 (5.15)***	0.073 (10.43)***	0.077 (14.25)***
dvAbMaj	-2.258 (-1.77)*	-2.436 (-1.93)*	-2.752 (-2.16)**	-2.638 (-1.83)*	-1.577 (-1.17)	-1.650 (-0.54)	-1.400 (-0.46)	-1.407 (-0.48)	-1.767 (-0.60)	-1.651 (-0.54)
dvRight	-0.829 (-0.53)	-0.734 (-0.47)	-0.531 (-0.34)	-0.309 (-0.24)	-1.329 (-1.47)	1.949 (0.66)	1.718 (0.57)	1.510 (0.52)	2.141 (0.82)	-0.168 (-0.07)
dvCIRace	0.071 (0.04)	0.212 (0.12)	-0.479 (-0.28)	-0.279 (-0.22)	0.871 (0.72)	-2.921 (-1.12)	-2.728 (-1.04)	-1.708 (-0.69)	-3.069 (-1.19)	-1.090 (-0.40)
dvTLimit	0.042 (0.03)	0.274 (0.23)	0.076 (0.06)	-0.138 (-0.12)	-3.000 (-2.67)***	-4.334 (-1.96)*	-4.340 (-2.00)**	-4.162 (-2.00)**	-4.413 (-1.95)*	0.280 (0.13)
_cons					-2.950 (-0.64)					-106.572 (-6.37)***

Spatial effects

Dr		-0.006 (-0.02)					-0.950 (-1.37)			
PopD		-0.022 (-1.53)					0.094 (2.25)**			
PPpc		-0.193 (-1.15)					-0.190 (-0.59)			
Grant_pc		-0.005 (-0.57)					0.038 (1.97)**			
dvAbMaj		3.103 (0.67)					2.079 (0.33)			
dvRight		-2.769 (-0.78)					-3.436 (-0.43)			
dvCIRace		-0.017 (-0.01)					4.755 (0.76)			
dvTLimit		5.257 (1.83)*					2.731 (0.42)			
rho (dependent variable)	0.127 (6.58)***	0.136 (6.21)***	0.118 (3.91)***			0.205 (10.44)***	0.195 (9.69)***	0.529 (10.65)***		
lambda (error term)			0.045 (1.06)	0.179 (9.01)***	0.476 (31.75)***			-0.523 (-6.36)***	0.179 (8.44)***	0.295 (14.08)***
phi (fixed effects)					1.027 .					0.446 (5.07)***

Panel Length (years)	19	19	19	19	19	19	19	19	19	19
Groups (municipalities)	278	278	278	278	278	278	278	278	278	278
Observations	5282	5282	5282	5282	5282	5282	5282	5282	5282	5282
Hausman χ^2										
Hausman <i>p</i> -value	(a)	(a)	-	(b)	-	(a)	(a)	-	(b)	-
Log-likelihood	-2,5630	-2,5660	-2,5660	-2,5660	-2,5660	-2,8920	-2,8950	-2,8950	-2,8950	-2,8950

Note: ***, **, * statistically significant at 99%, 95% and 90% levels, respectively; z-statistics in parentheses. (a) Hausman test is ignored, since the dynamic random effects model is not allowed; (b) Fitted models fail to meet the asymptotic assumptions of the Hausman test.

Table 7: Estimation results for acquisition of capital goods

	cod_07, acquisition of capital goods				
	SAR	SDM	SAC	SEM	GSPRE
lag_cod07_pc	0.268 (10.11)***	0.253 (9.68)***	0.180 (7.11)***	0.205 (16.93)***	0.279 (20.65)***
Dr	-1.393 (-1.25)	-1.172 (-0.92)	-1.190 (-0.95)	-1.365 (-2.24)**	-4.274 (-9.13)***
PopD	-0.029 (-0.83)	-0.053 (-1.40)	-0.043 (-1.20)	-0.037 (-0.84)	0.014 (1.93)**
PPpc	-3.214 (-7.44)***	-2.351 (-4.25)***	-2.679 (-5.29)***	-3.170 (-8.65)***	-0.546 (-2.20)**
Grant_pc	0.482 (14.53)***	0.559 (14.54)***	0.549 (15.03)***	0.533 (35.67)***	0.332 (23.49)***
dvAbMaj	19.371 (2.76)***	19.227 (2.78)***	18.682 (2.80)***	20.029 (3.27)***	22.970 (3.67)***
dvRight	-10.414 (-1.14)	-10.295 (-1.15)	-8.687 (-1.02)	-10.364 (-1.91)*	7.496 (1.48)
dvClRace	9.938 (1.53)	10.056 (1.60)	6.425 (1.07)	8.056 (1.51)	6.094 (1.11)
dvTLimit	-5.425 (-1.16)	-4.643 (-0.96)	-4.335 (-1.00)	-5.229 (-1.12)	-18.011 (-3.85)***
_cons					251.277 (6.73)***

Spatial effects

Dr		-0.160 (-0.08)			
PopD		0.012 (0.17)			
PPpc		-0.673 (-0.80)			
Grant_pc		-0.296 (-7.60)***			
dvAbMaj		-4.500 (-0.32)			
dvRight		1.957 (0.12)			
dvClRace		15.890 (1.19)			
dvTLimit		-0.986 (-0.09)			
rho (dependent variable)	0.144 (7.09)***	0.212 (9.35)***	-0.363 (-6.04)***		
lambda (error term)			0.511 (11.18)***	0.224 (11.17)***	0.333 (17.05)***
phi (fixed effects)					0.681 (10.62)***

Panel Length (years)	19	19	19	19	19
Groups (municipalities)	278	278	278	278	278
Observations	5282	5282	5282	5282	5282
Hausman χ^2					
Hausman p -value	(a)	(a)	-	(b)	-
Log-likelihood	-3,2920	-3,2690	-3,2690	-3,2690	-3,2690

Note: ***, **, * statistically significant at 99%, 95% and 90% levels, respectively; z-statistics in parentheses. (a) Hausman test is ignored, since the dynamic random effects model is not allowed; (b) Fitted models fail to meet the asymptotic assumptions of the Hausman test.

In table 6, the theory of yardstick competition is seemingly the least suitable, primarily due to the nature of personnel expenditures, which are less visible and less susceptible at the local level to direct influences from electoral considerations. These expenses, governed by labour contracts and long-term commitments, do not lend themselves to easy adjustments in response to policy imitation or comparisons across jurisdictions. In addition, the persistence of spending levels contrasts with the rapid adjustments typically associated with tax competition. The robust significance of grants underlines their direct impact on personnel expenditures, highlighting that the ability to maintain or increase such spending hinges more on the availability of external funding than on the need to compete for a mobile tax base with neighbouring municipalities. Therefore, the notable influence of purchasing power and the population dependency ratio indicates that decisions regarding personnel spending are predominantly shaped by local needs and internal economic capacity, rather than external competitive pressures.

As for the acquisition of goods and services, the theory of spillover effects also seems to be the more appropriate explanation because expenditures in this area often yield regional impacts, benefiting not only the municipality making the purchases, but also neighbouring municipalities, thereby encouraging regional coordination and collaboration. Moreover, there is evidence that municipalities that receive intergovernmental grants can afford to buy goods and services that have positive impacts on their neighbours, encouraging regional coordination in spending decisions. Population density loses some relevance in relation to current expenditure, as the focus is on the benefits that these acquisitions can generate for the region as a whole. Non-eligibility for re-election has a strong negative influence on the purchase of goods and services, suggesting that politicians at the end of their terms may not see electoral benefits in making large purchases that would also benefit their neighbours.

As expected, since it represents the bulk of capital expenditure, expenditure on the acquisition of capital goods, detailed in Table 7, has similar results to capital expenditure. In turn, results on detailed capital expenditures provide additional insights (tables 8 and 9).

Table 8: Estimation results for sports and recreation and for education

	Sports and recreational facilities, parks and gardens					Daycare centres, schools				
	SAR	SDM	SAC	SEM	GSPRE	SAR	SDM	SAC	SEM	GSPRE
lag_pc	0.359 (13.53)***	0.356 (13.22)***	0.296 (10.72)***	0.296 (23.48)***	0.390 (28.00)***	0.383 (16.44)***	0.376 (15.44)***	0.306 (11.86)***	0.312 (24.03)***	0.413 (31.37)***
Dr	-0.216 (-0.80)	-0.079 (-0.19)	-0.234 (-0.79)	-0.238 (-1.189)	-0.377 (-4.46)***	0.150 (0.55)	0.184 (0.58)	0.202 (0.69)	0.181 (0.89)	-0.631 (-7.16)***
PopD	-0.002 (-0.29)	-0.009 (-1.35)	-0.002 (-0.38)	-0.003 (-0.16)	0.001 (0.59)	0.008 (0.94)	0.006 (0.74)	0.004 (0.51)	0.006 (0.41)	0.000 (-0.04)
PPpc	-0.448 (-3.04)***	-0.419 (-2.35)**	-0.470 (-3.01)***	-0.467 (-3.88)***	-0.025 (-0.58)	-0.661 (-4.98)***	-0.445 (-3.31)***	-0.647 (-4.92)***	-0.675 (-5.56)***	0.064 (1.46)
Grant_pc	0.058 (5.97)***	0.066 (5.75)***	0.061 (5.35)***	0.061 (12.50)***	0.025 (10.68)***	0.103 (5.75)***	0.119 (5.97)***	0.116 (5.88)***	0.110 (22.08)***	0.027 (10.35)***
dvAbMaj	3.142 (1.41)	2.957 (1.31)	3.378 (1.53)	3.372 (1.59)	4.030 (2.08)**	2.251 (1.23)	2.108 (1.19)	2.369 (1.32)	2.434 (1.13)	4.003 (2.03)**
dvRight	-2.883 (-1.40)	-2.689 (-1.32)	-2.758 (-1.33)	-2.814 (-1.51)	1.128 (0.89)	-0.155 (-0.09)	0.022 (0.01)	0.077 (0.04)	0.017 (0.01)	0.561 (0.42)
dvCIRace	5.138 (2.10)**	5.240 (2.17)**	4.823 (1.96)*	4.869 (2.63)***	2.749 (1.58)	1.618 (0.80)	1.460 (0.74)	1.546 (0.78)	1.596 (0.85)	3.016 (1.70)*
dvTLimit	-0.327 (-0.22)	-0.313 (-0.21)	-0.430 (-0.29)	-0.447 (-0.27)	-4.166 (-2.77)***	-2.198 (-1.23)	-1.947 (-1.10)	-2.141 (-1.22)	-2.172 (-1.32)	1.929 (1.25)
_cons					20.599 (3.21)***					24.901 (3.67)***

Spatial effects

Dr		-0.480 (-0.81)					0.118 (0.28)			
PopD		-0.025 (-1.09)					0.062 (2.83)***			
PPpc		0.133 (0.60)					-0.273 (-1.29)			
Grant_pc		-0.031 (-2.67)***					-0.063 (-4.26)***			
dvAbMaj		-3.399 (-0.78)					-2.992 (-0.64)			
dvRight		-7.067 (-1.43)					0.226 (0.05)			
dvCIRace		1.888 (0.38)					-2.046 (-0.44)			
dvTLimit		-2.376 (-0.69)					0.605 (0.16)			
rho (dependent variable)	0.083 (3.90)***	0.085 (4.04)***	-0.037 (-0.25)			0.038 (1.28)	0.076 (2.74)***	-0.168 (-2.14)**		
lambda (error term)			0.130 (0.89)	0.093 (4.36)***	0.146 (6.82)***			0.231 (3.40)***	0.078 (3.58)***	0.132 (6.23)***
phi (fixed effects)					-0.125 (-0.16)					0.944 (24.56)***

Panel Length (years)	19	19	19	19	19	19	19	19	19	19
Groups (municipalities)	278	278	278	278	278	278	278	278	278	278
Observations	5282	5282	5282	5282	5282	5282	5282	5282	5282	5282
Hausman χ^2										
Hausman p -value	(a)	(a)	-	(b)	-	(a)	(a)	-	(b)	-
Log-likelihood	-2,7030	-2,6980	-2,6980	-2,6980	-2,6980	-2,7140	-2,7050	-2,7050	-2,7050	-2,7050

Note: ***, **, * statistically significant at 99%, 95% and 90% levels, respectively; z-statistics in parentheses. (a) Hausman test is ignored, since the dynamic random effects model is not allowed; (b) Fitted models fail to meet the asymptotic assumptions of the Hausman test.

Table 9: Estimation results for social protection and for infrastructure and public construction

	Elderly homes					Viaducts, roads and complementary works				
	SAR	SDM	SAC	SEM	GSPRE	SAR	SDM	SAC	SEM	GSPRE
lag_pc	0.503 (9.12)***	0.502 (9.15)***	0.429 (7.78)***	0.429 (34.85)***	0.530 (45.94)***	0.362 (8.93)***	0.361 (8.85)***	0.293 (7.25)***	0.299 (23.58)***	0.383 (27.47)***
Dr	0.010 (0.26)	-0.019 (-0.33)	0.009 (0.24)	0.010 (0.29)	-0.012 (-1.07)	-0.185 (-0.68)	-0.086 (-0.24)	-0.196 (-0.78)	-0.213 (-1.10)	-0.365 (-3.24)***
PopD	0.000 (1.07)	0.001 (1.05)	0.001 (1.33)	0.001 (0.21)	0.000 (-0.03)	-0.018 (-2.53)**	-0.022 (-3.02)***	-0.019 (-2.69)***	-0.018 (-1.22)	0.001 (0.53)
PPpc	-0.014 (-0.77)	-0.006 (-0.31)	-0.015 (-0.85)	-0.015 (-0.73)	0.003 (0.51)	-0.212 (-1.61)	-0.168 (-1.18)	-0.202 (-1.65)*	-0.223 (-1.93)*	-0.186 (-2.88)***
Grant_pc	0.002 (1.78)*	0.002 (1.63)	0.002 (1.86)*	0.002 (2.35)**	0.001 (3.29)***	0.024 (3.45)***	0.026 (3.25)***	0.023 (3.42)***	0.025 (5.31)***	0.018 (5.92)***
dvAbMaj	-0.239 (-0.91)	-0.239 (-0.91)	-0.249 (-0.95)	-0.249 (-0.67)	-0.010 (-0.03)	-0.235 (-0.11)	-0.252 (-0.12)	0.271 (0.13)	-0.018 (-0.01)	0.607 (0.29)
dvRight	-0.111 (-0.82)	-0.050 (-0.34)	-0.148 (-1.09)	-0.152 (-0.47)	-0.500 (-2.45)**	0.694 (0.25)	0.745 (0.27)	0.638 (0.24)	0.833 (0.46)	3.619 (2.24)**
dvClRace	-0.236 (-0.63)	-0.217 (-0.60)	-0.298 (-0.79)	-0.297 (-0.91)	0.098 (0.33)	1.413 (0.64)	1.666 (0.76)	1.712 (0.80)	1.585 (0.87)	1.238 (0.68)
dvTLimit	-0.322 (-0.79)	-0.309 (-0.78)	-0.312 (-0.76)	-0.310 (-1.08)	0.065 (0.26)	0.316 (0.16)	0.283 (0.15)	0.264 (0.14)	0.280 (0.17)	-1.883 (-1.29)
_cons					0.323 (0.36)					41.292 (4.76)***

Spatial effects

Dr		0.072 (0.85)					-0.395 (-0.70)			
PopD		0.004 (1.73)*					-0.023 (-0.94)			
PPpc		-0.021 (-0.88)					-0.075 (-0.26)			
Grant_pc		0.000 (-0.24)					-0.006 (-0.38)			
dvAbMaj		0.501 (0.72)					4.138 (0.89)			
dvRight		-0.707 (-1.48)					-3.639 (-0.90)			
dvClRace		0.638 (0.71)					3.366 (0.77)			
dvTLimit		0.288 (0.35)					-0.096 (-0.02)			
rho (dependent variable)	-0.019 (-1.43)	0.018 (1.36)	-0.028 (-0.72)			0.031 (1.62)	0.028 (1.51)	0.232 (1.94)*		
lambda (error term)			0.011 (0.32)	-0.016 (-0.73)	0.002 (0.10)			-0.230 (-1.52)	0.025 (1.16)	0.070 (3.17)***
phi (fixed effects)					1.445 (0.00)					0.328 (3.23)***

Panel Length (years)	19	19	19	19	19	19	19	19	19	19
Groups (municipalities)	278	278	278	278	278	278	278	278	278	278
Observations	5282	5282	5282	5282	5282	5282	5282	5282	5282	5282
Hausman χ^2										
Hausman p -value	(a)	(a)	-	(b)	-	(a)	(a)	-	(b)	-
Log-likelihood	-17740	-17740	-17740	-17740	-17740	-26870	-26860	-26860	-26860	-26860

Note: ***, **, * statistically significant at 99%, 95% and 90% levels, respectively; z-statistics in parentheses. (a) Hausman test is ignored, since the dynamic random effects model is not allowed; (b) Fitted models fail to meet the asymptotic assumptions of the Hausman test.

According to Table 9, the lack of evidence of strategic interaction between municipalities in social protection investments, especially in elderly homes – no spatial dependency parameter is statistically significant (spatial rho, spatial lambda and spatial phi, according to the model used), – suggests that these services are highly localised, with less visibility and comparability between different localities. Management autonomy and the financing directed towards these programmes, combined with the low relevance of spillover effects, lead municipalities to develop and administer their own social protection programmes independently, without the need for coordination or strategic comparison with neighbouring municipalities.

On the other hand, the strategic interaction between municipalities regarding spending on sports infrastructure, parks (as shown in Table 9) and road infrastructure (as shown in Table 8) seems to be driven by spillover effects, which generate regional benefits, as well as tax competition, in which municipalities seek to attract residents and companies by offering better living conditions. Investment decisions are influenced by various socio-economic and political factors: municipalities with a larger dependent population generally have less capacity to invest in these infrastructures, while those with greater purchasing power may prioritise other areas considered more essential or with a more direct return. Despite political variables, such as the intensity of electoral competition, showing some influence on expenditures for sports and recreational facilities, parks and gardens, there is a greater tendency to invest in infrastructure which is visible and valued by the community, but we do not consider them to be the primary explanatory theory. In our analysis, other factors appear to play a more significant role in determining these expenditures.

Similar results are seen in Table 8 for education investments, where regional benefits extend beyond municipal borders, encouraging spending adjustments to maintain the competitiveness and quality of education services. Fierce electoral competition also indicates investment in nurseries and schools, as politicians seek to demonstrate effective commitment to improving education in order to secure electoral support.

The negative coefficient on the dependency ratio suggests that, although there is a potentially greater demand for educational services and recreational facilities due to a larger dependent population, other economic and political factors may limit the ability of municipalities to meet this demand in a proportionate manner. The complex interaction between these factors is crucial to understanding why the dependency ratio does not necessarily result in higher spending on schools and childcare centres in all municipal contexts.

The yardstick effect observed for total capital expenditure is lost when we analyse specific components of this expenditure. This indicates that, in the context of electoral competition, the overall magnitude of acquisition of capital goods is of greater relevance than its specific composition. It suggests that politicians and voters seem to prioritise the total amount of capital spending as a benchmark for assessing the effectiveness and commitment of local governments. The emphasis on total capital expenditure implies that broad investment figures are more influential in shaping public perception and electoral outcomes than the detailed allocation of funds across various infrastructure projects.

6. Conclusion

Strategic interaction in public policies occurs when political decision-makers react to actions in nearby jurisdictions, adopting behaviours that may be similar or deliberately different in order to enhance their attractiveness. This behaviour is grounded in three main theories: spillover effects, tax competition and yardstick competition.

In the specific case of Portugal, empirical studies on strategic interaction are notoriously scarce. The present study addresses this gap by assessing the existence of strategic interactions in expenditure and its disaggregation between the 278 municipalities of mainland Portugal throughout the period from 2003 to 2022. When strategic interaction is identified, the study also aims to determine which the three theories best explain these behaviours.

Preliminary spatial analysis, using the Moran I statistic, indicated the presence of significant neighbourhood effects for total expenditure. In order to test whether these neighbourhood effects could be attributed to strategic interactions between Portuguese municipalities, we estimated different spatial panel data models. Specifically, we included indicators of the state of public finances (expressed by the lagged value of municipal expenditure *per capita*), demographic data (including population density and the total dependency ratio) and features of the economic environment (represented by purchasing power *per capita*). To comprehensively explore the dynamics of yardstick competition, we also incorporated a diverse set of political variables into our models. Based on a model selection analysis, the SDM model appears to be the better fit to our data.

The outcome of the estimations revealed positive and statistically significant spatial dependency parameters, providing empirical evidence of strategic interactions in which the actions of neighbouring local governments increase the spending of municipalities. The mechanism of spillover effects stood out as the most prominent in the spending decisions of Portuguese municipalities.

Both total and current expenditure are also strongly influenced by demographic and economic factors. These types of expenditure are best explained by the spillover effects theory, which emphasises shared regional benefits. In contrast, capital expenditure, which represents approximately 30% of total expenditure, showed significant differences from total and current expenditure. This type of expenditure confirms the continuity of investment projects and the importance of grants received from the central government. Here, in

addition to the spillover effects, we also observed elements of yardstick competition with some political variables proving to be statistically significant.

On the surface, the theory of spillover effects is particularly suited to comprehend both personnel expenditures and the acquisition of goods and services. Personnel expenses, characterised by limited visibility and long-term commitments, are largely determined by local needs and internal economic capacities rather than external competitive pressures. Similarly, the acquisition of goods and services is appropriately analysed through the lens of spillover effects, given the regional impacts these decisions often involve.

When we further disaggregate the expenditure item of investments in capital goods, curiously, we find no evidence of strategic interaction in social protection investment expenditure, especially in homes for the elderly. In contrast, strategic interaction between municipalities in areas such as sports infrastructure, parks and road infrastructure are driven by both spillover effects and tax competition. Municipalities seek to attract residents and businesses by offering better living conditions. Socio-economic and political factors have a significant influence on these investment decisions. In the education sector, we observed that intense electoral competition drives investments in nurseries and schools, as politicians seek to demonstrate effective commitment to improving education. In analysing the detailed components of investments in capital goods, yardstick competition centres on the overall amount of resources invested, rather than focusing on the specific details of where exactly these resources are being applied.

These findings have important policy implications to consider. For instance, central administration should take into account spatial spillover effects when promoting specific expenditures through conditional grants. For example, it may be prudent to increase grants for investments expenses related to sports, recreation and education when there are positive spillover effects. If neighbouring municipalities already possess these infrastructures and the municipality can benefit from them, then it should receive fewer grants for this purpose. This approach aims to better align economic incentives with regional policy impacts. Furthermore, a stable political environment tends to foster investment expenditures while reducing current expenditures, particularly personnel expenses. This emphasises the fundamental role of political stability in the effective management of public resources and the implementation of policies centred on austerity or strategic investment.

This study, although very broad, has some limitations that should be taken into account. The main limitation lies in the specification of the models and the choice of explanatory variables. The inclusion of additional variables could provide a more detailed view of the dynamics involved, namely to explain the strong spatial correlation found in error terms. For future research, we also suggest exploring alternative criteria for constructing the spatial weights matrix, such as incorporating physical distance, or demographic and political data. This approach could provide new perspectives into interactions between municipalities. By addressing these limitations and exploring these suggestions, future research could deepen the understanding of strategic interactions and their implications for public policymaking in Portugal.

References

- Allers, M. A., & Elhorst, J. P. (2005). Tax Mimicking and Yardstick Competition Among Local Governments in the Netherlands. *International Tax and Public Finance*, 12(4), 493-513. <https://doi.org/10.1007/s10797-005-1500-x>
- Anselin, L., Gallo, J. L., & Jayet, H. (2008). Spatial Panel Econometrics. In L. Mátyás & P. Sevestre (Eds.), *The Econometrics of Panel Data: Fundamentals and Recent Developments in Theory and Practice* (pp. 625-660). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-540-75892-1_19
- Baicker, K. (2005). The spillover effects of state spending. *Journal of Public Economics*, 89(2), 529-544. <https://doi.org/10.1016/j.jpubeco.2003.11.003>
- Barreira, A. P. (2011a). Spatial strategic interaction of Portuguese local government expenditures as a factor for regional development: The case of Algarve municipalities. In R. N. Baleiras (Ed.), *Casos de Desenvolvimento Regional* (pp. 615-625). Principia. <https://sapientia.ualg.pt/handle/10400.1/3895?locale=en>
- Barreira, A. P. (2011b). Spatial strategic interaction on public expenditures of the northern Portuguese local governments. *Spatial and Organizational Dynamics Discussion Papers*, 2, 23-38.
- Baskaran, T. (2014). Identifying local tax mimicking with administrative borders and a policy reform. *Journal of Public Economics*, 118, 41-51. <https://doi.org/10.1016/j.jpubeco.2014.06.011>
- Belotti, F., Hughes, G., & Mortari, A. P. (2017). Spatial panel-data models using Stata. *The Stata Journal*, 17(1), 139-180.
- Besley, T., & Case, A. (1995). Incumbent Behavior: Vote-Seeking, Tax-Setting, and Yardstick Competition. *The American Economic Review*, 85(1), 25-45. <http://www.jstor.org/stable/2117994>
- Borck, R., Caliendo, M., & Steiner, V. (2007). Fiscal Competition and the Composition of Public Spending: Theory and Evidence. *FinanzArchiv / Public Finance Analysis*, 63(2), 264-277. <http://www.jstor.org/stable/40913149>

- Bordignon, M., Cerniglia, F., & Revelli, F. (2003). In search of yardstick competition: a spatial analysis of Italian municipality property tax setting. *Journal of Urban Economics*, 54(2), 199-217. [https://doi.org/10.1016/S0094-1190\(03\)00062-7](https://doi.org/10.1016/S0094-1190(03)00062-7)
- Brueckner, J. K. (2003). Strategic Interaction Among Governments: An Overview of Empirical Studies. *International Regional Science Review*, 26(2), 175-188. <https://doi.org/10.1177/0160017602250974>
- Brueckner, J. K., & Saavedra, L. A. (2001). Do Local Governments Engage in Strategic Property—Tax Competition? *National Tax Journal*, 54(2), 203-229. <https://doi.org/10.17310/ntj.2001.2.02>
- Case, A. C., Rosen, H. S., & Hines, J. R. (1993). Budget spillovers and fiscal policy interdependence: Evidence from the states. *Journal of Public Economics*, 52(3), 285-307. [https://doi.org/10.1016/0047-2727\(93\)90036-S](https://doi.org/10.1016/0047-2727(93)90036-S)
- Castro, V., & Martins, R. (2013). Running for office again: evidence from Portuguese municipal elections. *Public Choice*, 156, 677-702.
- Coimbra, M. L., Costa, J. S., & Carvalho, A. (2011). A concorrência fiscal entre os municípios portugueses. *Revista Portuguesa de Estudos Regionais*, (28), 27-38. <https://doi.org/10.59072/rper.vi28.331>
- Costa, H., Veiga, L. G., & Portela, M. (2015). Interactions in Local Governments' Spending Decisions: Evidence from Portugal. *Regional Studies*, 49(9), 1441-1456. <https://doi.org/10.1080/00343404.2013.835798>
- Costa, J., & Carvalho, A. (2013). Yardstick Competition among Portuguese Municipalities: The Case of Urban Property Tax (IMI). Place-Based Policies and Economic Recovery (pp. 99-111). Universidade do Minho, Braga.
- Elhorst, J. P. (2009). Spatial panel data models. In M. Fischer, and A. Getis (Ed.), *Handbook of Applied Spatial Analysis*. Berlin/Heidelberg/New York: Springer.
- Elhorst, J. P. (2010). Applied Spatial Econometrics: Raising the Bar. *Spatial Economic Analysis*, 5(1), 9-28. <https://doi.org/10.1080/17421770903541772>
- Elhorst, J. P. (2014). *Spatial econometrics: from cross-sectional data to spatial panels* (1 ed.). Springer Berlin, Heidelberg. <https://doi.org/10.1007/978-3-642-40340-8>

- Ermini, B., & Santolini, R. (2010). Local expenditure interaction in Italian municipalities: Do local council partnerships make a difference? *Local Government Studies*, 36(5), 655-677.
- Geys, B. (2006). Looking across borders: A test of spatial policy interdependence using local government efficiency ratings. *Journal of Urban Economics*, 60(3), 443-462. <https://doi.org/10.1016/j.jue.2006.04.002>
- Greene, W. H. (2005). *Econometric Analysis* (6 ed.). Pearson Prentice Hall.
- Heyndels, B., & Vuchelen, J. (1998). Tax Mimicking among Belgian Municipalities. *National Tax Journal*, 51(1), 89-101. <https://doi.org/10.1086/ntj41789314>
- Jorge, S. M., Camões, P. J., Carvalho, J. B. C., & Fernandes, M. J. (2006). *Portuguese local government relative efficiency: A DEA approach*. 8th CIGAR Workshop on Performance Measurement and Output Based Budgeting in the Public Sector. Hamburg, Germany. <https://hdl.handle.net/1822/8229>
- Budgeting in the Public Sector. Hamburg, Germany. <https://hdl.handle.net/1822/8229>
- LeSage, J., & Pace, R. K. (2009). *Introduction to spatial econometrics* (1 ed.). Chapman and Hall/CRC. <https://doi.org/10.1201/9781420064254>
- LeSage, J. P. (1999). The theory and practice of spatial econometrics. *University of Toledo. Toledo, Ohio*, 28(11), 1-39.
- Martins, R., & Veiga, F. J. (2013). Economic voting in Portuguese municipal elections. *Public Choice*, 155(3), 317-334.
- Pinho, M. M., & Ribeiro, A. P. (2023). Tax mimicking among Portuguese Local Governments: The case of the Personal Income Tax. In A. Teixeira, Delgado, A.P., Carvalho, L., Mota, M.I. & Castro e Silva, M.M. (Ed.), *Estudos de Homenagem a José da Silva Costa* (pp. 234-247). Faculdade de Economia da U.Porto (FEP), U.Porto Press, 2023.
- Pinho, M. M., & Veiga, L. G. (2005). The determinants of intergovernmental grants in Portugal: A public choice approach. *Congress of the European Regional Science Association*, Porto, 2004. <https://hdl.handle.net/1822/2276>
- Revelli, F. (2002). Testing the tax mimicking versus expenditure spill-over hypotheses using English data. *Applied Economics*, 34(14), 1723-1731. <https://doi.org/10.1080/00036840210122353>

- Revelli, F. (2003). Reaction or interaction? Spatial process identification in multi-tiered government structures. *Journal of Urban Economics*, 53(1), 29-53. [https://doi.org/10.1016/S0094-1190\(02\)00512-0](https://doi.org/10.1016/S0094-1190(02)00512-0)
- Revelli, F. (2005). On spatial public finance empirics. *International Tax and Public Finance*, 12, 475-492. <https://doi.org/10.1007/s10797-005-4199-9>
- Saavedra, L. A. (2000). A Model of Welfare Competition with Evidence from AFDC. *Journal of Urban Economics*, 47(2), 248-279. <https://doi.org/10.1006/juec.1999.2141>
- Salmon, P. (1987). Decentralisation as an incentive scheme. *Oxford review of economic policy*, 3(2), 24-43.
- Schaltegger, C. A., & Küttel, D. (2002). Exit, Voice, and Mimicking Behavior: Evidence from Swiss Cantons. *Public Choice*, 113(1), 1-23. <https://doi.org/10.1023/A:1020377207035>
- Shleifer, A. (1985). A Theory of Yardstick Competition. *The RAND Journal of Economics*, 16(3), 319-327. <http://www.jstor.org/stable/2555560>
- Silva, H., Veiga, L. G., & Portela, M. (2011). Strategic interaction in local fiscal policy: evidence from Portuguese Municipalities. Núcleo de Investigação em Políticas Económicas (NIPE) Working Papers 23/2011, NIPE - Universidade do Minho.
- Soro, W. L., Zhou, Y., & Wayoro, D. (2017). Crash rates analysis in China using a spatial panel model. *IATSS Research*, 41(3), 123-128. <https://doi.org/10.1016/j.iatssr.2016.11.001>
- Šťastná, L. (2009). Spatial interdependence of local public expenditures: Selected evidence from the Czech Republic. *Czech Economic Review*, 3(01), 7-25.
- Tiebout, C. M. (1956). A Pure Theory of Local Expenditures. *Journal of Political Economy*, 64(5), 416-424. <http://www.jstor.org/stable/1826343>
- Veiga, L. G., & Pinho, M. M. (2007). The political economy of intergovernmental grants: Evidence from a maturing democracy. *Public Choice*, 133(3), 457-477.
- Veiga, L. G., & Veiga, F. J. (2007). Political Business Cycles at the Municipal Level. *Public Choice*, 131(1/2), 45-64. <https://doi.org/10.1007/s11127-006-9104-2>

- Wilson, J. D. (1986). A theory of interregional tax competition. *Journal of Urban Economics*, 19(3), 296-315. [https://doi.org/10.1016/0094-1190\(86\)90045-8](https://doi.org/10.1016/0094-1190(86)90045-8)
- Yu, J., Jong, R., & Lee, L.-F. (2008). Quasi-maximum likelihood estimators for spatial dynamic panel data with fixed effects when both n and T are large. *Journal of Econometrics*, 146, 118-134. <https://doi.org/10.1016/j.jeconom.2008.08.002>
- Zodrow, G. R., & Mieszkowski, P. (1986). Pigou, Tiebout, property taxation, and the underprovision of local public goods. *Journal of Urban Economics*, 19(3), 356-370. [https://doi.org/10.1016/0094-1190\(86\)90048-3](https://doi.org/10.1016/0094-1190(86)90048-3)

Annexes

Annex 1 – Description of the expenditure categories

Variable	Description
cod_01	Personnel Expenses
cod_02	Acquisition of Goods and Services
cod_03	Interest and Other Charges
cod_04	Current Transfers
cod_05	Subsidies
cod_06	Other Current Expenses
cod_07	Acquisition of Capital Goods
cod_07_01_01	Investment: Lands
cod_07_01_02	Investment: Housing
cod_07_01_03_01	Investment: Buildings - Facilities and Services
cod_07_01_03_02	Investment: Buildings - Sports and Recreation Facilities
cod_07_01_03_03	Investment: Markets and Sanitary Inspection Facilities
cod_07_01_03_04	Investment: Nurseries
cod_07_01_03_05	Investment: Schools
cod_07_01_03_06	Investment: Nursing Homes
cod_07_01_03_07	Investment: Others
cod_07_01_03	Investment: Buildings
cod_07_01_04_01	Investment: Viaducts, Roads, and Complementary Works
cod_07_01_04_02	Investment: Drainage Systems
cod_07_01_04_03	Investment: Wastewater Treatment Stations
cod_07_01_04_04	Investment: Public Lighting
cod_07_01_04_05	Investment: Parks and Gardens
cod_07_01_04_06	Investment: Sports and Recreation Facilities
cod_07_01_04_07	Investment: Water Catchment and Distribution
cod_07_01_04_08	Investment: Rural Roads
cod_07_01_04_09	Investment: Signalling and Traffic
cod_07_01_04_10	Investment: Electric Power Distribution Infrastructure
cod_07_01_04_11	Investment: Solid Waste Treatment Infrastructure
cod_07_01_04_12	Investment: Cemeteries
cod_07_01_04_13	Investment: Others
cod_07_01_04	Investment: Various Constructions
cod_07_01_05	Investment: Land Improvements
cod_07_01_06	Investment: Transportation Equipment
cod_07_01_07	Investment: Computer Equipment
cod_07_01_08	Investment: Software
cod_07_01_09	Investment: Administrative Equipment
cod_07_01_10	Investment: Basic Equipment

Variable	Description
cod_07_01_11	Investment: Tools and Utensils
cod_07_01_12	Investment: Valuable Articles and Objects
cod_07_01_13	Investment: Intangible Investments
cod_07_01_14	Investment: Military Investments
cod_07_01_15	Investment: Other Investments
cod_07_01	Investment
cod_07_02	Financial Leasing
cod_07_03	Public Domain Goods
cod_08	Capital Transfers
cod_11	Other Capital Expenditure

Annex 2 – Descriptive statics of the expenditure categories

Variable	Obs	Mean	Std. dev.	Min	Max
cod 01pc	5,282	335.680	196.841	40.469	1,683.135
cod 02pc	5,282	278.233	156.857	10.762	1,367.564
cod 03pc	5,282	14.515	22.915	0.000	321.916
cod 04pc	5,282	72.764	59.334	0.000	835.843
cod 05pc	5,282	8.673	20.571	0.000	456.362
cod 06pc	5,282	12.994	15.993	0.000	239.212
cod 07pc	5,282	277.223	208.770	0.000	3,033.550
cod 07 01 01pc	5,282	7.313	13.870	0.000	257.009
cod 07 01 02pc	5,282	7.235	22.555	0.000	522.644
cod 07 01 03 01pc	5,282	12.580	27.933	0.000	599.362
cod 07 01 03 02pc	5,282	9.644	26.381	0.000	504.300
cod 07 01 03 03pc	5,282	2.071	10.110	0.000	227.303
cod 07 01 03 04pc	5,282	0.690	4.476	0.000	103.511
cod 07 01 03 05pc	5,282	22.454	48.193	0.000	852.880
cod 07 01 03 06pc	5,282	0.819	8.543	0.000	235.001
cod 07 01 03 07pc	5,282	17.089	38.242	0.000	557.687
cod 07 01 03pc	5,282	65.351	77.503	0.000	1,004.451
cod 07 01 04 01pc	5,282	30.909	53.767	0.000	717.405
cod 07 01 04 02pc	5,282	7.250	20.348	0.000	489.191
cod 07 01 04 03pc	5,282	2.201	12.313	0.000	238.882
cod 07 01 04 04pc	5,282	2.450	8.042	0.000	113.211
cod 07 01 04 05pc	5,282	5.138	14.390	0.000	223.023
cod 07 01 04 06pc	5,282	11.937	35.152	0.000	886.191
cod 07 01 04 07pc	5,282	6.417	20.568	0.000	625.335
cod 07 01 04 08pc	5,282	17.877	45.562	0.000	823.219
cod 07 01 04 09pc	5,282	1.397	5.514	0.000	288.528
cod 07 01 04 10pc	5,282	0.708	3.356	0.000	62.598
cod 07 01 04 11pc	5,282	0.178	1.882	0.000	74.606
cod 07 01 04 12pc	5,282	0.948	3.659	0.000	78.851
cod 07 01 04 13pc	5,282	18.587	45.067	0.000	743.531
cod 07 01 04pc	5,282	105.998	134.497	0.000	1,517.950
cod 07 01 05pc	5,282	0.369	5.649	0.000	259.935
cod 07 01 06pc	5,282	6.249	10.762	0.000	151.402
cod 07 01 07pc	5,282	3.938	5.843	0.000	141.012
cod 07 01 08pc	5,282	2.891	4.272	0.000	78.871
cod 07 01 09pc	5,282	2.152	4.681	0.000	149.862
cod 07 01 10pc	5,282	12.033	14.742	0.000	213.843
cod 07 01 11pc	5,282	0.585	1.721	0.000	65.681
cod 07 01 12pc	5,282	0.328	1.872	0.000	87.622
cod 07 01 13pc	5,282	1.294	4.998	0.000	151.838
cod 07 01 14pc	5,282	0.000	0.002	0.000	0.129
cod 07 01 15pc	5,282	6.855	19.363	0.000	414.904
cod 07 01pc	5,282	222.592	190.937	0.000	1,693.872
cod 07 02pc	5,282	2.334	5.092	0.000	67.894
cod 07 03pc	5,282	52.297	94.440	0.000	1,811.961
cod 08pc	5,282	34.819	38.526	0.000	1,344.210
cod 11pc	5,282	2.703	12.339	0.000	235.349

Annex 3 – Correlation matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) Exp_pc	1.0									
(2) Grant_pc	0.9	1.0								
(3) Pop	-0.4	-0.5	1.0							
(4) PopD	-0.2	-0.3	0.7	1.0						
(5) Dr	0.7	0.8	-0.4	-0.3	1.0					
(6) PPpc	-0.3	-0.5	0.7	0.6	-0.4	1.0				
(7) dvRight	-0.0	-0.0	-0.0	-0.0	0.0	-0.1	1.0			
(8) dvAbMaj	0.1	0.1	-0.2	-0.1	0.1	-0.2	0.1	1.0		
(9) dvClRace	0.0	0.0	-0.0	0.0	-0.0	-0.0	-0.0	-0.3	1.0	
(10) dvTLimit	0.0	0.0	-0.0	-0.0	0.0	0.0	0.0	0.1	-0.1	1.0

Annex 4 – Moran I test

Moran's I (varname: Exp_pc)

Number of obs = 5560

Group variable: _ID

Number of groups = 278

Time variable: year

Panel length = 20

year	I	E(I)	Sd(I)	Z	p-value
2003	0.4356	-0.0036	0.0378	11.6273	0.0000
2004	0.4758	-0.0036	0.0378	12.6896	0.0000
2005	0.5050	-0.0036	0.0378	13.4609	0.0000
2006	0.5528	-0.0036	0.0378	14.7101	0.0000
2007	0.4778	-0.0036	0.0377	12.7555	0.0000
2008	0.5095	-0.0036	0.0377	13.6154	0.0000
2009	0.4453	-0.0036	0.0377	11.9229	0.0000
2010	0.3058	-0.0036	0.0373	8.3041	0.0000
2011	0.4598	-0.0036	0.0378	12.2611	0.0000
2012	0.4851	-0.0036	0.0378	12.9435	0.0000
2013	0.4468	-0.0036	0.0377	11.9589	0.0000
2014	0.4416	-0.0036	0.0374	11.8978	0.0000
2015	0.4592	-0.0036	0.0378	12.2545	0.0000
2016	0.5145	-0.0036	0.0378	13.7036	0.0000
2017	0.4869	-0.0036	0.0378	12.9764	0.0000
2018	0.4660	-0.0036	0.0378	12.4399	0.0000
2019	0.4537	-0.0036	0.0377	12.1135	0.0000
2020	0.4719	-0.0036	0.0377	12.6049	0.0000
2021	0.4791	-0.0036	0.0377	12.7979	0.0000
2022	0.5078	-0.0036	0.0378	13.5380	0.0000

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