University of Minho
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Local Taxation Dynamics: The Case of Personal Income Tax in Portuguese Municipalities

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Master's Dissertation
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Work done under the supervision of
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Statement of Integrity

I hereby declare having conducted this academic work with integrity.

I confirm that I have not used plagiarism or any form of undue use of information or falsification of results along the process leading to its elaboration.

I further declare that I have fully acknowledged the Code of Ethical Conduct of the University of Minho.

University of Minho, Braga, April 2024

A Dinâmica da Tributação Local: O Caso do Imposto sobre o Rendimento das Pessoas Singulares nos Municípios Portugueses

Resumo

Com a descentralização fiscal no cerne da agenda política atual, em Portugal, torna-se crucial compreender os fatores que influenciam os níveis de impostos municipais, podendo ajudar os decisores políticos a conceber um melhor quadro institucional. Desta forma, a presente dissertação tem como principal objetivo ajudar a preencher a lacuna existente na literatura empírica no que respeita ao estudo da interação fiscal estratégica entre os municípios portugueses, nomeadamente ao nível da Taxa de Participação Variável no Imposto sobre o Rendimento das Pessoas Singulares.

A análise empírica foi feita utilizando dados de painel para o período entre 2009 e 2020, para todos os 278 municípios de Portugal Continental. Utilizando o estimador System-GMM, estimou-se um modelo empírico em que a Taxa de Participação Variável no Imposto sobre o Rendimento das Pessoas Singulares de um determinado município depende de uma média ponderada das Taxas de Participação Variável no Imposto sobre o Rendimento das Pessoas Singulares dos municípios vizinhos e de um conjunto de variáveis de controlo, incluindo o valor desfasado da Taxa de Participação Variável no Imposto sobre o Rendimento das Pessoas Singulares. Adicionalmente, de forma a testar a robustez dos resultados foram utilizadas diferentes matrizes de ponderação espacial.

Os resultados empíricos permitem concluir que as decisões fiscais das autarquias não são isoladas, sendo afetadas por variáveis socioeconómicas, bem como influenciadas pelas decisões fiscais dos municípios vizinhos. Nomeadamente, um aumento de 1 ponto percentual na Taxa de Participação Variável no Imposto sobre o Rendimento das Pessoas Singulares dos municípios vizinhos dá origem a um aumento de, em média, 0,29 pontos percentuais da Taxa de Participação Variável no Imposto sobre o Rendimento das Pessoas Singulares de um determinado município. Para além disso, a robustez dos resultados confirmou-se uma vez que os resultados não parecem ser dependentes da escolha de matriz de ponderação espacial, sendo muito semelhantes para as quatro matrizes de distância geográfica utilizadas. Foi ainda possível concluir que as autarquias portuguesas reagem à definição da Taxa de Participação Variável no Imposto sobre o Rendimento das Pessoas Singulares dos municípios vizinhos devido a efeitos de derramamento (spillovers).

Palavras-Chave: Econometria espacial, Impostos Locais, Interação Fiscal, Municípios Portugueses

Local Taxation Dynamics: The Case of Personal Income Tax in Portuguese Municipalities

Abstract

Decentralization is at the forefront of the current Portuguese political agenda. Understanding the factors that influence the level of municipal taxes is crucial, as it can help decision makers in shaping a better institutional framework. Thus, the main objective of this dissertation is to help fill the gap in the empirical literature regarding strategic fiscal interactions among Portuguese municipalities, namely in terms of the Variable Participation Rate in Personal Income Tax (VPIT).

The empirical analysis used panel data for the period between 2009 and 2020 for all 278 municipalities in mainland Portugal. Using the System-GMM estimator, an empirical model was estimated where the Variable Participation Rate in the Personal Income Tax of a given municipality depends on the average of the Variable Participation Rates in the Personal Income Tax of its neighbouring municipalities and a set of control variables, including the lagged value of the VPIT. Different spatial weighting matrices were used to evaluate the robustness of the results.

The empirical results allow us to conclude that municipal tax decisions are interrelated. They are affected by socioeconomic factors and significantly influenced by the tax decisions of neighbouring municipalities. Specifically, a one percent increase in the Variable Participation Rate in the Personal Income Tax of neighbouring municipalities leads to an increase of, on average, 0.29 percentage points in the Variable Participation Rate in the Personal Income Tax of the municipality in question. The results are robust to the choice of spatial weighting matrix, specifically to the four geographical distance matrices used. The results also suggest that Portuguese municipalities react to the definition of the Variable Participation Rate in the Personal Income Tax of neighbouring municipalities due to spillover effects.

Keywords: Local Taxes, Portuguese Municipalities, Spatial Econometrics, Spatial Interaction

CONTENTS

Acronyms

CNE - National Elections Commission (Comissão Nacional de Eleições)

DGAL - Directorate-General for Local Authorities (Direção-Geral das Autarquias Locais)

EU - European Union

FE - Fixed Effects

IRC - Corporate Income Tax (Imposto sobre o Rendimento de Pessoas Coletivas)

GMM - Generalised Method of Moments

IEFP - Institute of Employment and Vocational Training (Instituto do Emprego e Formação Profissional)

IMI - Municipal Property Tax (Imposto Municipal sobre Imóveis)

IMT - Municipal Tax on Transactions (Imposto Municipal sobre Transmissões Onerosas de Imóveis)

INE - Statistics Portugal (Instituto Nacional de Estatística)

IUC - Single Circulation Tax (Imposto Único de Circulação)

IV - Instrumental Variables

ML – Maximum Likelihood Methods

OLS - Ordinary Least Square

PIT – Personal Income Tax

RE - Random Effects

SI - Marketest Sales Index

VPIT - Variable Participation Rate in Personal Income Tax

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1. Introduction

In recent decades, there has been a power decentralisation from central governments to local governments. In Portugal, successive tax reforms have accentuated the administrative decentralisation process in terms of the amount of revenue allocated to local authorities and the extent of the powers granted to them to manage and act in their local areas. Although Portugal is still a fairly centralised country, in recent decades, Portuguese municipalities have been playing an increasingly significant role in providing public goods and increasing the population's well-being. Municipalities depend mainly on transfers from the central government and their own tax revenues to provide for these goods.

The effective establishment of the decentralization process depends on the local governments' financial autonomy (Carbonnier, 2013). However, a greater degree of autonomy resulting from the decentralization process leads to a horizontal competition between municipalities, particularly regarding the taxes and services they offer (Salmon, 2006). Horizontal strategic interaction among local governments is predicated on the notion that jurisdictions do not act in isolation, *i.e.* they can be significantly influenced by neighbouring jurisdictions and can react to the policies adopted by the latter. In simple terms, strategic interaction happens when changes in tax rates or spending levels by local governments are linked, which is justified by strategic considerations. Therefore, political choices are interdependent, and the resulting interaction must be considered when characterizing the balance of the public sector (Brueckner, 1998).

The strategy of fiscal interaction between neighbouring municipalities is based on the theory of the agency problem, which states that political agents are better informed than voters, which is advantageous for political decision-makers to achieve their goals (Bastida *et al.,* 2019). Thus, electoral competition is an effective solution to the agency problem between policymakers and voters because, in the presence of asymmetric information about the cost of providing local public services and the need to increase local taxes, voters can use the performance of neighbouring municipalities as a standard to evaluate their own municipality. In this performance comparison scenario, political decision-makers tend to be concerned about their own performance and how it compares to neighbouring political decision-makers.

The theory explaining the existence of strategic interactions between local governments is essentially based on three models: the expenditure spillover model, the model of tax competition and the yardstick competition model. According to the traditional "spillover" model, a municipality's public expenditure has positive or negative effects beyond its borders, impacting neighbouring jurisdictions, more specifically on the well-being of the population of neighbouring municipalities. Thus, since municipal

spending tends to be correlated between neighbouring jurisdictions, the same should apply to tax rates (Bastida *et al.*, 2019). On the other hand, the tax competition theory assumes the existence of tax-based mobility - citizens will move to neighbouring municipalities if their municipality's taxes are too high. Thus, tax competition between municipalities stems from their competition for the mobile tax base (Ferraresi *et al.*, 2018). Finally, the yardstick competition model is based on the asymmetry of information regarding the costs of public goods and services between voters and political decision-makers. Thus, by having access to incomplete information, voters evaluate the choices of their own local government by comparing it with the fiscal choices of neighbouring governments, whereby the fiscal policies of their neighbours become crucial for the performance evaluation by the voters, leading jurisdictions to imitate each other (Bocci *et al.*, 2019).

In recent years, there has been a growing interest in fiscal interactions between local governments. The abundance of new data available at the local level, the possibility of using new spatial econometric techniques suitable for testing the spatial interaction between local politicians when they set local tax rates and a growing interest in fiscal policy at the local level have led to the publication of a significant number of empirical articles on the strategic interaction between local governments in the setting of local tax rates (Costa and Carvalho, 2013). However, how Portuguese municipalities set their taxes and, in particular, the strategic interaction between them is a very recent research topic in Portugal, and there are very few studies on how the interaction between municipalities can influence the determination of municipal taxes. Furthermore, it is interesting to study the case of Portugal since all municipalities are subject to the same rules and legislation, they all have the same political instruments and resources at their disposal, and local politicians have moderate discretionary power over them (Costa and Carvalho, 2013; Costa *et al.*, 2015). It is worth noting that in mainland Portugal, there is only one level of local government. This means that the extent of fiscal interaction between municipalities cannot be attributed to political externalities between distinct levels of authorities, as might occur in countries with a multi-level government structure (Costa *et al.*, 2015).

Given the focus on fiscal decentralization in current political discussions in Portugal, understanding which factors influence the level of municipal taxes gains higher importance and can help decision makers design a better institutional framework. Thus, this dissertation will help fill the gap in the empirical literature regarding the study of fiscal interaction between Portuguese municipalities, namely at the level of the definition of the Variable Participation Rate in Personal Income Tax (VPIT). Thus, the main objective is to assess the existence and size of strategic fiscal interactions between Portuguese municipalities in relation to the Variable Participation Rate in Personal Income Tax, taking advantage of variability over time

and using panel data for the period between 2009 and 2020 for all 278 municipalities in mainland Portugal. By using the System-GMM estimator, an empirical model was estimated in which the Variable Participation Rate in the Personal Income Tax of a given municipality depends on the average of the Variable Participation Rates in the Personal Income Tax of neighbouring municipalities and a set of control variables, including the lagged value of the Variable Participation Rate in Personal Income Tax. In addition, different spatial weighting matrices were used to evaluate the robustness of the results.

The empirical results allow us to conclude that the tax decisions of municipalities are not isolated, as they are both affected by socioeconomic variables and significantly influenced by the tax decisions of neighbouring municipalities. In particular, a one percentage point increase in the Variable Participation Rate in Personal Income Tax of neighbouring municipalities leads to an increase of, on average, 0,29 percentage points in the Variable Participation Rate in Personal Income Tax of a given municipality. The results do not seem to be dependent on the choice of spatial weighting matrix, as they are remarkably similar in the four distance-based geographical matrices used. Finally, the evidence suggests yardstick competition does not explain the observed strategic interaction, however spillovers might.

This dissertation is organized as follows: section 2 presents a brief review of the theoretical literature on the decentralization process and fiscal strategic interaction between local governments; section 3 describes the institutional context of Portugal, namely the various decentralization reforms of recent years and the fiscal framework of Portuguese municipalities; section 4 presents the empirical framework of the dissertation and the econometric procedures; section 5 presents the data to be used and its sources, as well as the empirical methodology to be used and the derivation of the models; section 6 presents the results obtained; and section 7 presents the main conclusions, highlighting the main results and possible explanations for them, as well as reinforcing the need for future research in this area of study.

2. Theoretical Framework

Decentralization is an important process for the democratic development of a country.[1] Decentralization stands out as a significant form of political reform and institutional restructuring in modern times. Its impact is widespread, affecting numerous countries, and it has profound implications on governance, influencing its nature and quality (Faguet, 2014; Oates, 1972). The decentralization trend spans throughout all regions of the world and includes nations both rich and poor, large, and small, and with very different histories, thus overcoming geographic and ideological barriers (Faguet, 2014; Teles, 2021). During the last few decades, numerous countries around the world, with both developed and developing economies, have undergone a fiscal, political, and administrative decentralization (Martinez-Vazquez *et al.*, 2017; Veiga *et al.*, 2015)

The decentralization process can be defined as "*the transfer of authority to plan, make decisions, as well as manage public functions from a higher level of government to any individual, organization or agency at a lower level*" (Rondinelli, 1981). Therefore, decentralization can be defined as the process of transferring responsibility, authority, powers, and resources from the Central Government to regional and local governments (Böckenförde, 2011; Faguet and Sánchez, 2014; Martinez-Vazquez *et al.*, 2017; Schneider, 2003). Decentralization can take multiple forms, being a complex concept involving political, fiscal, and administrative dimensions (Veiga *et al.*, 2015). A decentralized system is one in which the Central Government plays a minor role in any or all of these dimensions. From this perspective, the Central Government has a smaller percentage of fiscal resources, grants greater administrative autonomy, and cedes a greater degree of responsibility for political functions (Schneider, 2003).

In order to understand the process and the different types of decentralization, Teles (2021) starts from a hypothetical situation in which there is a totally centralized regime, with a single government, with the entire national territory as its jurisdiction, with all policies decided directly by the central government. An additional step towards the decentralization of decision-making can be taken with the creation of institutional units with legal personality and a higher degree of autonomy, appointing local representatives and delegating certain administrative and financial powers in the respective territory, in what can be designated as territorial administrative decentralization (Teles, 2021). Thus, administrative

[1] For surveys on Decentralization see Oates (1999), Ahmad and Brosio (2006) and Veiga and Kurian (2015).

decentralization can be described as the degree of autonomy in the management of government affairs that local governments have in relation to the central government (Böckenförde, 2011; Schneider, 2003). In this type of decentralization, political power resides exclusively with the central government, and local representatives are agents of the central power – being appointed and dismissed by the central government – implying that local governments do not have the right to annul, adapt or condition the guidelines of the central government, whereby the preferences of the government supersede those of the local agent[2] (Teles, 2021).

Political decentralization, on the other hand, is based on the sharing of democratically legitimized political power between the central government and the regional and local governments and takes the form of transferring increased attributions and competences to these entities. Political decentralization measures the degree to which the central government allows regional and local governments to assume the political functions of governance (Böckenfoerde, 2011; Schneider, 2003). Holders of national, regional, and local political offices are agents of the preferences of the citizens of their respective jurisdictions, both having the same democratic legitimacy. Thus, political decentralization will be greater the greater the competences and resources of the subnational levels of government.

Finally, it is also important to consider what is usually called fiscal decentralization. As a rule, the literature refers to two types of fiscal decentralization: that which concerns autonomy in the fiscal definition of fees and taxes and in their use for public expenditure at the local level; and that concerning the ex-post division of tax revenues between the different levels of jurisdiction (Teles, 2021). In the first case of fiscal decentralization, a State would be more decentralized the more autonomy local governments had in determining their own taxation. On the other hand, in the second case, the degree of decentralization would result from the greater percentage of participation in total tax revenues. Fiscal autonomy, or tax power, captures the extent of freedom that local governments exercise over fiscal policy, such as the right to introduce or abolish a tax, to set tax rates, to define the tax base, or to grant deductions or tax breaks for individuals and businesses (Blöchliger and Nettley, 2015). Fiscal decentralization thus refers to a public sector structure in which responsibilities for expenditure, revenue and fiscal policy are not monopolized by the central government, but rather decentralized at lower levels of government (Oates, 1972). Thus, a local government capable of defining its own tax bases, tax rates and other features of a tax has a high degree of fiscal autonomy or taxing power.

[2] As a rule, the "preferences" of local agents tend to reflect the preferences of the citizens of a given jurisdiction.

The decentralization process is, therefore, the result of a mix of political, administrative, and fiscal measures, and the trajectory and results of decentralization depend on the different options taken in each of these alternatives, on contextual factors that involve demographic characteristics, social, economic, and political aspects of the country, as well as how these are implemented in each country (Faguet, 2014; Teles, 2021). It is common to see that, even in cases where local governments have a relatively high degree of autonomy in terms of decision-making, aspects relating to expenditure and revenue are subject to central control mechanisms, namely in the areas of public policy, such as health, education, and social services. On the other hand, regarding local infrastructure, autonomy tends to be greater. In addition, as a rule, decision-making autonomy with regards to expenditure tends to be greater than that regarding revenue, and economic theory suggests that if you want to optimize efficiency in resource allocation there is more capacity to hand over responsibilities to local governments in the area of expenditures than in the area of revenues (Alfirman, 2003; Teles, 2021).

2.1. Arguments For and Against Decentralization

Decentralisation of central governments can have positive outcomes as well as adverse effects on public sector performance. Decentralisation is regarded as a critical component of good governance and development; however, it is recognised as a process fraught with complexity and potential failures (Kuhlmann and Wayenberg, 2016; White, 2011).

From an administrative efficiency standpoint, the existence of local governments allows for a better satisfaction of citizens' needs, since public services need to provide differentiated responses according to the characteristics of different territories and populations (Lockwood, 2015; Prud'homme, 1995). It is expected that through the decentralization process, and since local governments are closer to the population, they will become more attuned and responsive to citizens' needs and preferences. This proximity enables them to explore innovative and efficient methods to deliver services and public goods, thereby enhancing the well-being of the population (Oates, 1972; Oates, 1999; Wallis and Oates, 1988). Thus, since local agents have a greater capacity to formulate policies that respond to the needs of the population, it is possible to implement more effective regional development policies (OECD, 2019). In addition, decentralization allows for a greater capacity to adapt policies to the situation in which they are applied, which can promote development and result in the reduction of territorial asymmetries (Martinez-Vazquez *et al.*, 2017; Teles, 2021).

Another argument in favour of political decentralization stems from a simple postulate: the proximity and reduced size of a community increases electoral responsibility and citizen participation in government decisions and supervision (Bahl and Martinez-Vazquez, 2006; Hindriks and Lockwood, 2009). While there are many reasons for this type of decentralized government, the main incentive comes from the system for financing locally provided public services and the available information on the results of those same services – if residents finance a considerable part of those services through the payment of local taxes and fees, they will have a strong incentive to monitor their performance (Teles, 2021). Decentralization means accountability, based on the assumption that those who decide must justify their decisions, as the decision-maker is closer to the people, the easier it is to obtain the necessary clarifications (Bahl and Martinez-Vazquez, 2006; Lockwood, 2015). Therefore, decentralization promotes politician accountability and establishes supplementary avenues for democratic representation. It diminishes corruption and enhances competition among subnational governments, offering exit and voice mechanisms, heightened transparency, and diminishes perceived benefits from corruption by increasing the likelihood of detection and punishment (Veiga *et al.*, 2015).

Decentralization could boost the development of each region as a differentiated area from the others, making it possible to combat regional asymmetries (Kyriacou *et al.*, 2015), thanks to greater transparency and bringing more efficiency and equalization between jurisdictions, by taking advantage of the endogenous resources, and the potential and synergies of each region (Martinez-Vazquez *et al.*, 2017; Shankar and Shah, 2003). Therefore, decentralization is typically introduced as part of reforms aimed at enhancing the efficiency and quality of public services, boosting regional and local productivity and growth, and achieving fiscal consolidation goals in the aftermath of economic crises (Teles, 2021). However, the positive effects of decentralization may depend on factors such as the level of economic development (Lessmann, 2012) or the quality of governance (Kyriacou *et al.*, 2015).

Decentralization also recognizes the existence of risks, such as increased ineffectiveness and inefficiency of public policies due to insufficient or inappropriate application of the principles of subsidiarity and proportionality; the trend towards intensified competition between regions in different domains; the danger of aggravating intra-regional asymmetries and even an increase in public spending. Moreover, the proliferation of subnational governments can elevate the costs linked to establishing new administrations, conducting multiple local elections, and grappling with coordination challenges (Veiga *et al.*, 2015). If local governments are not able to cooperate with each other, decentralization may result in the loss of certain economies of scale and the fragmentation of certain public policies (OECD, 2019).

Decentralization, without an adequate institutional framework, can give rise to an abuse of discretionary powers by local governments (Veiga *et al.*, 2015). Additionally, there is a greater likelihood that the benefits of decentralized service delivery will primarily fall to local elites, as local jurisdictions may be vulnerable to capture by predatory pressure groups, intent on receiving a disproportionate share of spending on public goods to use them for their own benefit (Teles, 2021). Thus, according to Veiga *et al.*, (2015), decentralization measures must be accompanied by increased accountability of subnational governments. Alternatively, subnational governments might exploit their newfound discretionary powers, leading to heightened corruption as a result of inadequate monitoring systems, expanded involvement of officials in public management, and heightened incentives to accept bribes due to low wages (Veiga *et al.*, 2015).

Some literature argues that decentralization can be a source of local dissymmetry, giving privileges to regions that by nature present better conditions, such as more population and more wealth (Besley and Ghatak, 2003; Martinez-Vazquez *et al.*, 2017; Rodríguez-Pose and Gill, 2005). As a general rule, wealthier regions tend to possess larger tax bases, enabling them to fund local public goods with lower tax rates or finance a greater number of public goods with similar rates. This situation can potentially draw resources away from poorer regions, thereby exacerbating regional disparities (Martinez-Vazquez *et al.*, 2017; Oates, 1999).

From a financial point of view, when there is a high degree of dependence on transfers from the central administration and there is an expectation of rescue by the central administration, in the event of financial difficulties, decentralization may lead local governments to overspend, to lower own revenues and increase indebtedness (Veiga *et al.*, 2015). A high reliance on central government transfers can reduce the incentives for the local governments to have a responsible fiscal behaviour, thus own-source revenues are required as this contributes to accountability and efficiency in the delivery of local public services (OECD, 2019).

Thus, for decentralization to be effectively instituted, it is necessary for local governments to have financial autonomy (Carbonnier, 2013). However, a higher degree of autonomy, resulting from the decentralization process, leads to competition between municipalities, a horizontal competition, namely in terms of taxes and services they offer (Salmon, 2006). If local governments meet the needs and preferences of the population, they will offer different combinations of public goods and services, thus applying different levels of local taxes. In situations where there is significant mobility, individuals will express their preferences for public goods by relocating to the jurisdiction that aligns best with their specific preferences (Veiga *et al.*, 2015). This competitive pressure induces efficiency and responsiveness

from the local governments, which can generate incentives for the implementation of public policies aimed at attracting people and investment (Besley and Case, 1995; Salmon, 2006; Veiga *et al.*, 2015) – decentralization associated with the mobility of the tax base impose discipline on local governments, since they either provide goods and services efficiently or risk losing their tax base, since citizens "*vote with their feet*"(Tiebout, 1956). However, with regards to redistributive policies, differentiating between local governments can result in unsustainable policies if resources are highly mobile (Veiga *et al.*, 2015), with tax competition generating a bias towards low local corporate tax rates and therefore leading to the under provision of capital (Carbonnier, 2013).

Horizontal strategic interaction among local governments is founded on the notion that these jurisdictions do not operate independently, that is, they can be significantly influenced by neighbouring jurisdictions, and they are able to react to the policies adopted by them. In simple terms, strategic interaction happens when local governments adjust their tax rates or spending levels based on what other nearby governments are doing, all for strategic reasons. Therefore, policy choices are interdependent, and the resulting interaction must be considered when characterizing public sector equilibrium (Brueckner, 1998).

2.2. Explaining Strategic Interaction

The empirical literature uses two major types of models to explain the strategic interaction between local governments: spillover models and resource-flow models (Brueckner, 2003). Despite employing different structures to empirically evaluate strategic interaction, both models estimate a reaction function illustrating how the decision variable for a particular jurisdiction is influenced by the choices made by other jurisdictions. If the slope of the reaction function – which indicates how alterations in a neighbouring jurisdiction's variable affect the jurisdiction's own variable (Sedmihradská, 2013) – deviates from zero, it confirms the existence of strategic interaction (Brueckner, 2003).

In the spillover model, when making decisions about a variable, such as local taxes or expenditures, jurisdictions consider the decisions of other municipalities in relation to that same strategic variable, because the choices of those municipalities affect the utility derived from the jurisdiction's own choice (Brueckner, 2003). Thus, the decisions taken by each jurisdiction depend on their specific conditions, as well as on the decisions of other municipalities, through a spillover mechanism (Carvalho *et al.*, 2011). Empirical models that focus on the strategic choice of environmental standards, on yardstick competition,

and on public expenditure (benefit) spillovers were all shown to fit within the spillover model (Brueckner, 2003).

In the resource-flow model, the strategic decisions of a jurisdiction are not directly affected by the decisions of other jurisdictions, that is, jurisdictions make decisions about their strategic variable without directly considering the decisions of other jurisdictions about that same variable (Brueckner, 2003). However, the jurisdiction is affected by the locally available quantity of a given resource. Thus, since the distribution of this resource is affected by everyone's choices, the decisions of each municipality on the strategic variable are indirectly influenced by the decisions of all other municipalities (Brueckner, 2003; Carvalho *et al.*, 2011). Models that focus on tax competition and welfare competition represent cases of the resource-flow model.

Spillover Models: Public Expenditure Spillovers

Local governments may also be concerned about how their level of spending compares with neighbouring jurisdictions due to the existence of spillover effects of expenditures in these neighbouring jurisdictions (Baicker, 2005).

In the traditional "*spillover*" model, the public expenditures of a municipality can have positive or negative effects (spillovers) on the well-being of residents in nearby jurisdictions (Gordon, 1983), with the spillovers arising if the residents of a jurisdiction can benefit from services provided by other jurisdictions. If neighbouring jurisdictions increase expenditures related to the provision of complementary local public goods, such as infrastructure and roads, the municipality will likely increase its public expenditures (Coimbra *et al.*, 2013; Costa *et al.*, 2015). However, if local public goods are substitutable, such as sports, recreational and school infrastructures, municipalities may reduce their expenses on public goods and take advantage of the spillovers (Costa *et al.*, 2015). Municipalities can take advantage of neighbouring jurisdictions, as the public expenditure of the neighbouring jurisdiction can serve as a substitute for the municipality's own public expenditure (Arze del Granado *et al.*, 2008). Thus, municipalities decide the level of their own expenditure, by strategically considering the expenditure of neighbouring municipalities (Costa *et al.*, 2015).

Hence, as a result of the spillovers associated with the local expenditure of neighbouring municipalities, the local government can set lower or higher expenditure levels than would be necessary to maximise the welfare of the population. In these cases, models are expected to show negative or positive spatial autocorrelation, since if the neighbouring jurisdiction makes an investment that benefits the local jurisdiction, the latter will not need as many financial resources (López *et al.*, 2017). Thus,

strategic interaction in tax setting may result from benefit spillovers, where residents of a municipality consume the public goods provided by neighbouring jurisdictions (Brueckner and Saavedra, 2001), allowing the benefiting jurisdiction to provide fewer public goods, which in turn allows it to impose lower tax rates, relative to the neighbouring jurisdiction. Thus, positive spillovers in public expenditure can give rise to negative interactions in tax rates (Baskaran, 2014).

Resource-flow Models: Tax Competition

The idea of tax competition is present in the work of Tiebout (1956) and Oates (1972), but the first formal models of tax competition were presented by Zodrow and Mieszkowski (1986) and Wilson (1986). According to the tax competition theory, the strategic interaction between municipalities arises due to the interjurisdictional mobility of the tax base, that is, we are dealing with tax interaction when decisions about tax rates set by jurisdictions consider the effects they have on the mobile features (Brueckner and Saavedra, 2001; Parchet, 2019).

According to Tiebout (1956), local governments compete in order to attract mobile factors from neighbouring jurisdictions, with the aim of improving their tax base. "*Consumer-voters*" are aware of different spending and tax patterns across jurisdictions, reacting accordingly, and choosing the jurisdiction that offers the package of public tax revenues and supply of public goods most suited to their preferences (Tiebout, 1956). Consumers "*vote with their feet*" (Tiebout, 1956) sorting efficiently across jurisdictions, and local governments respond by tailoring their taxes and expenditures to the preferences of their residents. Thus, the spatial distribution of individuals depends as much on the tax rates and expenditure levels of the jurisdiction as on neighbouring jurisdictions, whereby higher tax levels in a given jurisdiction will benefit neighbouring jurisdictions with an influx of mobile factors (Buettner and von Schwerin, 2016; Parchet, 2019). As a result, each jurisdiction is indirectly impacted by the policies of neighbouring jurisdictions, rendering tax policy decisions interdependent and fostering strategic interactions. The influx of new residents serves as the linchpin for the interactions between local governments (Barreira, 2011).

Although some research acknowledges that competition for resources can be advantageous for consumers by promoting a variety of beneficial public choices, there is another perspective that highlights the potential drawbacks associated with local competition and strategic behaviour (Devereux and Loretz, 2013). The competition among local jurisdictions to lower tax rates in order to attract capital can lead to inefficient taxation systems and insufficient funding for crucial public goods and services – a "race to the bottom" (Brueckner and Saavedra, 2001; Oates, 1972; Zodrow and Mieszkowski, 1986). The theory of tax competition predicts a local tax rate that is below the socially optimal (Lundberg, 2021). By setting

low tax rates in order to attract capital, jurisdictions set expenditures below levels at which marginal benefits equal marginal costs (Oates, 1972). Therefore, the level of local taxes is not sufficient to finance public goods, leading to welfare losses (Brueckner and Saavedra, 2001). In addition, it is necessary to consider equity aspects, since not all economic agents are equally mobile, so the local tax burden could end up being borne essentially by the less mobile ones, such as, for example, less qualified workers and property owners.

Spillover Models: Yardstick competition

Shleifer (1985) initially developed a yardstick-competition mechanism to promote the regulation of commercial monopoly schemes and it was then used by Salmon (1987) to analyse horizontal competition between sub-central authorities. It was later explored by Case *et al.* (1993) and modelled by Besley and Case (1995).

Unlike the tax competition model, which assumes that there is mobility of taxable resources, the yardstick model assumes that the tax base is fixed, considering, in turn, the electoral process to explain the strategic interaction between jurisdictions, *i.e.*, jurisdictions compete for votes in the political market (Allers and Elhorst, 2005).

Under the yardstick-competition model, fiscal interactions arise from the existence of imperfect and asymmetric information between local politicians and their voters. Political representatives have more information regarding their capacities or administrative competences, and the cost of providing services and public goods and, consequently, the level of local taxes required to provide these services and public goods (Allers and Elhorst, 2005; Belleflamme and Hindriks, 2005; Revelli, 2006). The model also divides local politicians into two types: "good politicians", whose objective is to provide public goods at the lowest possible cost, and rent-seeking "bad politicians", who try to finance their "wishes" at the expense of taxpayers (Besley and Case, 1995). This opportunistic behaviour exhibited by local politicians leads them to withhold pertinent information from their constituencies. This tactic facilitates more manageable increases in tax rates, allowing them to generate more revenue than necessary to fund the optimal level of local public goods. The surplus tax revenue is then utilized for the personal benefit of local politicians. Consequently, a political agency problem emerges due to the inability of voters to clearly differentiate between the two types of politicians (Belleflamme and Hindriks, 2005).

However, voters have the possibility, through the media or other sources of information, to use the tax situation of neighbouring jurisdictions as a criterion for comparing and evaluating the relative performance of their local political representatives, thus being able to reduce the asymmetric information

problem, as well as to circumvent and overcome problems of political agency (Allers and Elhorst, 2005; Bodenstein and Ursprung, 2005). Indeed, voters utilize information on tax rates and expenditure levels from neighbouring jurisdictions as a benchmark, or yardstick, for evaluating the costs and suitability of policies within their own jurisdiction (Besley and Case, 1995; Bordignon *et al.*, 2003). If voters are indeed aware of and sensitive to what happens in neighbouring jurisdictions, the choices of neighbouring jurisdictions provide a positive externality of information about the quality of their own government. Voters, when observing fiscal choices and public expenditures in neighbouring jurisdictions, can more accurately assess whether their own government's choices are adequate or if they include waste (Bordignon *et al.*, 2003). That is, voters can see if their political representatives are rent seekers. Thus, the ability of citizens to use information from neighbouring jurisdictions improves the assessment of the quality of their own jurisdiction, preventing politicians from abusing political power, and allowing for the restriction of their discretionary power, therefore increasing their political responsibility (Wrede, 2001).

The poor relative performance of local politicians constrains their chances of re-election, thereby diminishing incentives for fiscal exploitation by rent-seeking politicians (Bastida *et al.*, 2019). Local politicians, being rational agents, anticipate voters' behaviour, so before deciding which policies to implement they consider the voters' behaviour to avoid being seen by them as bad politicians and being rejected in elections (Bordignon *et al.*, 2003; Edmark and Ågren, 2008). Consequently, to maximize their chances of remaining in power, political representatives consider fiscal decisions made in neighbouring jurisdictions. This makes local governments interact strategically with each other in the formulation of their respective policies, namely in what regards fiscal policies (Revelli, 2006; Solé-Ollé, 2003).

In a decentralized tax system, the political consequences of tax adjustments depend on the surrounding circumstances (Besley and Case, 1995). The electoral performance of a jurisdiction will depend both on its own fiscal policy and on the fiscal policy of neighbouring jurisdictions. An increase in tax rates may be well tolerated by voters when similar increases are seen in neighbouring or similar jurisdictions (Bastida *et al.*, 2019). That is, tax increases may only have an adverse electoral impact when they are not simultaneously accompanied by a similar tax increase in neighbouring jurisdictions (Bosch and Solé-Ollé, 2007). However, if voters notice tax reductions in neighbouring jurisdictions, they are less likely to tolerate their local politician not implementing tax cuts as well. Consequently, electoral defeat is more likely to occur when taxes increase within a jurisdiction, while it is less likely when taxes increase in neighbouring jurisdictions (Besley and Case, 1995). For yardstick competition to take place and for voters to be able to compare the tax performance of neighbouring or similar jurisdictions more easily with their own jurisdiction, relevant information needs to be collected from jurisdictions that share similar geography

or social and economic characteristics, and such information also needs to be readily available (Bordignon *et al.*, 2003; Buettner and von Schwerin, 2016). In addition, it is necessary that electoral behaviour be the main tool citizens have to reward politicians by re-electing them and punish bad mayors through electoral losses (Wrede, 2001). Note that if the costs associated with citizen mobility are low enough, citizens could escape incompetent governments simply by emigrating or changing their taxable assets (Bordignon *et al.*, 2003).

Distinguishing Tax and Yardstick Competition

The ability of mayors to raise tax rates, as well as the effects of yardstick competition, depend on the specific characteristics of the local electoral accountability process (Solé-Ollé, 2003). In particular, the strength of re-election incentives is likely to play a key role in generating yardstick competition, but not necessarily in tax competition.

In jurisdictions where political representatives cannot be re-elected, due to binding institutional term limits, ideological factors appear to be more dominant in the decision-making process, and, as a rule, the imitation of the behaviour of the policies of neighbouring jurisdictions tends to be absent (Bordignon *et al.*, 2003; Ferraresi, 2020). Therefore, local representatives with limited mandates are inclined to establish higher tax rates compared to their counterparts (Padovano and Petrarca, 2014). In this scenario, the yardstick competition hypothesis can be assessed by contrasting the actions of political representatives who are eligible for re-election with those who are not (Allers and Elhorst, 2005). If evidence is found of strategic interaction only between jurisdictions whose political representatives can be re-elected, there is evidence for yardstick competition. However, in the context of tax competition, behaviour imitation is expected to happen regardless of the chances of being re-elected (Allers and Elhorst, 2005).

In jurisdictions where the political representative is supported by a large majority or enjoys a large margin of electoral victory, imitation behaviour is less pronounced (Bastida *et al.*, 2019; Bordignon *et al.*, 2003), since politicians in such a comfortable position are usually confident in their re-election, thus enjoying more freedom to establish their own fiscal policies. A political representative who has low popularity and is seeking re-election may try to win votes by reducing local tax rates. On the other hand, if the political representative is confident of re-election, because a certain popularity target has been exceeded or because he hopes not to be opposed by any strong contenders, he can raise the local tax and expect to stay in office (Revelli, 2002a). Therefore, the imitation of neighbours is expected to decrease

as the electoral margin increases if it is generated by yardstick competition (Allers and Elhorst, 2005), and in general, only political representatives who face uncertain electoral results are committed to imitating behaviours for re-election purposes (Bordignon *et al.*, 2003).

As a rule, governments formed by coalitions are less likely to be held accountable, both when it comes to the rewards and punishments, for their political and economic performance (Fisher and Hobolt, 2010; Solé-Ollé, 2006). Since there is less "clarity of responsibility", voters have more difficulty in identifying which politician is responsible for the changes in the local tax rates. Consequently, local coalition governments exhibit less concern about the repercussions of tax hikes for re-election purposes. As a result, they tend to implement higher tax rates, deviating from mimicking the tax policies of neighbouring jurisdictions (Solé-Ollé, 2003).

The party ideology of the political representatives of the jurisdictions can have a relevant effect on the strategic interaction between them. In this perspective, as a rule, left-wing political parties are more favourable to an active state and income redistribution than right-wing parties, so in terms of taxation, it is expected that the right-wing government will be more favourable to a lower tax burden than leftist parties (Allers *et al.*, 2001). According to Alesina and Rosenthal (1995), voters do not evaluate all parties in the same way, since depending on the party's ideology, they have different expectations regarding what are reasonable tax increases. Typically, when right-wing parties are in power, adaptation behaviour is more pronounced. This is because right-wing voters tend to be more responsive to tax increases in neighbouring jurisdictions, when compared to left-wing voters (Allers and Elhorst, 2005). On the other hand, when left-wing parties are in power, imitation behaviour is expected to be less prominent. This is because left-wing parties typically face less voter backlash over tax increases, as they are less responsive to neighbouring jurisdictions' efforts to lower taxes (Solé Ollé, 2003).

2.3. Overview of Empirical Studies of Spatial Interactions

Strategic interactions between local governments are an important topic in political and public economics, and the empirical literature has been expanding rapidly, due to recent theoretical developments and the evolution of spatial econometrics. However, despite the development of the literature, the best methodology for estimating the strategic fiscal interaction is still under debate, and many authors argue that the identification strategies used do not meet the required standard for the results to have a causal interpretation (Gibbons and Overman, 2012).

Table 1 presents an overview of empirical studies in the context of fiscal interaction between local governments. In general, in the field of fiscal policy, the empirical literature finds evidence of positive strategic interactions between local governments. It should be noted that studies that do not present significant strategic interactions (Baskaran, 2014; Isen, 2014; Lyytikainen, 2012) use non-traditional estimations. In many cases, it is not readily clear whether the tax interaction, namely tax imitation, stems from tax competence, yardstick competition, or both. However, most empirical studies present yardstick competition as a source of strategic interaction. Regarding spatial matrices, although some empirical studies use matrices of political, economic, or demographic weighting (Brueckner and Saavedra, 2001; Delgado and Mayor, 2011; Solé-Ollé, 2003), the geographic matrix, whether based on contiguity or distance, is used in all empirical studies.

Regarding the empirical evidence for Portugal, there are three articles which focus on the strategic interaction in tax setting behaviour (Carvalho *et al.*, 2011; Coimbra *et al.,* 2013; Costa and Carvalho, 2013). The results of these papers regarding the existence of strategic interaction in the definition of the Variable Participation Rate in Personal Income Tax were inconclusive.

Table 1 - Empirical Studies of Spatial Interactions - Tax Mimicking

Authors	Spatial Dimension		Dependent Variable	Weighting Matrix	Estimation Method	Coefficient Sign	Source of Strategic Interaction
	Country	Level					
Besley and Case (1995)	USA	States	Sales Tax and Income Tax	Geographical Contiguity	Instrumental Variables	+	Yardstick Competition
Heyndels and Vuchelen (1998)	Belgium	Municipalities	Income Tax and Property Tax	Geographical Contiguity	Instrumental Variables	+	-
Brueckner and Saavedra (2001)	USA	Boston Metropolitan Area	Property Tax	Geographical Contiguity, Geographical Distance Population Weighted	Maximum Likelihood	Mixed results depending on year studied and matrix applied	Tax Competition
Buettner (2001)	Germany	Municipalities	Business Tax	Geographical Distance	Instrumental Variables	+	Tax Competition
Revelli (2002b)	England	Non-metropolitan districts	Property Tax	Geographical Contiguity	Maximum Likelihood and Instrumental Variables	+	Tax Competition
Bordignon *et al.*, (2003)	Italy	Municipalities	Business Property Tax	Geographical Contiguity	Maximum Likelihood	+	Yardstick Competition
Solé-Ollé (2003)	Spain	Municipalities	Property Tax, Business Tax and Vehicle Tax	Geographical Distance Political Orientation Population Weighted Fiscal Stress	Instrumental Variables	+ for Property and Vehicle Tax, no significant effects for Business Tax	Yardstick Competition
Allers and Elhorst (2005)	Netherlands	Municipalities	Property Tax	Geographical Contiguity Geographical Distance	Maximum Likelihood	+	Yardstick Competition
Edmark and Ågren (2008)	Sweden	Municipalities	Income Tax	Geographical Contiguity	Instrumental Variables	+	Tax competition
Feld and Reulier (2009)	Switzerland	Cantons	Income Tax	Geographical Contiguity	Instrumental Variables	+	Tax Competition

Carvalho *et al.,* (2011)	Portugal	Municipalities	Property Tax, Participation in Income Tax and Business Tax	Geographical Contiguity	Spatial Autoregressive Models	+	Yardstick Competition for Property and Business Tax
Delgado and Mayor (2011)	Spain	Municipalities	Property tax, vehicle tax and building activities tax	Geographical Contiguity, Geographical Distance, combination of economic and geographical characteristics	Maximum Likelihood	+ for property and building activities tax, no significant effects for vehicle tax	-
Lyytikäinen (2012)	Finland	Municipalities	Property Tax	Geographical Contiguity	Quasi-experimental Method	No significant interactions	-
Coimbra *et al.*, (2013)	Portugal	Municipalities	Property Tax, Participation in Income Tax and Business Tax	Geographical Contiguity	Spatial Autoregressive Models	+	-
Costa and Carvalho (2013)	Portugal	Municipalities	Property Tax	Geographical Contiguity	Instrumental Variables	+	Yardstick Competition
Baskaran (2014)	Germany	Municipalities	Property and Business Tax	Geographical Contiguity, Geographical Distance, Geographical Contiguity, population weighted	Difference in difference	No significant interactions	-
Isen (2014)	USA	Counties, municipalities, and school district, Ohio	Property, Bonds, Income and Sales Tax	Geographical Distance	Quasi-experimental	No significant interactions	-
Padovano and Petrarca (2014)	Italy	Municipalities	Property Tax	Geographical Contiguity Geographical Distance	Instrumental Variables	+	Yardstick Competition
Buettner and Von Schwerin (2016)	Germany	Municipalities	Business Tax	Geographical Distance	-	+	Yardstick Competition
Bocci *et al.*, (2019)	Italy	Municipalities	Property Tax	Geographical Contiguity, Geographical Distance	Instrumental Variables	+	Spillover Effects
Parchet (2019)	Switzerland	Municipalities	Income Tax	Geographical Distance	Quasi-experimental Method	-	-
Ferraresi (2020)	Italy	Municipalities	Income Tax	Geographical Contiguity with different years of the political term	Instrumental Variables	+	Yardstick Competition

3. Portuguese Local Institutional Framework

Article 235 of the Constitution of the Portuguese Republic (CRP) determines that "*the democratic organization of the State comprises the existence of Local Authorities*", defining the existence of three categories of local authorities: parishes (the lowest category), municipalities (the intermediate category) and administrative regions (the highest category). Local Authorities are public legal entities representing the population of a specific territory, corresponding to the aggregates of residents in various areas of the national territory, endowed with their own bodies, which ensure the pursuit of these populations' common interests resulting from their proximity. Currently, in Portugal there are two autonomous regions (Madeira and Azores), 308 municipalities (of which 19 in the Azores and 11 in Madeira) and 3092 parishes (of which 156 in the Azores and 54 in Madeira).[3]

Municipalities are constitutionally and legally defined as local authorities that seek the interests of the population residing in their respective areas through legal bodies, which represent the most important local government unit both at the political, economic, administrative, and financial levels. As the entities closest to the population, when compared to the central authority, the Municipalities are the entities that are best positioned to promote the economic, social, and cultural development of their own territory, and, therefore, the law grants them powers to promote their own development (Veiga and Pinho, 2007). Municipal political-administrative units are extremely different from each other in terms of territorial support and similar in terms of their legal framework, with budgetary rules, competences and political instruments being the same for all Portuguese municipalities in the mainland, regardless of their size (Barreira, 2011; Veiga and Veiga, 2007).

The Portuguese Constitution of 1976, Law no. 79/1977, of October 25th, and the First Local Finance Act[4] brought new responsibilities and more powers to the municipalities, allowing the reform of local finances through the consolidation of financial decentralization (Veiga and Pinho, 2007). Law no. 79/1977, of October 25th established the competences and attributions of the municipalities, legislatively framing the attributions of the municipalities and the competences of the bodies that constitute them (the

[3] Although Madeira and the Azores are autonomous regions, and a division of the continent into new administrative regions with local authority status was decided, due to the rejection of the national referendum on regionalisation, these regions were never actually created.

[4] Law no. 1/79, January 2nd.

Municipal Assembly and the Municipal Council), namely competences in terms of infrastructural interventions, utilities, culture and social assistance and public health. Decree-Law no. 100/84 of March 29th, extended the competences of the municipalities to areas such as rural and urban equipment, culture, leisure and sport, transportation and communications, education, and health, setting up a broader framework of attributions in the social sphere, which is why it is one of the most relevant diplomas in terms of attributions and competences of local authorities and a benchmark for the consolidation of the Municipal Social Service. The Framework Law for the Transfer of Attributions and Powers to Local Authorities[5], established a new framework for transferring attributions and competences to local authorities, among which stand out their competences in the areas of education, rural and urban equipment, transportation and communications, energy, heritage sites, culture and science, leisure activities and sports, health, social intervention, housing, civil protection, environmental protection and basic sanitation, consumer protection, promoting development, territorial planning and urbanism, municipal police and external cooperation. Article 2 of this same law establishes an administrative decentralization and coordination of the local and the central administration, ensuring the principle of subsidiarity, which assures the redistribution of attributions and powers to local authorities, in order to ensure national cohesion, proximity to citizens and the promotion of efficiency and effectiveness in public management.

Law no. 2/2007, of January 15th, established the financial regime of municipalities and parishes, providing rules to ensure the adequate financing of the new responsibilities and powers of the municipalities. According to Article 7 of that law, the participation of each local authority in public resources is determined under the terms and criteria set out in the Local Financing Law, aiming at a vertical financial balance - adapting the resources of each level of administration to their respective responsibilities and competences - and horizontal – by promoting the correction of inequalities between municipalities of the same level resulting, in particular, from different capacities in revenue collection or different expenditure needs.[6] However, with the Economic and Financial Assistance Programme, signed with the European Union (EU), the International Monetary Fund (IMF) and the European Central Bank

[5] Law no. 159/99, September 14th.

[6] The distribution of public resources between the State and the municipalities can be obtained through the variable participation of 5% in the personal income tax, determined under the terms of article 20 of Law no. 2/2007, of taxable persons with a fiscal residence in the respective territorial circumscriptions, calculated over the respective collection, net of the deductions provided for in article 78(1) of the PIT Code.

(ECB), Portugal undertook the responsibility to revise Law no. 2/2007 of January 15th, by creating Law no. 73/2013, of September 3rd, which established the Financial Scheme for Local Authorities and Intermunicipal Entities. This revision sought to adjust municipal revenues to the current reality, increase the demand and transparency in terms of accountability, as well as provide local finances with the necessary instruments to ensure an effective coordination between the central and the local government, thus contributing to budgetary control and preventing situations of instability and financial imbalance. The structural reforms aimed at stabilizing Portugal's public finances during the international financial assistance program from 2011 to 2014 led to alterations in the distribution of powers and responsibilities among municipalities. This included the approval of legislative amendments and new measures intended to enhance the municipalities' fiscal autonomy, encourage inter-municipal tax competition, and improve electoral accountability. Additionally, efforts were made to reduce costs and enhance transparency in the management of municipalities, all aimed at fostering local development (Veiga *et al.*, 2015).

Bearing in mind that the administrative decentralization was a constitutional task that had yet to be implemented, Law no. 50/2018, of August 16th, transferred powers to local authorities in several domains, such as housing, health, social intervention, justice, civil protection, proximity policing, tourist promotion, culture, management of certain seaside, river and lake beaches, the exploitation of certain types of gambling, means of communication, programs for attracting investment, structures for serving citizens, and public parking. This law is characterized, not only by its diversity of subjects, but also by the polymorphism of its solutions, by the universal and gradual transfers of new competences, having, specifically, in mind the actors of the local power, and the carrying out of a decentralized process.

In order to establish the financial resources to be allocated to local authorities and intermunicipal entities for the exercise of the transferred powers, the Local Finance Law, approved by Law no. 73/2013, of September 3rd, was revised and amended by Law no. 51/2018, of August 16th. Thus, according to Article 25 of the aforementioned law, municipalities now have a 7.5% share of the VAT revenue collected in the accommodation, catering, communications, electricity, water, and gas sectors, calculated in accordance with the provisions set in Article 26-A. This participation is calculated on the basis of the year before to the one mentioned in the State Budget Law and is distributed to the municipalities proportionally, with reference to the VAT paid in their respective territorial circumscriptions for the aforementioned economic activities. In addition, Law no. 51/2018, of August 16th, determined the creation of the Decentralisation Financing Fund (FFD), a financial transfer from the State Budget to finance the powers of local authorities and intermunicipal entities, resulting from the framework law on the transfer of powers to local authorities and intermunicipal entities, approved by Law no. 50/2018, of August 16th.

3.1. The Degree of Decentralization in Portugal

Although the list of competences and responsibilities of municipalities has been increasing over time, the position occupied by Portugal in all decentralization indices, and when compared to other countries, has not fluctuated significantly over the last few years (Teles, 2021). Considering the Decentralization Index[7] provided by the Committee of European Regions (CoR), Portugal is in the 15th position of the Member States of the EU regarding Global Decentralization. In view of the different types of decentralization, Portugal presents a greater political decentralization, in relation to an administrative and fiscal decentralization.

One of the most common instruments used by international agencies to compare the level of decentralization between different countries is to identify the share of public expenditure incurred by local governments, as a percentage of the gross domestic product (GDP). In 2021, the consolidated public expenditure,[8] as a percentage of the GDP, incurred by the Portuguese local authorities (municipalities and parishes) corresponded to 6,85%, whereas the average of the countries of the Organization for Economic Cooperation and Development (OECD)[9] was of 10.23% and the European Union was of 15,5% (OCDE, 2023).

Currently, municipalities are responsible for most of the consolidated expenses of local administrations. Municipal public expenditures are divided into capital expenditures, such as investment expenditures, capital transfers to parishes, financial assets and liabilities, and other capital expenditures, and current expenditures, such as expenditures on goods and services, financial expenditures, human resources, current transfers to parishes, among others. Local expenditures by Portuguese municipalities correspond only to 14,3% of the total public expenditure of 2021, which are quite low numbers when compared to the European average (34,3%) (OECD, 2023). Regarding the weight of local investment in total public investment, according to the Financial Yearbook of Portuguese Municipalities (2021), Portugal has a higher value (48,1%) than the European average (40,1%), which clearly suggests a greater intervention by Portuguese municipalities in public investment activities. While in the EU the three largest

[7] The Decentralization Index considers the different dimensions of decentralization – political, administrative, and fiscal – in the 27 EU Member States.

[8] A consolidated expenditure is defined as total expenditure minus the expenditure on intergovernmental transfers.

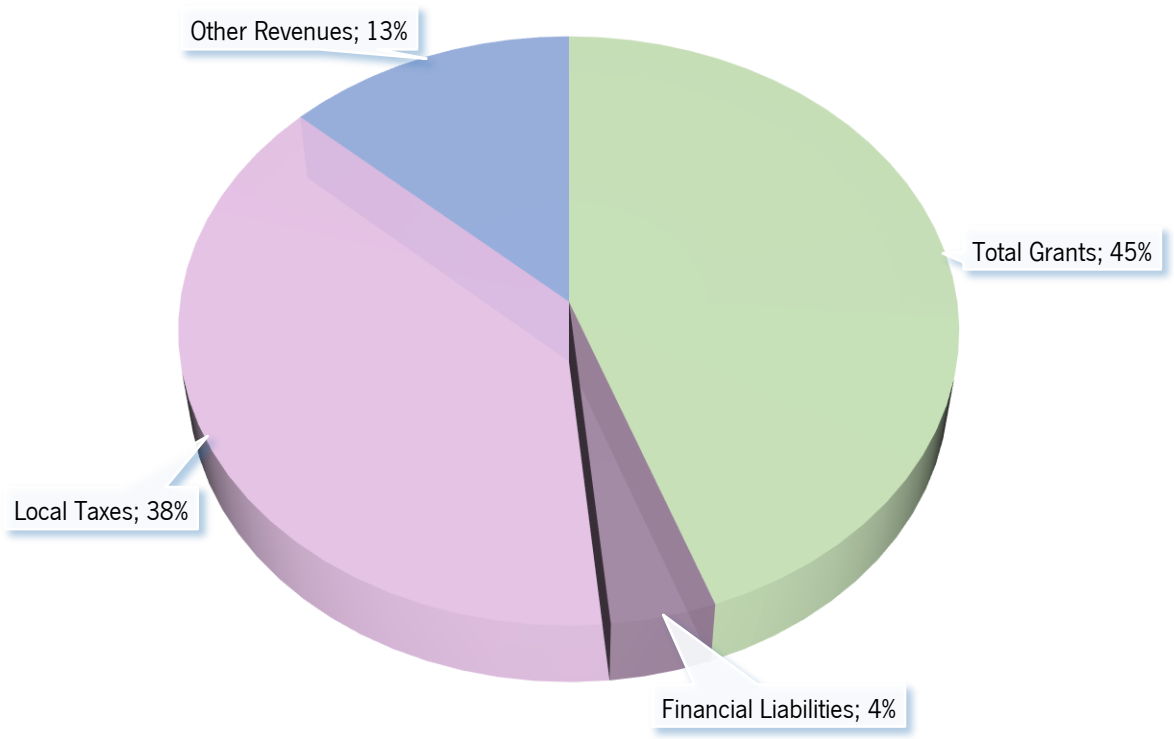
[9] Data for 2021 were not available for Australia, Chile, Colombia, Japan, Korea, New Zealand, Turkey, and the United States at the time this database was updated (December 2022).

categories of subnational expenditure by sectors of public policy are education, social protection, and health, in Portugal the main local competences comprise general services and economic affairs, whereas the main responsibilities of the central administration are education, social protection and general services.

In 2021, the consolidated own revenues of the municipalities (except for intergovernmental transfers from the Central Government) represented 10.20% of the total consolidated revenues[10], which represents an extremely low or almost non-existent decentralization. Furthermore, it should be noted that this indicator has remained constant, at approximately 10%, since 2010. Municipal revenues consist of transfers from the Central Government, which include transfers based on formulas, programs, protocols, and others; transfers from the European Union, such as structural funds, cohesion funds and others; direct and indirect local taxes; fees, fines, and other penalties; selling of goods and services, loans, and other financial liabilities. Figure 1 shows the municipal revenues in 2021. The main source of revenue for the municipalities are total transfers, which represent 45% of the total revenue, followed by tax revenues, namely local taxes, and fees, which represent 38%. Since 2020, the total value of Current and Capital Transfers has exceeded the value of revenue from Taxes and Fees; however, between 2016 and 2019 inclusive, the relationship between these two revenue aggregates changed, with the value of taxes and fees exceeding the total value of total transfers. It should also be noted that, since 2013, the revenue item related to Taxes and Fees has shown continuous growth, but in 2020, it fell by 3,4%, with growth recovering in 2021.

[10] The total consolidated general government revenue was calculated as the grand total of revenue at the general government level plus total intergovernmental property income.

Figure 1 - Weight of Main Municipal Revenue in Total Municipal Revenue (2021)

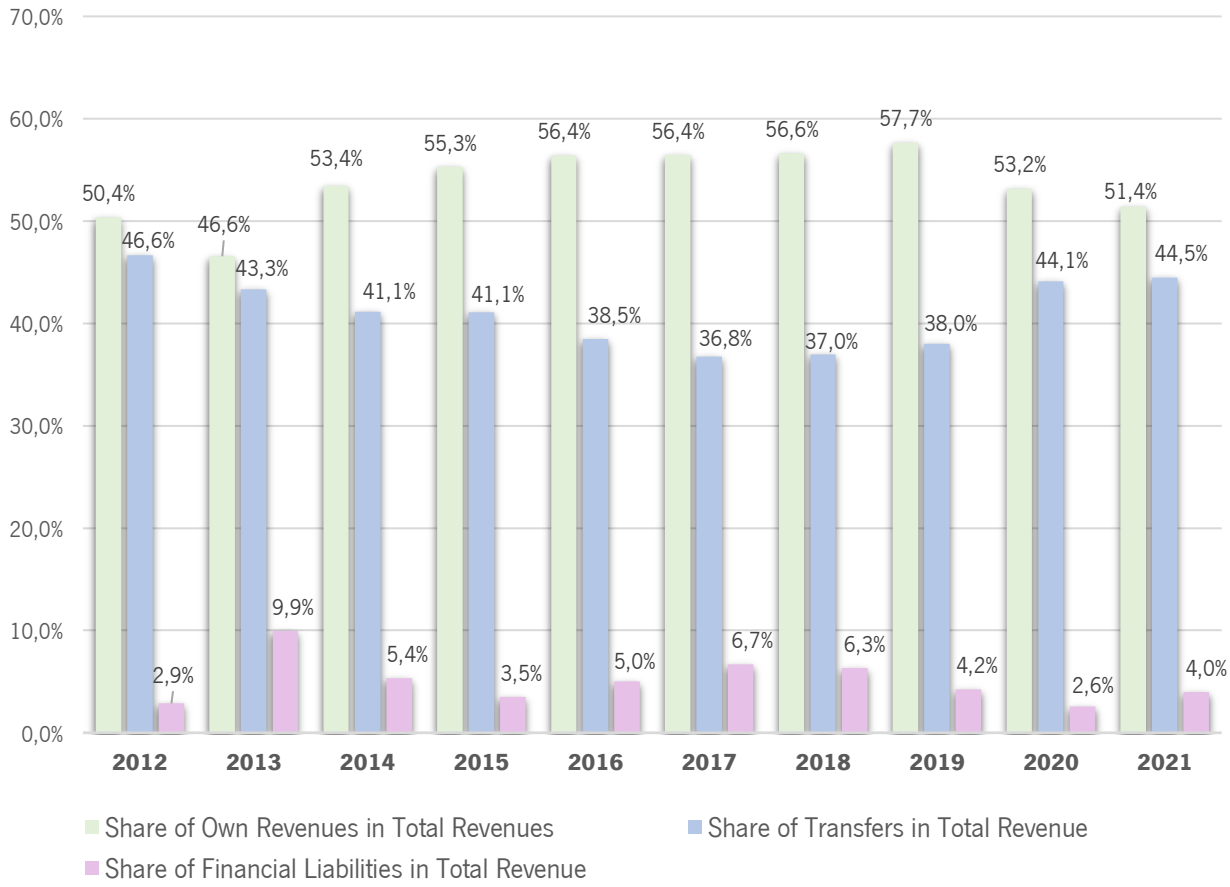


Data Source: DGAL. Own calculations

Financial independence is considered to exist in cases where own revenues represent at least 50% of the total revenues. To better understand the evolution of this indicator, for the years between 2012 and 2021, the weight of own revenues[11] , transfers, and financial liabilities, in total revenues, is presented in a comparative way. Through the analysis of Figure 2, it is possible to conclude that, in 2021, own revenues represented 51,4% of total revenues. It is also possible to conclude that the financial independence of municipalities has been decreasing in the last two years, which may be related to the impacts of the Covid-19 pandemic, since with the crisis associated with Covid-19 there was a reduction in revenues collected by municipalities, as they are also highly sensitive to economic and social activities, such as those regarding the municipalities' participation in state taxes (IRS and VAT) or tax revenue collection (IMI, IMT and fees).

[11] Own revenues include direct taxes, indirect taxes, fees, fines and other penalties, property income, selling of current goods and services, other current revenues, selling of investment goods, financial assets, and other capital revenues.

Figure 2 - Evolution of the Financial Independence of the 308 Municipalities



Data Source: DGAL. Own calculations.

Typically, own revenues do not cover all local expenses, although there are huge differences between the more urbanized and the more rural councils. The vertical gap imbalance in the set of Public Administrations is closed by transfers at the regional, central, and European levels. This dependence on intergovernmental transfers can be demonstrated by the fact that the weight of revenue from total transfers represented 68.2% of total revenue for small municipalities, and only 27.8% for large municipalities, with the amount of tax revenue representing 16.3% of total revenue for the former and 54.5% for the latter (Financial Yearbook of Portuguese Municipalities, 2021). This is because numerous small municipalities possess exceedingly narrow tax bases, due to their diminutive size, sparse population, and a dearth of substantial economic activity (Baleiras *et al.*, 2018). According to the Financial Yearbook of Portuguese Municipalities (2021), own revenues assumed a greater relative weight in large municipalities, representing, in 2021, an average value of 62.2% of total revenues. The financial resources of small-sized municipalities significantly depended on transfers received through the Financial Equilibrium Fund (FEF), which, in 2021, represented, on average, 71.1% of total revenues. The average

weight of own resources in the total revenue was of 25.8%, which means that about ¼ of the total financial resources generated, translated into a very reduced financial independence in this category of municipalities.

3.2. Tax Framework of Portuguese Municipalities

Local autonomy, as a constitutional right,[12] provides that municipalities have sufficient financial means to carry out the competences and attributions that they are constitutionally and legally entrusted with and that they are not dependent on the financial means of the central power, such as contributions and subsidies, and that they have autonomy in the management of these means.

The Local Finance Law[13] establishes that municipalities have their own assets and finances whose management is the responsibility of their respective bodies. The financial autonomy of local authorities is based, namely, on the following powers: a) to prepare, approve and modify the activity plan options, budgets and other forecast documents, as well as to prepare and approve the corresponding accountability documents, b) manage their assets, as well as those related to them; c) exercise tax powers; d) settle, collect, charge and dispose of revenue; e) order and process legally authorized expenses; and f) access to credit. Therefore, municipalities have tax powers[14] regarding the taxes to which they are entitled. These tax powers manifest themselves in the setting of rates and granting tax exemptions and benefits (Teixeira *et al.*, 2015). Thus, within their tax powers, municipalities have the right to[15]:

a. Access up-to-date information on municipal taxes and surcharges, settled and collected, when settlement and collection is ensured by the central administration services;

[12] According to no. 1 and no. 4 of article 238 of the CRP, municipalities have their own assets and finances and may have tax powers.

[13] Law no. 73/2013 of September 3rd establishes the financial regime of local authorities and intermunicipal entities.

[14] Regional or local tax power is considered a second-degree power, since it is implemented through primary laws, namely regional laws, and regulations, respectively.

[15] Article 15 of Law no. 73/2013, of September 3rd.

b. The possibility of settlement and collection of taxes and other taxes to which they are entitled to;

c. The possibility of coercive collection of taxes and other taxes to which they are entitled to;

d. Grant tax exemptions and benefits;

e. Compensation by the Government for granting tax benefits relating to taxes and other taxes to which they are entitled to;

f. Other powers provided in the tax legislation.

Under the terms of the Local Finance Law, the tax revenue of a municipality consists of direct taxes, indirect taxes,[16] and fees.[17] Municipal taxes are collected by the central government and then returned to the municipality, and can be levied on income, assets, and expenditure. Thus, Portuguese municipalities benefit from the revenues of the following municipal direct taxes: Municipal Property Tax ("Imposto Municipal sobre Imóveis - IMI"), Municipal Tax on Real Estate Transfers ("Imposto Municipal sobre Transmissões Onerosas de Imóveis - IMT"), a surcharge on Corporate Income Tax ("Derrama") and the Tax on the Circulation of Vehicles ("Imposto Único de Circulação - IUC") (Costa and Carvalho, 2013). Income from fees and indirect taxes is considered a set of income resulting from the granting of licenses and other services provided by municipalities in different areas of their activity, such as markets and fairs, subdivisions and public works, occupation of public roads, advertising, sanitation, hunting, use and possession of weapons, among others. In addition to collecting the aforementioned taxes, the current Local Finance Law grants municipalities the possibility of a Variable Participation Rate in the Personal Income Tax (VPIT), partially or totally, up to the limit of 5%, for the benefit of taxpayers residing in the

[16] Indirect taxes fall exclusively on the production sector, focusing on the production, sale, purchase or use of goods and services and which, in accounting rigour, must be imputed to the operating costs of the paying agents. Indirect taxes are also considered to be revenues in the form of fees, licenses, or similar fees paid by business units.

[17] Fees are revenues paid by individuals (who do not constitute business units, otherwise they are classified as indirect taxes), in return for services received in connection with the application of general regulations, only chargeable as long as the respective services are used. The fees are intended to cover the expenses of public entities, which are based on the payment for the specific provision of a public service.

municipal district. Although the VPIT is not considered a local tax, its revenue reverts in favour of the Portuguese municipalities.

In terms of taxation, there are taxes over which the law grants the Municipalities certain powers, particularly in what regards the creation of taxes, the proceeds of their collection and the instrumental tax administration. They are as follows:

a. Powers regarding the setting of the Municipal Property Tax (IMI) rate, as well as its revenue;
b. Powers regarding the Single Circulation Tax (IUC) product;
c. Powers regarding the setting of the Municipal Tax rate on Transactions (IMT), as well as its revenue;
d. Powers regarding the setting of the Derrama rate and the right to its revenue;
e. Personal Income Tax powers of relief;
f. Capital Gains Tax Receipts

These municipal tax powers essentially have two objectives: to obtain resources that allow the municipalities to carry out their expenses, and to legitimize the local power through its political-financial responsibility for the resources that they will use.

Revenue from local taxes reverts entirely to the municipalities, with the exception of 50% of the IMI revenue product on rural buildings, which reverts to the respective parishes. In addition to the powers of the municipalities regarding the taxes mentioned above, the Local Finance Law gives municipalities the power to have a Variable Participation Rate in the Personal Income Tax, either in whole or in part, up to a limit of 5%, benefiting taxpayers with a tax domicile in their jurisdiction. This is a tax that is not local, nor created for the benefit of local authorities, but its revenue reverts in part to local authorities. Municipal revenue is also constituted by the collection of surcharges levied, up to a limit of 1,5% on taxable income subject to and not exempt from Corporate Income Tax (IRC), which corresponds to the proportion of income generated in the municipality's geographic area.

In 2021, tax revenues accounted for approximately 38% of all revenues for Portuguese municipalities, around €3,656 million, which was a good year for tax revenues, with a real growth rate of 8,96% (+301 million euros) compared to 2020. Upon analysing the structure of tax revenue in 2021, it is clear that the item that contributed the most to this good tax execution was direct taxes, representing 89,7% of tax revenue (3,282.6 million euros), showing a real increase in value of 8.6% when compared to the previous year. Indirect taxes had a weight of approximately 1% in the collected tax revenue, around

34,8 million euros, representing a real decrease of 12,8% when compared to 2020, which had a negative impact on the total tax collection. Finally, fees, fines and other penalties showed a real increase of 16,4% when compared to 2020, representing around 9,6% of the total tax revenue (342,3 million euros).

Table 2 - Value of the Components of Tax Revenue Collected between 2014 and 2021.

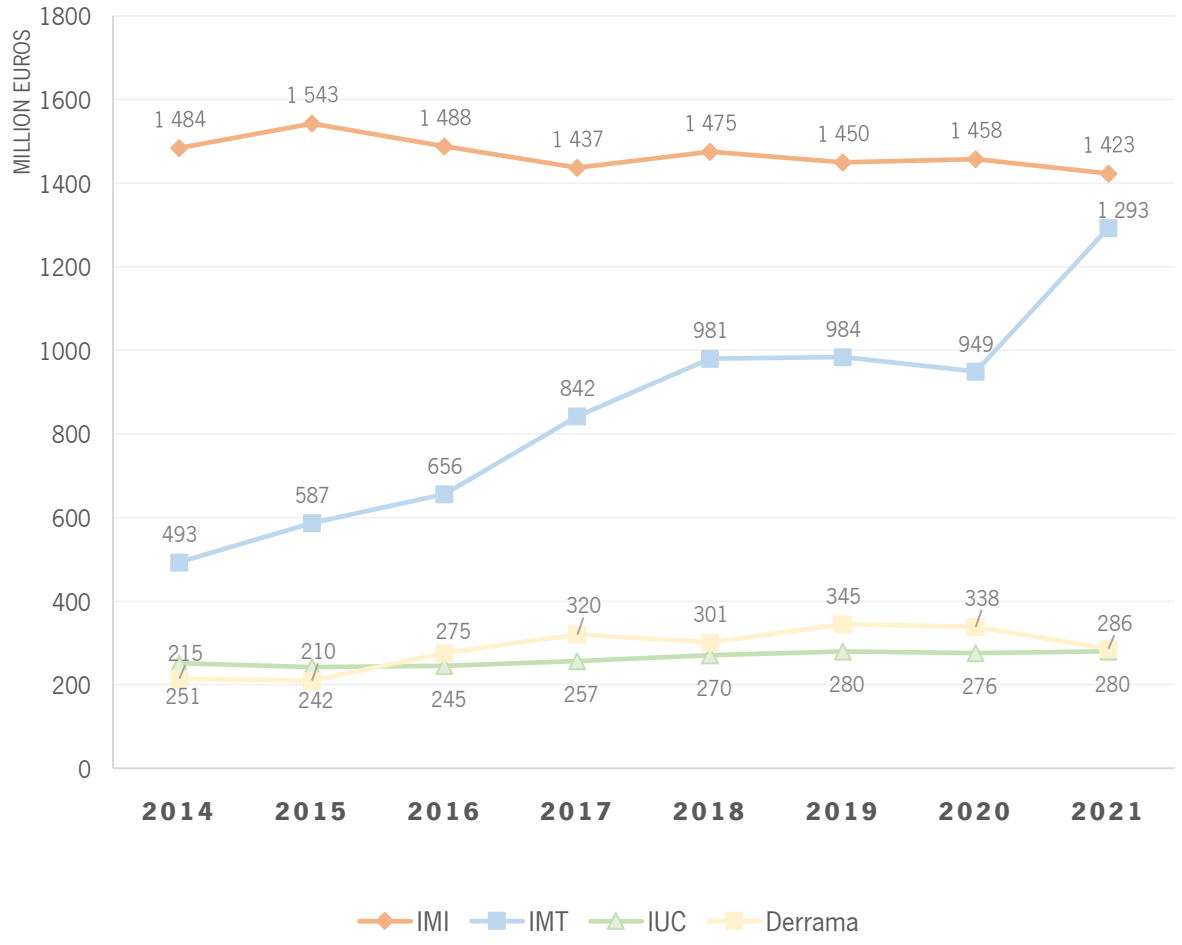
	Mandate 2014 - 2017				Mandate 2018 - 2021				Tax revenue as a % of total actual revenue 2021
	2014	2015	2016	2017	2018	2019	2020	2021	
Direct Taxes	2 451,4	2 581,7	2 664,1	2 858,6	3 028,4	3 058,8	3 021,9	3 282,6	34,4
Indirect Taxes	108,3	122,4	118,8	130,5	146,4	161,5	39,92	34,80	0,36
Fees, fines, and other penalties	187,3	189,9	212,0	201,5	185,9	224,1	293,9	342,3	3,6
Total	2747	2894	2994,9	3190,6	3360,7	3444,4	3355,7	3656,7	38,4

Data Source: DGAL. Own calculations | **Note:** The values, which are in millions of euros, refer to the 308 municipalities, at 2016 prices.

In view of the weight that direct taxes have assumed in total municipal revenues, Figure 3 shows the evolution of the collection of each of its components between 2014 and 2021. Regarding IMI, it is possible to conclude that, in 2021, it resumed its downward trend, registering a real decrease of 2,4%, having contributed to 43,4% of direct taxes (1,423.1 million euros). When analysing the data related to the IMT, we can see its sharp recovery from 2014 onwards, with an extraordinary reinforcement of this trend in 2017 (30,2%). In 2021, after registering a decrease in 2020 (-3,5%), the IMT growth was once

again consolidated by a tax collection amounting to 1,293 million euros. However, the IMT, which was at risk of disappearing as a municipal revenue, has been approaching the value of the IMI, representing, in the fiscal year of 2021, 39,4% of the total direct taxes obtained by the municipalities. The value of the IUC, in 2021, resumes a positive real variation of 1,3%, after a decrease in 2020, representing 8,5% of the total direct taxes. After the significant increase in the amount of the Surcharge in 2017, attesting to the impact of economic growth on the municipal economy, in 2018 there was a slight overall decrease in this revenue (-4,8%). However, in 2019, it showed a new growth of 14,9%. In 2020 and 2021, Derrama showed a decrease in the volume of collection, and in 2021, it represented 8,7% of total direct taxes, which represents a real decrease of about 15%.

Figure 3 - Evolution of the Components of Direct Taxes, between 2014 and 2021



Data Source: DGAL. Own calculations | **Note:** The values, which are in millions of euros, refer to the 308 municipalities, at 2016 prices.

3.3. The Variable Participation Rate in the Personal Income Tax

In seeking to promote local financial autonomy, increasing the municipalities' own revenues, promoting inter-municipal tax competition, and making local elected officials accountable for their decisions, the Local Finance Law of 2007[18] introduced the Variable Participation Rate in the Personal Income Tax by the municipalities. Therefore, municipalities are entitled to a variable participation, of up to 5%, of the Personal Income Tax of taxable persons with a tax domicile in the municipality's area, calculated on the respective net collection of the deductions provided for in paragraph 1 of article 78 of the personal income tax code.

Each year, the Municipalities can decide what to do with these revenues: keep them as income or give them back, partially, or totally, to benefit their local taxpayers. Thus, municipalities must deliberate and communicate the intended percentage to the Tax and Customs Authority, by December 31st of the year prior to the year to which the income relates to. If a percentage lower than the maximum of 5% is deliberated, the product of the difference between the rates and the net collection is considered as a deduction from the Personal Income Tax (PIT) in favour of the taxpayer. However, to benefit from this deduction, the income declaration must be submitted within the legal period established by law. According to Law no. 2/2007 of January 15th, the absence of communication of the Variable Participation Rate in the Personal Income Tax by the municipality to the Directorate General of Taxes or the receipt of the communication after the established deadline would be equivalent to the absence of a deliberation, and in these cases the municipalities would be entitled to the maximum rate of 5%. However, Law no. 73/2013 of September 3rd repealed this principle and established that the lack of communication and the lack of deliberation by the Municipal Council would result in the loss of the right to the variable participation by the municipalities. Finally, Law no. 7/2018 of December 31st of 2018 amended the Local Finance Law approved by Law no. 73/2013 of September 3rd of 2013, establishing that municipalities are entitled to a 5% participation in Personal Income Tax in the absence of communication and deliberation by the Municipal Council.

Portuguese policymakers viewed this new instrument in a positive light as it could potentially result in a decrease in public expenditure while simultaneously reducing the municipalities' reliance on revenue from central government transfers. This anticipation stems from the fact that, with municipalities now

[18] Law no. 2/2007 of January 15th, defines that transfers resulting from participation in state taxes include transfers associated with the Financial Equilibrium Fund (FEF), the Municipal Social Funds (FSM) and the Variable Participation Rate in Personal Income Tax .

empowered to determine the percentage of tax revenue they receive, up to the 5% threshold, policymakers foresee a rise in inter-municipal tax competition and greater local political accountability for financial decisions (Teixeira *et al.*, 2016). Table 3 shows the number of municipalities according to the different rates of VPIT, for the period between 2009 and 2021.

Table 3 - Number of Municipalities according to the VPIT (2009–2021)

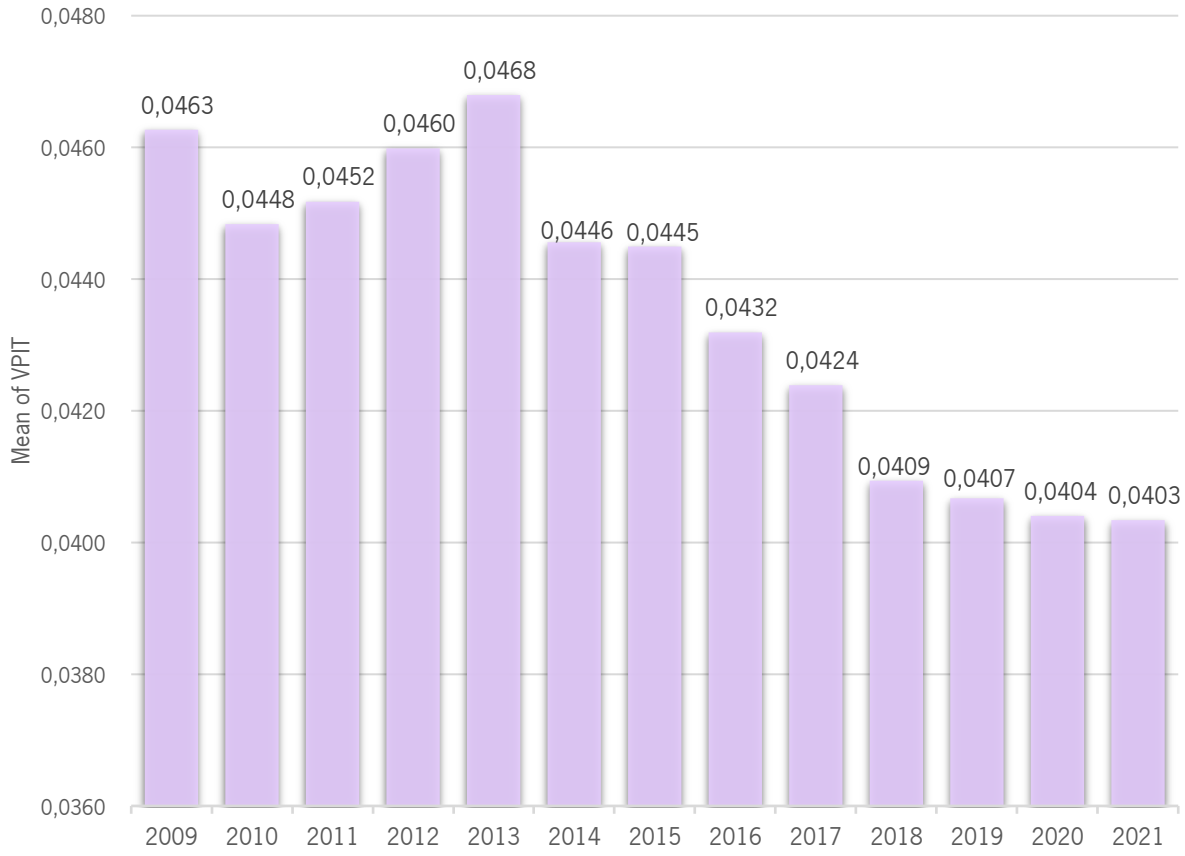
Year	Minimum rate (0%)	Between maximum rate and minimum rate	Maximum rate (5%)	Total
2009	9	35	264	308
2010	13	50	245	308
2011	10	56	242	308
2012	9	43	256	308
2013	6	35	267	308
2014	12	58	238	308
2015	12	64	232	308
2016	18	75	215	308
2017	20	86	202	308
2018	24	94	190	308
2019	25	105	178	308
2020	25	109	174	308
2021	24	106	178	308

Data Source: DGAL. Own calculations

In the period between 2013 and 2021, there has been an increase in the number of municipalities that waive a percentage of the income tax to which they are entitled in favour of their residents, with 130 municipalities offering a percentage of their share to their taxpayers in 2021. In 2013, on average, 86,7%

of municipalities implemented a variable participation rate of 5%, contrasting with 57.8% in 2021. This is visible in Figure 4, where it can be seen that the average municipality VPIT has been decreasing since 2013. However, more than half of all municipalities do not renounce their 5% rate.

Figure 4 - Average Variable Participation Rate in the Personal Income Tax (2009-2021)



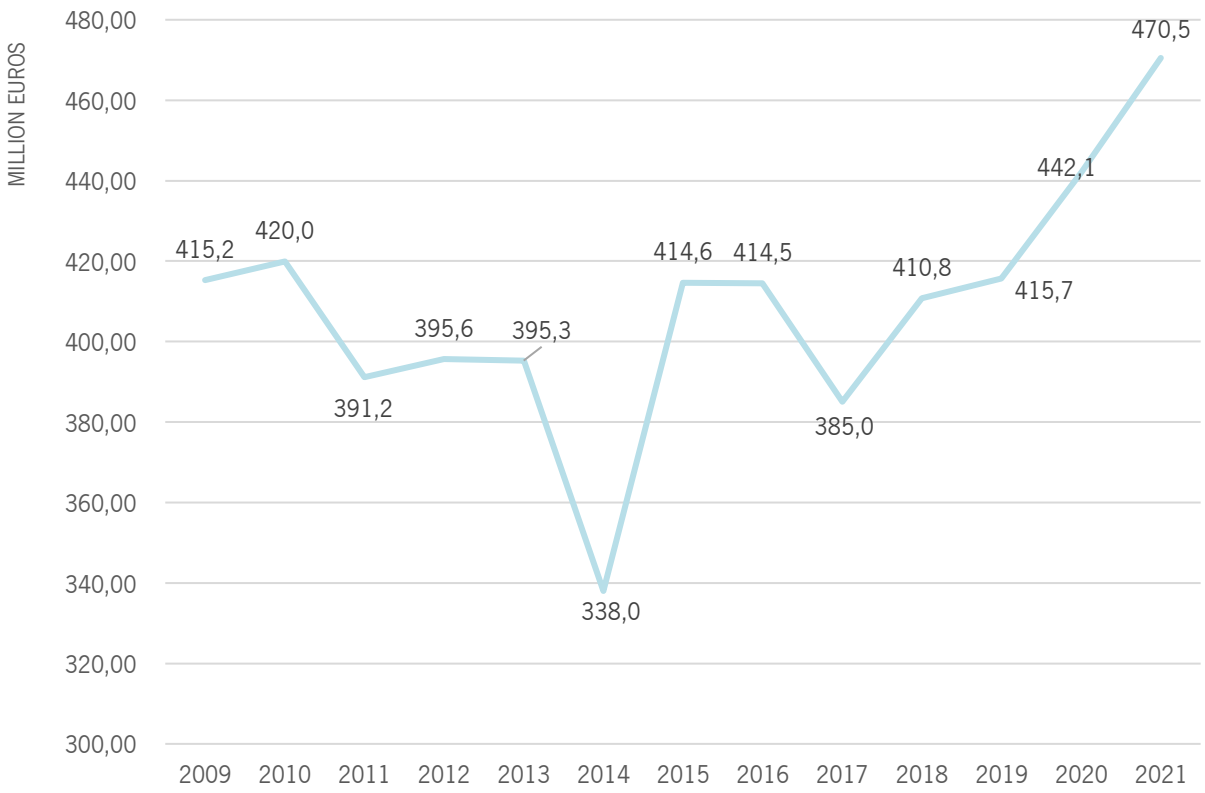
Data Source: DGAL. Own calculations

Regarding the transfers of revenues from the VPIT, upon analysing Figure 5, it is possible to perceive that there is a stable evolution over time, with a sharp decrease registered in the income collected in 2014. In 2014, there was a decrease of approximately 11% in the number of municipalities that applied a variable participation rate of 5% in personal income tax. This can also be seen in Figure 4, where there was a sharp decrease in the average rate of the Variable Participation Rate in the Personal Income Tax, with a decrease of approximately 5 per cent in 2014. This abrupt decrease in the average rate, and consequently in the revenue from transfers resulting from the VPIT, may be related, in part, to the implementation of Law no. 73/2013, of September 3rd, which established that the absence of communication and deliberation by the Municipal Council would lead to the loss of the right to the variable participation by the municipalities, repealing Law no. 2/2007, of January 15th, which established that in

the absence of communication and deliberation the municipalities would be entitled to the maximum rate of 5% .

Despite an increase in the number of municipalities that abdicate their percentage of income tax in favour of their residents, the revenue from transfers resulting from Variable Participation Rate in Personal Income Tax has shown growth, in the last few years. This may be associated with the nature of this tax, which aims at a global and personalised taxation of income, through the adoption of a broad concept of income, a system of progressive rates by brackets, and the relevance of a set of charges and deductions of a personal and family nature. Thus, one of the explanations for the growth in transfer revenue from the Variable Participation Rate in Personal Income Tax in recent years is that household taxable income has increased. In addition, changes to personal income tax rates and the associated brackets could lead to a higher level of personal income tax revenue and, consequently, a higher volume of personal income tax transfers to municipalities.

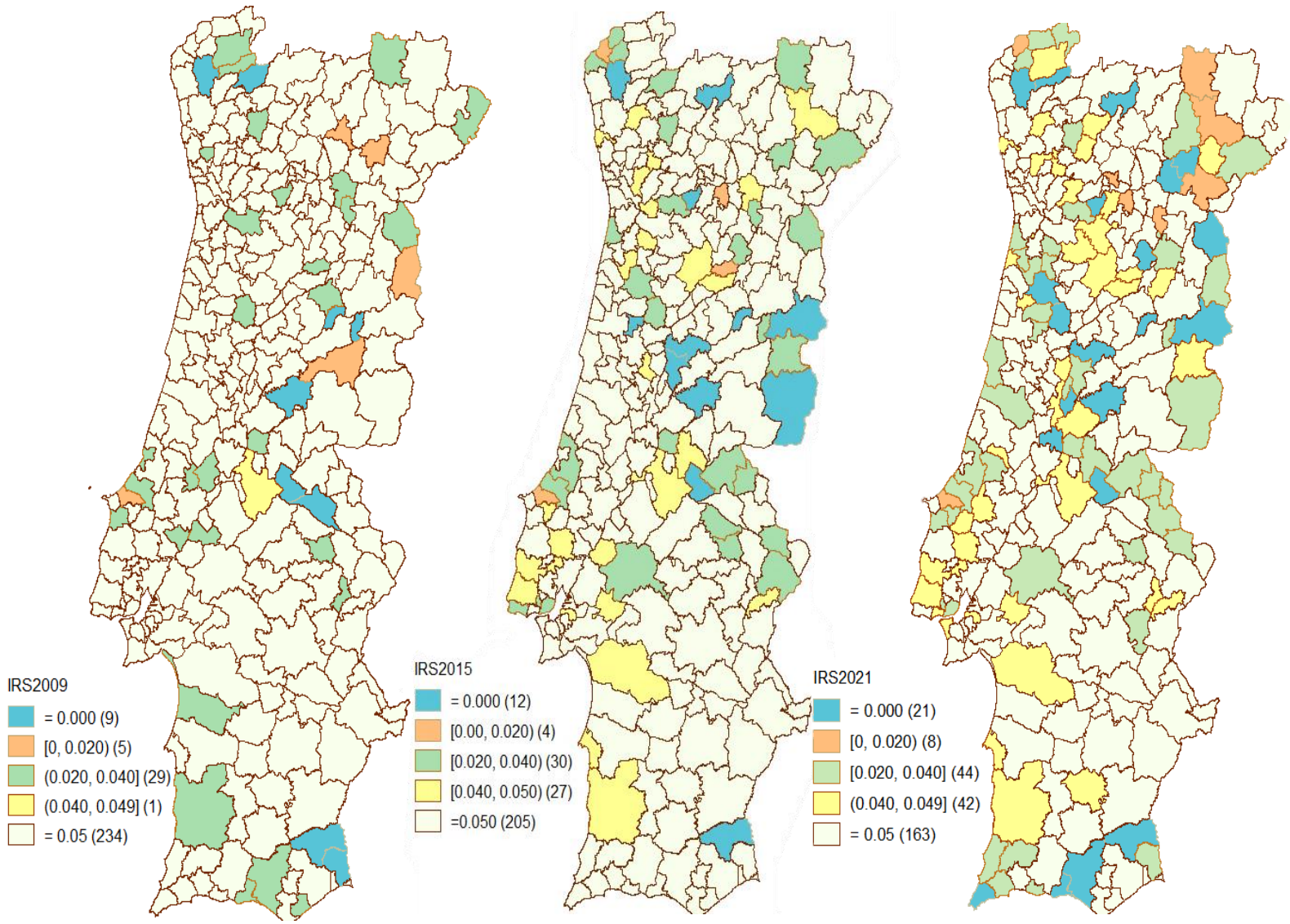
Figure 5 - Transfer Revenues from the Variable Participation Rate in Personal Income Tax (2009-2021)



Data Source: DGAL. Own calculations | **Note:** The values, are in millions of euros, and relate to the 308 municipalities, at 2016 prices.

Figure 6 shows the spatial distribution of the municipalities by Personal Income Tax participation rates, in 2009, 2015 and 2021. As can be seen from the map, the number of municipalities applying the maximum rate has been decreasing over time. Furthermore, it is possible to conclude that the number of municipalities implementing a VPIT rate between the minimum and the maximum has been increasing. As a rule, we can see that the size of the municipality is not directly related to the Variable Participation Rate in the Personal Income Tax rate implemented by municipalities. However, most large urban centres or district capitals do not abdicate of an important revenue like this to balance their municipal accounts, since the revenue from this transfer reaches tens of millions of euros. Sometimes, the smaller municipalities and those located in the interior of the country tend to impose lower rates, because here the loss of tax revenue is small and giving up the Variable Participation Rate in Personal Income Tax can be a way of attracting residents to combat desertification. The truth is that the fewer inhabitants a municipality has, the less taxes are charged (and the amount transferred by the Central Government to that Municipal Council will also be lower), so the financial autonomy of these municipalities is quite low. On the other hand, smaller municipalities may feel the need to take advantage of this transfer, as they feel a greater need to obtain additional revenue, thereby expanding their fiscal capacity, namely with regards to the Variable Participation Rate in Personal Income Tax.

Figure 6 - VPIT applied by Portuguese Municipalities in 2009, 2015 and 2021.



Data Source: DGAL. Own calculations. | **Note:** The numbers in brackets refer to the 278 mainland municipalities.

3.4. Characterization of Portuguese Municipal Elections

Portugal operates as a unitary state comprised of 308 municipalities, all governed by a uniform legal and institutional structure. Established formally by the Constitution of the Portuguese Republic in 1976, municipalities held their inaugural elections in December of that same year, with local governments being managed autonomously from the central administration of the Portuguese Republic.

Municipalities consist of two primary governing bodies: the Municipal Assembly and the Municipal Council. The Municipal Assembly, which is a deliberative organ, is responsible for endorsing the overarching framework of local policies. Conversely, the Municipal Council, an executive body, formulates and executes these policies (Veiga and Veiga, 2007; Veiga and Veiga, 2018). Members of the Municipal Council are chosen through direct elections by registered voters within the municipality, who cast their votes for party-affiliated or independent lists. Over half of the Municipal Assembly's members are elected directly by voters, while the remaining members are comprised of presidents from parish councils within the municipality, who are also elected directly by voters (Martins and Veiga, 2013).

The term of office for local authority office holders is four years, and elections to the Municipal Assembly, the City Council and the Parish Assembly are always held on the same day,[19] with no other concurrent elections (Veiga and Veiga, 2018).[20] The conversion of votes into mandates is done according to the proportional representation system, the d'Hondt method, which stipulates that seats are allocated proportionally to the votes received and that the first candidate on the most voted list becomes mayor/parish president (Veiga and Veiga, 2018).

Presidents of the executive bodies of local authorities - mayors of municipalities and presidents of parish councils - can only be elected for three consecutive terms. The imposition of limits on the successive renewal of mandates of the presidents of the executive bodies of local authorities was introduced by Law no. 46/2005 of August 29th. Thus, since the Law came into force on January 1st, 2006, which was after the 2005 municipal elections, the limitation of mandates only had practical effects in the 2013 elections (Veiga and Veiga, 2018).

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[19] On election day, each voter receives three ballot papers, one for each local election - Municipal Assembly, City Council and Parish Assembly -, choosing their preferred party or independent list of citizens on each of the ballot papers and inserting them in three separate boxes. Due to this procedure, turnout is the same in all three elections (Veiga and Veiga, 2018).

[20] The terms of office for local authority office holders were of three years until 1985, after which they were extended to four years. Until 2001, elections were held in December and then in October.

4. Empirical Framework and Econometric Procedure

From an econometric perspective, the strategic tax interaction in local politics results from the fact that the level of the tax base in a jurisdiction depends both on its own tax rates and on those of other jurisdictions (Revelli, 2002b), that is, there is a significant correlation between the rates among neighbouring municipalities (Bocci *et al.*, 2019). The empirical literature is based on two main theoretical explanations regarding the strategic interactions between local governments: spillover models – environmental models and yardstick competition models - and resource flow models – tax competition and welfare competition models (Delgado *et al.*, 2018). Despite their differences, these models end up presenting the same spatial reaction function in a reduced form (Brueckner, 2003), so that in many cases it is not always immediately clear whether the strategic interaction in taxes comes from tax competition, yardstick competition or both (Allers and Elhorst, 2005).

Empirical models of tax competition specify a reaction function that explains the political decision of a jurisdiction in terms of its preferences, spending and resource needs, and the political choices of neighbouring municipalities (Brueckner, 2003). Thus, when tax rates are chosen strategically, the reaction function, which relates the municipality's tax rate *i* with the characteristics of the municipality itself and with the tax rates of the neighbouring jurisdictions, has a positive (negative[21]) slope, demonstrating that changes in the tax rates of the neighbouring jurisdictions affect the tax rate of the municipality (Brueckner, 2003). Alternatively, if strategic interaction is absent, then the slope of the reaction function equals zero (Brueckner and Saavedra, 2001).

The reaction function of the tax competition models relates the strategic decision variable of each jurisdiction - tax rate -, Y_i , with a series of characteristics of the jurisdiction, X_i, and with the choices of neighbouring jurisdictions in relation to the same strategic variable, Y_j.

$$Y_{it} = \beta \sum_{j=1}^{n_i} w_{ij} Y_{jt} + \theta X_{it} + \varepsilon_{it} \qquad (1)$$

where X_{it} is a matrix of demographic and economic explanatory variables affecting the tax rates of municipality *i*, θ is the vector of parameters to be estimated, and ε_{it} corresponds to the error term, which

[21] If the chances of re-election by a weak government are extremely slim, it will be preferable, considering the tax rates of neighbouring jurisdictions, to increase tax rates, thus accumulating as much income as possible in the first term of office, thereby losing any chances of re-election. In this case, we are facing a situation where yardstick competition gives rise to a negative interaction between the tax rate definitions of neighbouring jurisdictions (Bordignon *et al.*, 2004; Edmark and Ågren, 2008).

is assumed to be normally distributed, with a constant and independent variance between observations. $W_{ij}Y_{jt}$ corresponds to the weighted average of tax rates in neighbouring municipalities, with W_{ij} being the weight matrix of neighbouring municipalities – these weights indicate the relevance of other municipalities in the interaction process. Thus, β is the spatial parameter that measures the interaction between municipal tax rates *i* and the tax rates of neighbouring municipalities. It should be noted that equation (1) implies that the type of interaction of the municipality *i* with all other municipalities is the same, and although the sign of the interaction is defined by β, the magnitude of the effect depends on the relevant weight, that is, on $\frac{\partial Y_i}{\partial Y_j} = \beta W_{ij}$.

A β coefficient different from zero is consistent with theories of strategic fiscal interaction, regardless of whether it is assumed that citizens react to differences in fiscal policy by moving - tax competition -, or whether immobile voters, at the ballot box, punish their elected politicians by expelling them from office - yardstick competition (Edmark and Ågren, 2008). To evaluate whether the strategic interaction stems from yardstick competition, we need to understand whether there is a link between the spatial interaction of tax rates and the political process (Allers and Elhorst, 2005), using the characteristics of the electoral system to identify the effects of yardstick competition. Some of the strategies involve distinguishing the municipalities where the parties in power enjoy a majority in the municipal council and the municipalities where they do not or using the fact that municipalities are surrounded by neighbours who are in different years of the political term and with term limits (Ferraresi, 2020). Regardless of the approach, if strategic interaction is influenced by factors external to the political process, as presupposed by a tax competition, the spatial correlation of tax rates should remain consistent regardless of whether political variables are included. However, if tax interaction is associated with the political process, then we are facing yardstick competition, since strategic spatial interaction is linked to voting behaviour (Sedmihradská, 2013), thus allowing us to rule out tax competition as the driver of strategic interaction (Allers and Elhorst, 2005).

4.1. Definition of Neighbouring Jurisdictions and the Spatial Weights

The choice of the spatial weight matrix that groups the tax rates of other municipalities into a single number is essential in empirical studies on tax competition (Lyytikäinen, 2012). Therefore, correctly selecting the criteria for defining the neighbourhood is imperative, since an incorrect specification of the matrix can give rise to inconsistent estimates and affect the interpretation of the coefficients (Anselin, 1988). The notion of spatial dependence implies that it is necessary to determine which other spatial

units have an influence on that particular unit under consideration – notion of neighbourhood (Anselin, 1988). According to Sedmihradská (2013), the two basic approaches to define neighbourhood are: (1) geographic distance, which considers municipalities that have a physical border in common or that distance less than a certain number of kilometres from each other; (2) municipalities that are somewhat comparable are also considered neighbours since, for example, they could have similar socioeconomic or demographic characteristics. In this study, the criterion of geographical distance will be applied for the definition of neighbourhood. The geographic criterion is supported by two arguments: it is quite likely that the tax bases of geographic neighbours suffer similar shocks, and the geographic neighbours belong to the same communication market and therefore have good information about what is happening in the neighbouring jurisdictions (Bastida, 2019; Besley and Case, 1995; Bordignon *et al.*, 2003). Moreover, using geographical distance to define neighbourhood is relevant for models focusing on tax competition, such as yardstick competition models, as citizens are more likely to move to municipalities which are geographically close and are more likely to have information on the tax situation of the closest neighbouring jurisdictions.

The elements of a spatial weight matrix must be specified *a priori* according to the criterion that reflects the expectations about the spatial pattern of interaction, emphasizing that the elements of the weight matrix are non-stochastic and exogenous to the model (Anselin, 1999). Thus, a spatial weight matrix is a positive matrix in which the rows and columns correspond to cross-sectional observations, being defined, generically, as:

$$W_{ij} = \begin{pmatrix} 0 & w_{ij} & \cdots & w_{ij} \\ w_{ij} & 0 & \cdots & w_{ij} \\ \vdots & \vdots & \ddots & w_{ij} \\ w_{ij} & w_{ij} & \cdots & 0 \end{pmatrix}$$

where w_{ij} represents the proximity between the municipality *i* (on the matrix line) and the municipality *j* (in the matrix column). For convenience, the diagonal values of the matrix are equal to zero, as the municipalities are not considered their own neighbours. The "*neutral*" criterion and usually used to define the geographical spatial matrix is the criterion of binary contiguity, where $w_{ij} = 1$ if municipality *j* shares a physical border with municipality *i* and $w_{ij} = 0$ otherwise, capturing the idea that the interaction is more likely to occur between closely neighbouring municipalities (Edmark and Ågren, 2008; Heyndels and Vuchelen, 1998). However, according to Anselin (1988), the criterion of binary contiguity offers only

a limited representation of the different types of spatial interaction that can be expressed in a model. Thus, different weights are often attributed to neighbouring municipalities, according to the degree to which they affect municipality *i* (Costa *et al.*, 2015). This assignment of different weights to the municipalities may be related to the geographical distance or to other variables that influence the interactions, such as demographic, socio-economic, or political variables.

As a rule, to facilitate the interpretation of spatial variables, spatial weight matrices are standardized - $\frac{w_{ij}}{\sum_j w_{ij}}$ -, so that the sum of elements in each row equals 1. A consequence of this standardization is that the sum of all elements in W equals N, the number of cross-sectional observations. Although the original weights are often symmetrical, the patterned shape of the lines is no longer symmetric, resulting in an unusual complication with significant computational implications (Anselin *et al.*, 2008). Once the notion of neighbourhood is structured and defined by the non-zero elements of the spatial weight matrix W, the dependent strategic variable will consist of the weighted average of the neighbouring values - $WY_{ji} = \sum_{j=1}^{n} w_{ij} Y_{jt}$. In matrix notation, it consists of the matrix product of the matrix of spatial weights, W, with the observations vector, y.

In the present work, following the empirical strategy used by Costa *et.al.*, (2015), the concept of neighbourhood was defined according to the Euclidean distance between the centres of Portuguese municipalities, the weights being equal to the inverse of this measure - $w_{ij} = \frac{1}{dist_{ij}}$. Therefore, firstly, a matrix was constructed that considered all Portuguese municipalities as neighbours (W_T), since Portugal is a relatively small country. Secondly, and in order to investigate the robustness of the results, the municipalities considered to be neighbouring were limited to those that were x or less kilometres away (W_x), x being equal to 30, 50 and 100 km. This is because fiscal interaction is more probable between municipalities that are geographically closer. Across all specifications, the impact of neighbouring municipalities diminishes as the distance between them increases (Costa *et al.*, 2015).

Since it is assumed that municipal tax rates *i* are affected by neighbouring municipalities' decisions regarding their own tax rates, in inverse proportion to distances from *i*, the weights are given by:

$$w_{ij} = \frac{1}{dist_{ij}} \qquad (2)$$

However, once the weights are normalized - $\sum_j w_{ij} = 1$ – then we have to:

$$w_{ij} = \begin{cases} \dfrac{\frac{1}{dist_{ij}}}{\sum_j \frac{1}{dist_{ij}}} & if \;\; 0 < d_{ij} \leq xkm \\ 0 & otherwise \end{cases} \quad (3)$$

4.2. Spatial Dependency Indicators

Assessing the presence of spatial autocorrelation is regarded as one of the main tasks of spatial econometrics (Hubert and Arabie, 1991).

Moran's Global Index – Moran's *I* test – is the most used indicator to assess the presence of global spatial autocorrelation. It was introduced by Moran (1950) and later generalized by Cliff and Ord (1972). Spatial autocorrelation refers to the tendency for similar values to be close to each other in a given geographical space. The Moran *I* test consists of representing the existence of spatial autocorrelation between the areas of a sample, measuring the spatial autocorrelation based on variable values and locations, simultaneously. The Moran I Index can be expressed as:

$$I = \frac{N}{\sum_i \sum_j w_{ij}} \frac{\sum_i \sum_j W_{ij} \varkappa_i \varkappa_j}{\sum_j \varkappa_i^2}, i \neq j \quad (4)$$

where, N is the number of observations, W_{ij} is the element of the matrix of spatial weights corresponding to the pair of observations *i, j* and the observations centred on the means $\varkappa_i$ and $\varkappa_j$.

The result of the Moran's *I* test indicates whether there are significant spatial patterns, *i.e.* whether similar values are grouped together geographically. Thus, Moran's I coefficients can vary between [-1, 1][22]. A coefficient whose value is close to -1 indicates a negative autocorrelation and is related to the dissimilarity of the neighbourhood. On the other hand, a coefficient with a value close to 1 indicates a positive autocorrelation and is related to the similarity of the neighbourhood (Zhang and Lin, 2007).

Thus, the Moran Index can be synthesized into a single value for the entire data set and can be visualized through a scatter diagram proposed by Anselin (1996), where the spatially lagged variable is presented on the vertical axis and the original variable on the horizontal axis. The slope of the linear

[22] This can be seen when the spatial weight matrix is row standardized.

adjustment corresponds to the index value and, as such, negative and significant coefficient values show negative spatial autocorrelation - the value of the variable of interest in a region tends to be different in neighbouring regions - and, in contrast, positive coefficient values reveal positive spatial autocorrelation. In addition to displaying the global measure of spatial linear association, the Moran scatterplot also provides the observation of four quadrants that represent the four different types of spatial linear association between the value of a given region and the mean of its neighbours.

When verifying the existence of spatial autocorrelation, it is necessary to consider the presence of unobserved variables, as these can lead to the correlation of spatial errors. Thus, whenever there are indications that there are correlation problems, the literature recommends the use of alternative methods to the Ordinary Least Square (OLS), such as the Spatial Auto Regressive Model (SAR), which aims to solve problems of spatial dependence between variables or the Spatial Error Model (SEM) when spatial dependency problems are related to errors.

4.3. Spatial Econometric Models

The empirical literature on spatial econometrics presents a plethora of spatial linear regression models, which can be used empirically to detect and measure spatial interaction effects. Anselin (1988) developed two main models to describe spatial interaction: the spatial lag model and the spatial error model.

Let us start by considering a simple linear regression model with specific spatial effects but without spatial interaction effects (Elhorst, 2010):

$$y_{it} = \varkappa_{it}\,\theta + \mu_i + \varepsilon_{it} \quad (5)$$

where each period is given by $t = 1 \ldots, T$. y_{it} corresponds to the column vector of the dependent variable, $\varkappa_{it}$ is a matrix of exogenous explanatory variables, with a corresponding vector of fixed but unknown parameters - θ. ε_{it} corresponds to the independent and identically distributed error term for all observations, with zero mean and variance σ^2, and μ_i represents a municipality specific fixed effect.[23]

[23] According to Elhorst (2010), spatial specific effects account for all time-invariant and spatially specific variables, the exclusion of which could distort estimates in a typical cross-sectional study. Spatial units are likely to vary in their background characteristics, which are usually spatially specific and time-invariant factors affecting the dependent variable but are challenging to measure or obtain. One solution is to introduce an intercept variable μ_i representing the impact of omitted variables, unique to each spatial unit under consideration (Elhorst, 2021).

The specification models of interaction between spatial units can contain a spatially lagged dependent variable – spatial autoregressive model (SAR) – or a spatial autoregressive process in the error term – spatial error model (SEM). In the SAR model, it is assumed that the municipal tax rate *i* depends on the tax rate of neighbouring municipalities and a set of observable local characteristics (Allers and Elhorst, 2005; Anselin *et al.*, 2008; Elhorst, 2010).

$$y_{it} = \beta \sum_{j=1}^{N} w_{ij} y_{ij} + \varkappa_{it}\, \theta + \mu_i + \varepsilon_{it} \quad (6)$$

Where β represents the spatial autoregressive coefficient, w_{ij} is an element of the matrix of spatial weights W, which describes the spatial arrangement of observations and μ_i represents municipality-specific time-invariant characteristics. It is assumed that $\mu \sim N(0, \sigma_\mu^2)$ in case the estimation is carried out using random effects (RE), while in the estimation with fixed effects[24] (FE), μ is a vector of parameters to be estimated (Belotti *et al.*, 2017). According to the empirical literature on strategic interactions between local governments, the spatial lag model is theoretically compatible with the hypothesis that municipal tax rates *i* interact with the tax rates of nearby jurisdictions (Allers and Elhorst, 2005; Brueckner, 2003).

On the other hand, the SEM model assumes that the municipal tax rate *i* depends on a set of observable local features - structural features of the jurisdiction and that the error terms are correlated in space (Allers and Elhorst, 2005; Anselin *et al.*, 2008; Elhorst, 2010)

$$y_{it} = \varkappa_{it}\, \theta + \mu_i + \phi_{it}\ ,\ where\ \ \phi_{it} = \rho \sum_{j=1}^{N} w_{ij} \phi_{it} + \varepsilon_{it} \quad (7)$$

where ϕ_{it} reflects the spatially autocorrelated error term and ρ represents the spatial autocorrelation coefficient. In the SEM model, a positive and significant ρ coefficient can also be evidence of fiscal interaction between municipalities (Bordignon *et al.*, 2003). According to the empirical literature, the spatial error model is theoretically compatible with the hypothesis that the tax rate determinants omitted in the model are spatially autocorrelated and with a situation in which unobserved shocks follow a spatial pattern (Delgado and Mayor, 2011; Elhorst, 2010). A spatially autocorrelated error term can also be

[24] In the fixed effects model, a dummy variable is introduced for each spatial unit and for each time period (except one to avoid perfect multicollinearity) (Elhorst, 2021).

interpreted as a mechanism to correct the rent-seeking policy (Allers and Elhorst, 2005; Brueckner, 2003).

According to Belotti *et al.*, (2017), the SEM model can be considered a special case of the Spatial Autocorrelation Model (SAC) and the Spatial Durbin Model (SDMs). The Spatial Autocorrelation Model, also called Spatial Autoregressive Model with Spatially Autocorrelated Errors (SARAR), assumes the combination of the SAR model with autoregressive perturbations (a spatial autoregressive error):

$$y_{it} = \beta \sum_{j=1}^{N} w_{ij} y_{ij} + \varkappa_{it}\, \theta + \mu_i + \phi_{it}\ ,\ where\ \ \phi_{it} = \rho \sum_{j=1}^{N} m_{ij} \phi_{it} + \varepsilon_{it} \qquad (8)$$

Where *m* corresponds to the matrix of spatial weights, which may or may not be equal to *w* (Belotti *et al.*, 2017).

The Spatial Durbin Model (SDM) is a generalization of the Spatial Autoregressive Model, which contains a spatially lagged dependent variable but also includes spatially lagged independent variables as explanatory variables (Belotti *et al.*, 2017; Elhorst, 2010)

$$y_{it} = \tau y_{it-1} + \rho W Y_{it-1} + \beta \sum_{j=1}^{N} w_{ij} y_{ij} + \varkappa_{it}\, \theta + \mu_i + \varepsilon_{it} \qquad (9)$$

4.4. Econometric Issues

According to the literature on spatial econometrics, there are three important spatial econometric issues associated with the estimation of equation (1) which call into question the success of the estimates: (i) endogeneity of the variable measuring the tax setting behaviour of other jurisdictions; (ii) dependence on spatial errors and (iii) correlation between the characteristics of each jurisdiction (X_i) and the error term (ε_i).

In the presence of strategic interactions, the municipalities' strategic variables, namely tax rates, are jointly defined – municipal tax rates *i* depend on those of *j*, but the tax rates of *j* also depend on the tax rates of *i* – therefore, in equilibrium, the strategic variables are endogenous. In the presence of endogeneity $\sum_{j \neq i} w_{ij} Y_{it}$ is correlated with the vector of the error term, ε_{it}:

$$E\{\varepsilon_{it}\, WY_{it}\} \neq 0 \qquad (10)$$

which implies that the OLS estimates of the slope of equation (1) – parameter β – are biased, inconsistent, and invalid for models that incorporate spatial effects. Thus, to obtain consistent estimates

of the fiscal interaction parameter, it is necessary to apply a simultaneous estimation procedure (Solé-Ollé, 2003). There are two alternative methods capable of overcoming the weaknesses of the OLS estimator suggested by the literature: maximum likelihood methods (ML) and instrumental variables (IV). Another approach is to consider that the interaction between municipalities happens with a time delay, which eliminates simultaneity issues. This adjustment makes the Ordinary Least Squares (OLS) estimate consistent (Brueckner, 2003).

Another empirical problem related to the estimation of spatial models is that sometimes the error term can be spatially dependent. As a rule, it is assumed that the variance-covariance matrix of the error term, ε, is proportional to the identity matrix, indicating that the error term is independent in between comments (Brueckner and Saavedra, 2001). When this assumption is violated and the error term is spatially dependent, the error term vector satisfies the following condition:

$$\varepsilon_{it} = \lambda W \varepsilon_{it} + \mu_{it} \quad (11)$$

where μ_{it} represents a white noise error term, which is not correlated across municipalities.

The spatial dependence of errors is correlated with the autocorrelation of omitted variables, that is, when ε includes omitted variables, which are not captured by Y, and which are themselves spatially dependent (Brueckner and Saavedra, 2001). If this spatial dependence of the error is ignored, the model estimation may indicate false evidence of strategic interactions. There are several methods to deal with this problem. One approach is to use the estimating the ML method, by incorporating the error structure, another approach is to use the IV method, which generates consistent estimates of fiscal interaction even in the presence of spatial correlation of the error term (Brueckner, 2003). It is also possible to estimate the model using the ML method under the assumption that the spatial error dependency is absent, relying on hypothesis testing to verify this absence (Brueckner, 2003).

If there is a correlation between the characteristics of the municipalities (X_i) and the error term, the ML and IV estimates become inconsistent. One approach to address this issue is to identify appropriate instruments for the dependent variables, although this can be challenging. An alternative method is to utilize panel data, where the estimation accounts for time-varying jurisdiction characteristics, whether observed or unobserved, through jurisdiction-specific intercepts. Additionally, panel data analysis can help mitigate spatial dependence in errors (Brueckner, 2003).

Although the ML and IV methods are the most used approaches in the literature, some authors argue that these methods do not offer a reliable identification of causal relationships (Gibbons and Overman, 2012; Parchet, 2019). The IV method assumes that the sociodemographic or political

characteristics of neighbouring municipalities are exogenous and can be excluded from the second phase in which the tax rate of a given municipality is explained and, therefore, used as instruments for the tax rates of other municipalities (Baskaran, 2014). However, this assumption may not hold, as the characteristics of neighbours can have a direct effect on the tax rates of a given municipality, and it is also plausible that the neighbours' tax policies have a direct effect on their own demographic structure, levels of performance and other characteristics.

The IV approach faces an additional challenge wherein the instrumental variables frequently exhibit limited predictive capability, resulting in a weak instrument issue. This is particularly pronounced in a panel data fixed effects context, where a weak correlation between the instruments and the error term can significantly introduce bias. Furthermore, the spatially correlated omitted variables can influence both the characteristics of neighbours and the tax rate in each municipality (Baskaran, 2014; Gibbons and Overman, 2012; Lundberg, 2021). Thus, the method of instrumental variables can give rise to invalid instruments due to the endogenous selection of the population and the existence of spatially correlated local shocks. According to Parchet (2019), the solution involves isolating variations in the tax rate of competing jurisdictions that can plausibly be considered exogenous.

5. Exploratory Data Analysis

5.1. Econometric Model

The main objective of this dissertation is to understand whether there is evidence of fiscal strategic interaction between municipalities by the imposition of the Variable Participation Rate in the Personal Income Tax of municipalities. Thus, the empirical model consists of an equation in which the VPIT of municipality *i*, in year t (τ_{it}), depends on the municipality's own characteristics (mun_i) and on the VPIT of neighbouring municipalities (τ_{jt}), in that same year. Thus, the empirical model has the following form:

$$\tau_{it} = \beta_1 + \gamma\tau_{it-1} + \alpha \sum w_{ij}\, \tau_{jt} + \beta_2 mun_{it-1} + year_t + id_i + \varepsilon_{it} \qquad (12)$$

where $w_{ij}\tau_{jt}$ corresponds to the average Variable Participation Rate in the Personal Income Tax of the neighbouring municipalities weighted by the distance between them. The coefficient α captures the degree of spatial strategic interaction of municipalities, *i.e.*, it allows us to check whether municipalities consider the rates set by neighbouring municipalities when choosing their tax base (Carvalho *et al.*, 2011). Thus, if the estimated coefficient of the variable is statistically significant, we are facing a situation of fiscal strategic interaction, *i.e.*, a change in the VPIT of neighbouring municipalities gives rise to a strategic change in the participation rate of municipality *i*. In the case of tax competition, we expect the coefficient to be positive, while in the framework of yardstick competition both a positive and a negative coefficient are possible (Bastida *et al.*, 2019; Costa and Carvalho, 2013). It is assumed that municipalities observe and react to the contemporaneous tax rates of their neighbours, with strategic interactions occurring simultaneously and not with a year's delay. Note that it is possible to make such an assumption since, in Portugal, municipalities decide on the variable tax rate to be set between the months of September and December of the previous year, and they can react to the tax rate decisions of their neighbours by revising their tax rate and changing it accordingly.

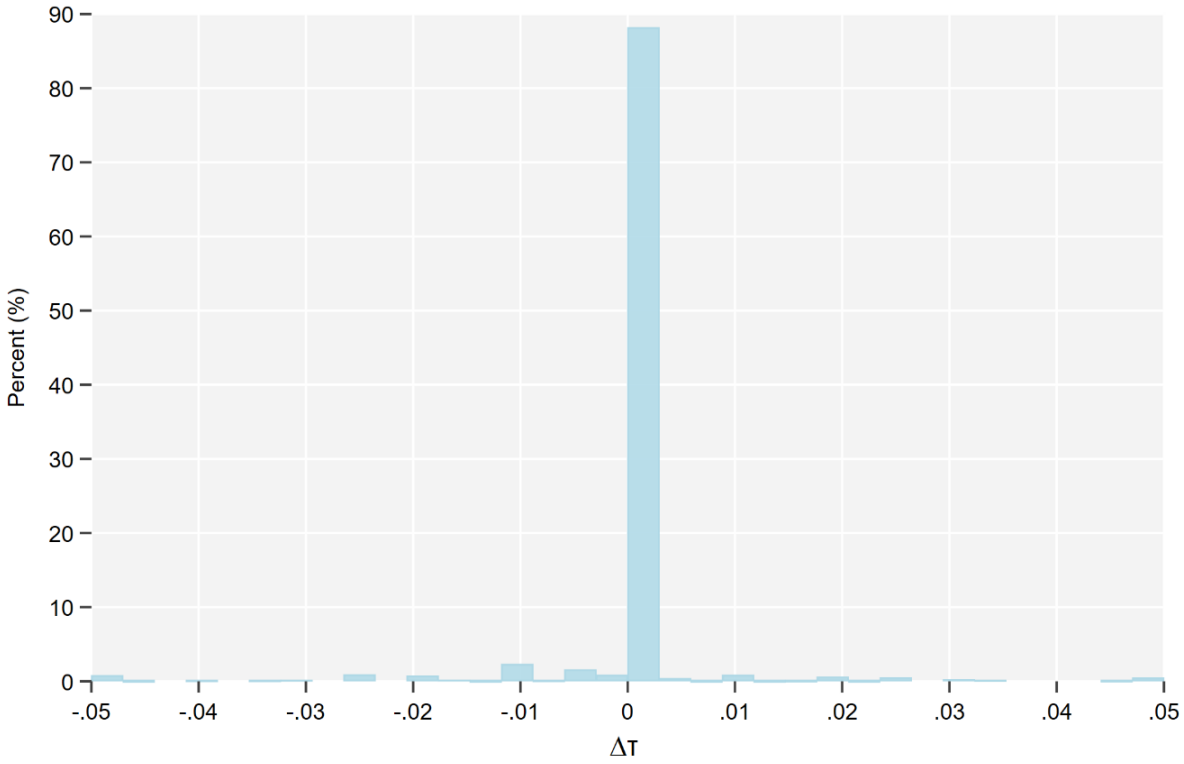
The empirical model also includes the individual municipality's (id_i) and time ($year_t$) fixed effects and an error term ε_{it}. The municipal fixed effects allow controlling for circumstances specific to each municipality that influence the tax rate, but that remain relatively constant during the analysed period, for instance, local political market characteristics, the existence of urban centres within the municipality, specific differences in the demand for public goods, among others. Temporal fixed effects, which capture time variant unobserved factors that are common to all municipalities (Lyytikäinen, 2012), are introduced in order to control for shocks that are common to all municipalities in the sample but

change from year to year. These shocks may reflect changes in laws, changes in the national political environment or general economic fluctuations that affect municipal tax bases (Solé Ollé, 2003). It is crucial to incorporate both the individual municipal effect and the time effect to mitigate the correlations in the Variable Participation Rate in Personal Income Tax across jurisdictions, stemming from common national-level shocks, and to avoid spatial significance (Case *et al.*,1993; Costa *et al.*, 2015).

$mun_{i,t-1}$ corresponds to the matrix of socioeconomic, demographic, and fiscal variables of municipality *i.* The local characteristics of municipality *i* are lagged one period because municipalities set the tax rate *ex ante*, *i.e.*, they decide on the following year's tax rate based on last year's values of socioeconomic and fiscal variables. Furthermore, all control variables are lagged by one period to avoid endogeneity biases.

In addition, the lag of the dependent variable, τ_{it-1}, was included in the equation as an explanatory variable. The inclusion of the lagged dependent variable may reflect a kind of inertia in adjusting to past commitments and incremental budgeting routines that slow down tax-setting behaviour at the local level (Bastida *et al.*, 2019; Revelli, 2001). Furthermore, the Variable Participation Rate in Personal Income Tax chosen by the municipalities exhibits a high level of persistence. This is clearly visible in the histogram below (Figure 7), relating to the first differences of the dependent variable τ_{it} $(\Delta\tau_{it})$.

Figure 7 - Histogramme of $\Delta\tau_{it}$



Data Source: DGAL. Own calculations | **Note:** The values refer to the 278 mainland municipalities, between the years 2009 and 2020.

The lagged dependent variable, τ_{it-1}, will be related to the individual municipal effects - id_i -, since by construction we have that:

$$\tau_{it-1} = \beta_1 + \gamma\tau_{it-2} + \alpha \sum w_{ij}\, \tau_{jt-1} + \beta_2 mun_{it-2} + year_{t-1} + id_i + \varepsilon_{it-1} \quad (13)$$

According to Arellano and Bond (1991), in order to eliminate the individual effects correlated with the covariates and the lagged dependent variable, the first differences model should be applied to individual *i* at time t. However, after applying first differences to remove the fixed effects, it turns out that the lagged dependent variable - τ_{it-1} – is correlated with the error term - ε_{it-1} -, so the OLS estimator applied to the first differences equation will be strongly negatively biased.

In order to solve this problem, it is possible to use as instruments for the lagged dependent variable in the first-order equation - $\Delta\tau_{it-1}$ - the lagged dependent variable from two or more previous periods - which are not correlated with the other individual differences, assuming that there is no serial correlation in ε_{it} (Costa *et al.*, 2015; Revelli, 2001). Thus, estimation can be conducted by using instrumental variables, more specifically the Generalised Method of Moments (GMM), which combines

the instruments effectively, estimating the model parameters directly from the moment conditions (Costa *et al.*, 2015). However, as previously mentioned, it is presumed that the Variable Participation Rate in Personal Income Tax chosen by the municipalities has a level of persistence, so using the System GMM (Sys - GMM) estimator may be the most appropriate solution. The idea is to estimate a system of equations that combines the conditions of the first differences model and the levels model, by using the lagged values of the first differences as instruments for the level equations (Bond *et al.*, 2001). This estimator is especially suitable when there is a high level of persistence in the dependent variable, as it tends to be less biased and more accurate in such cases.

However, effectiveness depends on the "correct" choice of instruments, which is not easy to determine (Kukenova and Monteiro, 2008). To evaluate the instruments used, the Sargan test is implemented, or Hansen's test in the presence of heteroscedasticity, for over-identification restrictions - the null hypothesis is that the instruments are not correlated with the differentiated first-order residuals (Kukenova and Monteiro, 2008). Secondly, the Arellano-Bond autocorrelation test is implemented, which examines the serial correlation of the residuals. First-order correlation exists by definition, since $\Delta\varepsilon_{it} = \varepsilon_{it} - \varepsilon_{it-1}$ and $\Delta\varepsilon_{it-1} = \varepsilon_{it-1} - \varepsilon_{it-2}$, however, the presence of second-order correlation would indicate the existence of first-order correlation of the level residuals, which would invalidate the moment conditions. Therefore, if this situation were to occur, only lags of three or more periods of the dependent variable could be used as valid instruments.

5.2. Data

The $mun_{i,t-1}$ corresponds to the matrix of socioeconomic, demographic, and fiscal variables of municipality *i* that affects the imposition of the Variable Participation Rate in the Personal Income Tax of municipality *i*. To be precise, matrix $mun_{i,t-1}$ consists of the following variables:

i. $PopDens_{i,t-1}$ represents the population density of municipality *i* at time t-1. This variable captures congestion costs or economies of scale in the provision of public goods. Furthermore, it is a proxy for the level of urbanization (Costa *et al.*, 2015). The expected sign of the coefficient of this variable may be ambiguous, since municipalities with lower population density may try to attract population by decreasing the VPIT - the coefficient will be positive. On the other hand, the estimated coefficient may have a negative sign, since highly populated municipalities benefit from urban agglomeration economies (lower costs) in the provision of public goods, and therefore are more capable of establishing lower tax rates (Carvalho *et al.*, 2011).

ii. $Depend_{i,t-1}$ represents the ratio between the elderly population (population over 65 years old) and the young population (population under 15 years old) and the active population (population between 15 and 64 years old). This variable captures the social vulnerability of the municipality, being an important variable in the decision to set taxes, since these population groups require specific services that are provided by local authorities. Municipalities with a high proportion of a young and elderly population are more socially vulnerable, having a lower capacity to set higher tax rates (Costa and Carvalho, 2013). On the other hand, these municipalities have a higher level of expenditure due to the needs of these population groups, which is why they are expected to establish higher tax rates (Carvalho *et al.*, 2011). Thus, the predicted sign of the coefficient of this variable is ambiguous (Padovano and Petrarch, 2014).

iii. $Unemp_{i,t-1}$ corresponds to a proxy of the unemployment rate of the municipality *i*, that is, it is the ratio between the number of unemployed individuals registered at employment centres and the resident population aged 15 or over. This variable can be treated as a proxy for the local economic situation. Municipalities that have a higher unemployment rate are not able to set very high tax rates, as unemployment affects residents' ability to pay taxes. Thus, the estimated coefficient of this variable is expected to have a negative sign (Bordignon *et al.*, 2003; Gérard *et al.*, 2010).

iv. $Income_{i,t-1}$ represents the Average Monthly Earnings of Employees. This variable reflects the relative capacity of the municipalities' tax base, and the rise in the average monthly income of the municipality's taxpayers is linked to an increase in the tax base of the local income tax. In addition, income can be an indicator of willingness to pay for public services. Thus, it is expected that the estimated coefficient of this tax variable will have a positive sign, since municipalities whose residents have higher average incomes have a greater ability to set higher taxes. Additionally, residents with higher incomes are more demanding, seeking more and better public services, leading local governments to set higher average tax rates to satisfy taxpayers' needs (Edmark and Ågren, 2008). It should be noted that disposable income is potentially endogenous, as a high tax rate may crowd out wealthier citizens. However, it is also possible that municipalities whose citizens have a higher average income apply a lower tax rate to raise the same amount of tax revenue as a municipality whose citizens have a lower average income. Therefore, a negative estimated coefficient associated with this variable is also plausible.

v. $Transf_{i,t-1}$ represents total real per capita transfers from the central government to municipalities after deducting transfers related to the Variable Participation Rate in Personal Income Tax. According to the literature, an increase in per capita transfers from the central government is associated with a reduction in tax rates, as they become less dependent on own tax revenues (Padovano and

Petrarca, 2014). Moreover, Bucovetsky and Smart (2006) demonstrate that transfers from central governments can curb tax competition among local governments, rectify fiscal imbalances, and augment government expenditure. Consequently, the anticipated coefficient for this fiscal variable is expected to be negative.

vi. $OwnRev_{i,t-1}$ represents the municipalities' own revenues per capita. An increase in own revenues is expected to be related to the decrease in the VPIT, since municipalities that present a more diversified tax base will not be so dependent on the revenue coming from the VPIT. Thus, the estimated coefficient of this fiscal variable is expected to have a negative sign.

vii. $Debt_{i,t-1}$ represents the total real debt per capita of the municipalities. Municipalities that have a higher level of debt may impose higher tax rates in order to meet the debt. Thus, the estimated coefficient of this fiscal variable is expected to have a positive sign.

viii. $Elect_{i,t}$ [25] consists of a dummy variable, which takes the value of 1 in the year of local elections. This variable allows for the controlling of the existence of electoral cycles, which, according to models of political budget cycles, are associated with opportunistic behaviours by mayors. That is, the mayor, in order to demonstrate his competence, tends to impose lower tax rates in the years close to elections and in election years in order to increase his chances of re-election (Bordignon *et al.*, 2003; Solé-Ollé, 2003). Therefore, the estimated coefficient of this policy variable is expected to have a negative sign.

In order to avoid major scale differences and to reduce the effect of outliers, all explanatory variables, apart from the population density, percentage of dependent population and the unemployment rate, were expressed in logarithms. In addition, all monetary variables were deflated to make it possible to compare data over time and between municipalities of assorted sizes.

To evaluate the strategic interactions between spatial units over time, panel data were used, thus allowing the observation of the behaviour of the 278 municipalities that constitute the Portuguese mainland, during the 2009-2020 period. Based on the empirical assumption that tax competition between municipalities is inherent to the existence of territorial contiguity, it was decided that the municipalities of Madeira and Azores should not be considered, since only this way would it be possible to reach adequate and viable conclusions regarding tax competition between municipalities. Using panel

[25] Initially, a variable related to the electoral year was added, but it was removed from the estimations due to collinearity problems with the year's fixed effects.

data has several advantages, namely the possibility to estimate more complex models when compared to cross-sectional data, the provision of a greater number of informative data, allowing for a greater control of unobserved local features and a lower collinearity between variables, resulting in greater estimation efficiency. Furthermore, the use of panel data helps to eliminate the spatial dependence of the error, which arises from the spatial autocorrelation of the omitted variables (Allers and Elhorst, 2005; Brueckner, 2003; Elhorst, 2010).

The data from the management accounts of the municipalities were extracted from the *General Directorate of Local Authorities* (DGAL). Sociodemographic data such as total population density and active population were obtained from *Marketest's Sales Index* (SI), the total dependency ratio and the average monthly earnings on behalf of others were extracted from the *National Institute of Statistics* (INE). Due to the lack of data on the annual unemployment rate for the municipalities, it was necessary to calculate proxies for it. Thus, the average number of registered unemployed people living in a given municipality and year was divided by the labour force living in the same municipality and year. The data referring to the number of unemployed people were obtained through the *Institute of Employment and Training* (IEFP[26]). Data referring to municipal elections were obtained through the National Elections Commission (CNE). Table 4 shows all the variables used in this study, their description and source.

[26] Due to the lack of annual data on unemployment by municipality, we opted to calculate an average using the monthly information released by the IEFP.

Table 4 - Description of the Variables used.

Variable	Description	Source
VPIT	Variable Participation Rate in the Personal Income Tax	DGAL
PopDens	Population Density	SI
Depend	Total Dependency Index	INE
Unemp	Unemployment Rate	IEFP
Income	Average Monthly Earnings of Employees	INE
Transf	Total Transfers received by Municipal Councils deducting transfers related to the Variable Participation Rate in the Personal Income Tax Per Capita	DGAL
OwnRev	Total Municipal Own Revenues Per Capita	DGAL
Debt	Total Debt of Municipal Councils Per Capita	DGAL
Elect	Election Year	CNE

Table 5 presents the descriptive statistics of all variables, and it also provides the correlation matrix of these variables in Appendix A. There are eight continuous variables and one dummy variable. Panel data is heavily balanced and the number of observations for each variable varies between 3300 and 3336, with values ranging from zero to 7799.

Regarding the dependent variable, VPIT, it has an average of 0.04, with the minimum and maximum indicating the rate margin – between 0 and 0.05. It is possible to conclude that the VPIT presents a greater variation between municipalities than over time in the same municipality. The population density varies greatly between observations, with municipalities having a maximum of 7799,8 inhabitants per km^2, contrasting with a minimum of 3,6 inhabitants per km^2. Such results explain the imbalance in population distribution across the Portuguese territory, with a notorious contrast between municipalities located on the mainland's coastal strip and those located inland. With regards to the percentage of dependent population, we can conclude that there is a disparity between the municipalities,

with municipalities with a very high dependency ratio, presenting a high dependency of young and/or elderly people in relation to the working age population, which may be associated with different financial pressures for municipalities. The same can be seen in the analysis of the unemployment rate, the average unemployment rate is 7,3%, however there is a high variation between observations, with municipalities with unemployment rates well above the average – 23,4% – and municipalities well below the average – 1,98%. Regarding the average monthly income, the average stands at 923,15 euros, with a high dispersion between municipalities. Transfers from the Central Government amount, on average, to 690,82 euros per capita, with a standard deviation of 485,60 euros. In addition, it is possible to verify that the amounts are quite different, with the maximum total transfer received by a municipality being 3.455,95 euros per capita, while the minimum is 75.47 euros per capita. Concerning own revenues, it can be seen that there is a great disparity between the municipalities, with some municipalities having own revenues of 2,602.95 euros per capita and others having own revenues of 68.99 euros per capita. Analysing Table 5, it is possible to conclude that there is, also, an extreme disparity between the municipalities in terms of their debt per capita. This result explains the significant dependence of some municipalities on transfers from the Central Government, their low financial independence, as well as the disparity of the finances of the Portuguese municipalities. Lastly, it should be noted that 25% of the observations correspond to municipal election years.

Table 5 - Summary Statistics

	Variable Type	Units	No. Obs	Mean	Stand. Dev.	Min	Max
VPIT	Continuous	Percentage	3 336	0.0435099	0.0132172	0	0.05
Population Density	Continuous	No. of Inhabitants per Km^2	3 336	306.6106	841.6166	3.6	7799.8
Depend	Continuous	Percentage	3 336	0.597442	0.11113	0.371	1.15
Unemp	Continuous	Percentage	3 336	0.073051	0.02781	0.01981	0.23413
Income	Continuous	Euros	3 336	923.1543	166.943	673.3326	2299.694
Transf	Continuous	Euros	3 336	690.8226	485.6018	75.4731	3455.955
OwnRev	Continuous	Euros	3 336	375.2347	207.3051	68.99473	2602.947
Debt	Continuous	Euros	3 330	706.3441	749.3859	0	7277.88
Elect	Dummy	-	3 336	0.25	0.4330776	0	1

Data Source: DGAL, IEFP, INE, SI | **Notes:** Monetary values are expressed in real euros per capita (at 2016 prices). Data refer to the period between 2009 and 2020 for the 278 municipalities in mainland Portugal.

6. Empirical results

6.1. Spatial Dependence

To assess the existence of spatial dependence in the definition of the Variable Participation Rate in the Personal Income Tax, Moran's spatial statistical / test was conducted, using cross-sectional data for the period between 2009 and 2020.

Based on the matrix of spatial weights, Moran's / statistic assesses the presence of spatial autocorrelation based on locations and it features values simultaneously. Thus, the absence of spatial correlation is assumed as a null hypothesis:

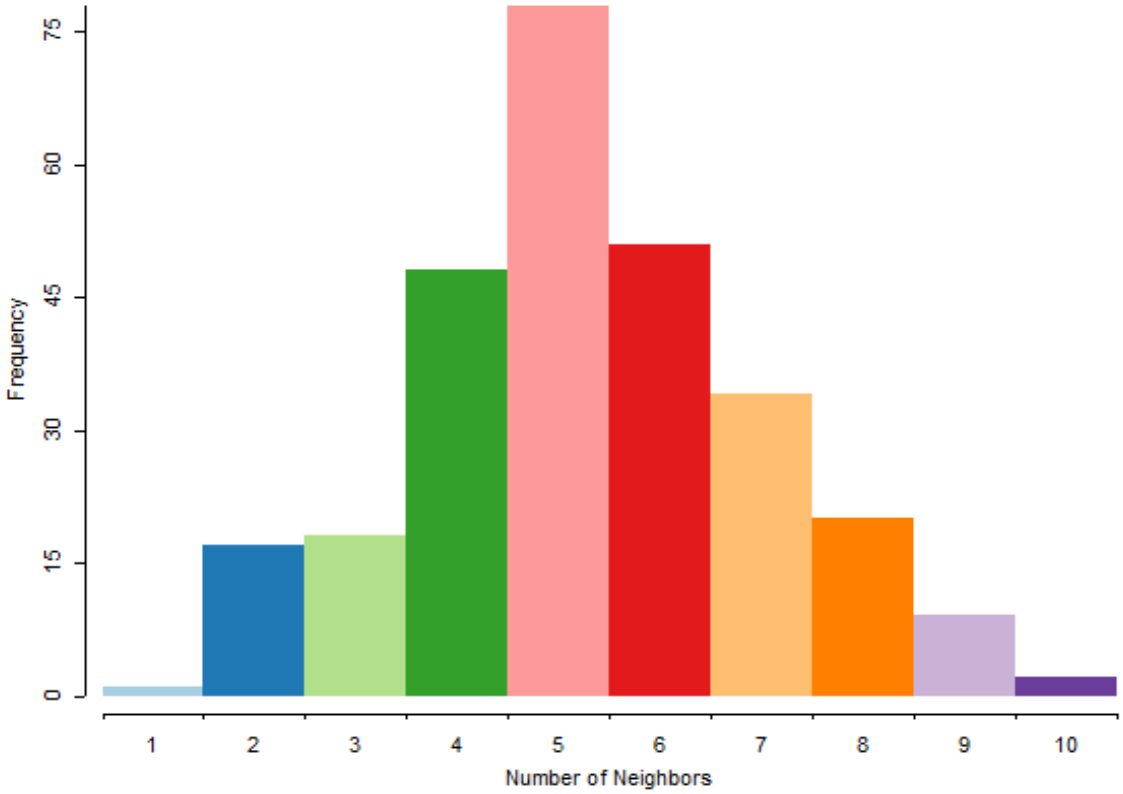
H_0: The definition of the VPIT is independent and identically distributed by space.

therefore, if Moran's / statistic is positive and statistically significant, the null hypothesis of non-existence of spatial autocorrelation is rejected, confirming the presence of spatial correlation in the definition of the VPIT.

To conduct this test, it is necessary to choose a W matrix in order to define the spatial weighting criterion to be used. Thus, in order to test whether there are spatial effects on the VPIT variable, a matrix of spatial weights was initially generated in the form of contiguity Queen.[27] As can be seen in Figure 8, the matrix of spatial weights, normalized by lines, is composed of 278 transversal spatial units, presenting an average of 5.3 contiguous units, that is, on average, each municipality has 5 other municipalities as neighbours. It should be noted that there is a municipality that has only one municipality as a neighbour – the municipality of Nazaré only borders the municipality of Alcobaça. On the other hand, there are two municipalities that have 10 neighbouring municipalities, as is the case of the municipalities of Santarém and Viseu.

[27] Contiguity means that two municipalities share a common border of non-zero length. It is possible to distinguish between a rook and a queen contiguity criterion: the rook criterion defines the neighbours by the existence of a common edge between the two municipalities, in turn the queen criterion is a little more comprehensive and defines the neighbouring municipalities as spatial units that share a common edge or vertex (Anselin, 1988).

Figure 8 - Spatial-Weights Contiguity Matrix Histogram



Data Source: GeoDa Computations

Then, and in order to investigate the robustness of the results, the definition of neighbourhood was set according to the Euclidean distance between the centres of the Portuguese municipalities, so that the municipalities considered as neighbours were limited to those that were x or fewer kilometres away, being x= 30, 50 and 100 km. Thus, we can conclude that as the distance increases, the average number of neighbouring municipalities also increases. Namely, a municipality has an average of 72.55 neighbours when considering a distance of 100 kilometres or less.

Table 6 - Summary of the Spatial-Weights Matrices

	Contiguity Matrix	**30km Matrix**	**50km Matrix**	**100km Matrix**
Minimum	1	1	3	15
Maximum	10	21	48	123
Mean	5,30	9,91	23,40	72,55
No. of Observations	278	278	278	278

Data Source: GeoDa Computations

Table 7 shows the results of the Moran's spatial statistical /test for the dependent variable of the present study – Variable Participation Rate in the Personal Income Tax – for each year of the period between 2009 and 2020, considering the different matrices of spatial weights. The statistical test is only significant for the years 2009, 2010, 2019 and 2020, which means that in these years the spatial distribution of the VPIT does not result from random spatial processes, confirming the presence of spatial correlation in the definition of the VPIT. It is also relevant to note that for some matrices, the years 2015, 2017 and 2018 are also significant.

Table 7 - Moran's /Test Results.

IRS	Moran's I			
	Contiguity Matrix	**30km Matrix**	**50km Matrix**	**100km Matrix**
2009	0,0629 (1,8160*)	0,0754 (2,4372**)	0,0383 (2, 1893**)	0,0058 (0,9453)
2010	0,1048 (2,9112***)	0,0867 (2,6806***)	0,0701 (3,8454***)	0,0304 (3,7807***)
2011	0,0462 (1,2802)	0,0231 (0,7107)	0,0176 (1,0258)	0,0008 (0,4427)
2012	0,0257 (0,7961)	-0,0149 (-0,3616)	0,0093 (0,6584)	-0,0050 (-0,1631)
2013	-0,0252 (-0,5554)	-0,0095 (-0,1937)	-0,0109 (-0,3690)	-0,0049 (-0,1157)
2014	0,0191 (0,6367)	0,0261 (0,9146)	0,0183 (1,1758)	0,0119 (1,6650)
2015	0,0310 (0,9251)	0,0590 (1,9694**)	0,0247 (1,5340)	0,0277 (3,3594***)
2016	0,0113 (0,3926)	0,0225 (0,7815)	0,0010 (0,2564)	0,0085 (1,3041)
2017	0,0222 (0,6815)	0,0468 (1,5277)	0,0236 (1,4044)	0,0204 (2,5578**)
2018	0,0383 (1,1234)	0,0391 (1,3397)	0,0189 (1,2007)	0,0195 (2,4233**)
2019	0,0584 (1,6662*)	0,0710 (2,3244**)	0,0532 (2,9625***)	0,0291 (3,4547***)
2020	0,0697 (1,9885**)	0,0651 (2,1146**)	0,0471 (2,6607***)	0,0244 (3,0269***)

Data Source: GeoDa Computations | **Note**: Z-statistics are in parentheses. Levels of significance *** p<0.01, ** p<0.05, * p<0.1

6.2. Econometric Results

Initially, equation (12) was estimated without considering the spatial interaction ($\alpha = 0$), and the fixed effects to check that the explanatory variables chosen were appropriate. The results of the initial estimations are shown in Table 8.

The results of the OLS estimation of the model (columns 1 and 2) show that most of the control variables are significant, which is a good indicator of the model's suitability. In addition, it can be concluded that the Variable Participation Rate in the Personal Income Tax shows some persistence, which is in line with the theory of inertia in the adjustment of budgetary commitments and the incremental routines of budget preparation, which produce slowness in the setting behaviour of local taxes. However, the OLS method does not allow for a coherent estimation of the complete model since it does not consider individual municipal effects and does not include fiscal interaction between municipalities. In addition, the OLS estimation does not consider the existence of heterogeneity and presents specification errors and biases.

The model was then estimated including municipality fixed effects (columns 3 and 4). We chose to use fixed effects (FE) estimation instead of random effects (RE), since the Hausman test rejected the null hypothesis. In addition, the fixed effects model is better suited since we are dealing with observations for a set of Portuguese municipalities over a set number of years and because there are unobservable variables that condition decision-making and are intrinsic to the characteristics of the political decision-maker. The estimation results that account for the specific unobserved effects of the municipality - FE estimation - corroborate the results obtained by the OLS estimation. Thus, although the OLS and FE models give rise to biased estimates due to the presence of the lagged dependent variable on the right-hand side of the equation and the fact that the strategic variables are endogenous, they offer a helpful reference on what to expect from GMM estimates.

Table 8 - Estimation Results with no Spatial Interaction

Dependent Variable	1 **VPIT**	2 **VPIT**	3 **VPIT**	4 **VPIT**
Estimation	OLS	OLS	FE	FE
$VPIT_{i,t-1}$		0.807*** (0.0276)		0.477*** (0.0398)
PopDens	-7.89e-07 (5.87e-07)	-2.54e-07 (1.73e-07)	1.32e-05** (5.46e-06)	7.41e-06** (2.96e-06)
Depend	-0.01662** (0.008007)	-0.00398* (0.0020144)	0.00738 (0.0128594)	0.00144 (0.0088925)
Unemp	-0.03829 (0.025966)	-0.00564 (0.0073427)	-0.06655*** (0.0241684)	-0.02357 (0.0144651)
Income	0.0111*** (0.00351)	0.00307*** (0.000991)	-0.0166* (0.00886)	-0.00607* (0.00354)
Transf	-0.00283*** (0.000932)	-0.000703** (0.000277)	-0.00227* (0.00133)	-0.00157 (0.000963)
OwnRev	-0.00535*** (0.00169)	-0.00146*** (0.000502)	0.00456** (0.00188)	0.00240* (0.00142)
Debt	0.00324*** (0.000699)	0.000910*** (0.000215)	0.00214*** (0.000627)	0.00152*** (0.000509)
Elect	0.00138 (0.000923)	-0.000134 (0.000578)	0.00126 (0.00125)	0.000218 (0.000840)
Constant	0.00694 (0.0240)	-0.00280 (0.00679)	0.124** (0.0625)	0.0476* (0.0268)
Time Effects	Yes	Yes	Yes	Yes
Observations	2,990	2,990	2,990	2,990
R-squared	0.146	0.677	0.109	0.721

Data Source: CNE, DGAL, IEFP, INE, SI| **Note**: Models estimated with robust standard errors, with clusters by municipality. Robust t-statistics in parentheses. | Levels of significance *** p<0.01, ** p<0.05, * p<0.1 | The variables *PopDens, Depend, Unemp, Income, Transf, OwnRev and Debt* are lagged by one period. | The variables *Income, Transf, OwnRev and Debt* are expressed in logarithms.

Equation (12) was then estimated, considering the persistence of the dependent variable ($\gamma \neq 0$), and the possible influence of the decisions made by neighbouring municipalities ($\alpha \neq 0$). In addition, the presence of specific and fixed effects of the municipalities ($id_i \neq 0$), was considered, making it possible to eliminate possible problems related to omitted variables, intuitively leading to a kind of 'difference in differences' approach, where changes in the taxes of neighbours can influence changes in one's own taxes (Cassette *et al.,* 2012).

The estimation of a dynamic spatial model presents two significant endogeneity issues. Firstly, in a dynamic model with municipal fixed effects, the lagged dependent variable becomes endogenous as it correlates with the fixed effect in the error term.[28] Secondly, the variable representing the participation rate in the average personal income tax of neighbouring municipalities is also endogenous. This is because municipal interactions are symmetrical and simultaneous: the actions of each municipality influence those of its neighbours and are likewise influenced by their behaviour (Ferraresi *et al.*, 2016). So, to get around both problems, equation (12) can be estimated using the Sys-GMM estimator.[29] This estimator is the only procedure for estimating spatial models that incorporate spatial dependence, time lags, and other endogenous variables. The Sys-GMM estimator combines the moment conditions of the first differences and levels' models. In addition, it uses the exogenous variables in levels as instruments for the equation in first differences and uses lagged values of the first differences as instruments for the equations in levels. Using the Sys-GMM estimator is especially appropriate when there is a high level of persistence in the dependent variable. It allows for the correction of econometric issues like weak instruments and measurement errors, thereby leading to less biased and more accurate results (Costa *et al.*,2015, Ferraresi *et al.*, 2018). Thus, as the dependent variable is suspected of having a high level of persistence, the use of the Sys-GMM estimator will be the most appropriate solution (Blundell and Bond, 1998; Costa *et al.*, 2015)

[28] The presence of endogeneity gives rise to biased results if OLS estimators (positive bias) or fixed effects estimators (negative bias) are used (Klemm and Van Parys, 2012).

[29] Unlike the difference GMM, which uses only the difference equation, the Sys-GMM establishes a set of overlapping data, one in levels and the other in differences. The difference equations are then instrumented with levels, while the level equations are instrumented with differences (Ferraresi *et al.*,2016).

The empirical results based on geographical proximity are shown in Table 9. A similar Sys-GMM strategy was implemented throughout the different regressions, making it easier to compare the results obtained for the different models.

Initially, regressions included the spatial dependence variable and the lagged dependent variable, using the W_T, which considers all the municipalities in mainland Portugal as neighbours, assigning weights inversely proportional to the distances between them. The two-stage Sys-GMM estimation was used with correction for finite sample standard errors (Costa *et al.*, 2015). A two-stage estimation[30] was employed, which enhances the robustness of the covariance matrix to panel-specific autocorrelation and heteroscedasticity, consequently making the estimator more efficient (Blundell and Bond, 1998; Ferraresi *et al.,* 2018). However, there is a significant risk that standard errors may be substantially biased downward (Roodman, 2009), and that should be corrected using Windmeijer's (2005) correction for finite sample standard errors.

According to Pinkse *et al.* (2002), continuous variables that are different in each location are valid Sys-GMM instruments. Thus, in all the regressions, the socioeconomic variables, namely Population Density, Total Dependency Index, and Unemployment rate, as well as the financial variable, Debt Per Capita and the economic variable, Total Transfers received by Municipal Councils after deducting transfers related to the VPIT, contained in the vector $mun_{i,t-1}$ were considered to be strictly exogenous variables, not related to any residual ε_{it-1}, so that:

$$E\{mun_{it-1}\ \varepsilon_{it-1}\} = 0 \quad (14)$$

Demographic variables were considered exogenous since we assumed that municipalities have no control over these variables. Furthermore, any shocks that might affect the country as a whole are controlled by time-fixed effects ($year_t$), which are also considered exogenous. The Total Transfers received by Municipal Councils after deducting transfers related to the VPIT were considered exogenous since it was considered that the Central Government's transfers received by the municipalities are not influenced by the choice of the Variable Participation Rate in the Personal Income Tax. The Debt Per Capita was also considered exogenous since the level of debt is not influenced by the choice of the VPIT.

[30] Two-stage estimation was favoured over one-stage estimation because the latter is not consistent in the presence of heteroscedasticity, *i.e.* when the standard errors are not constant over time.

Thus, based on this assumption, the variables mentioned above were used in levels as instrumental variables for the first differences equations and in differences for the level's equations.

Economic variables such as own revenues and the Average Monthly Earnings of Employees were considered to be endogenous. Disposable income is potentially endogenous since a high tax rate can exclude the wealthiest citizens (Tiebout, 1956). Per capita own revenues were considered endogenous since municipalities with higher VPIT may choose to have lower levels of own revenue.

Following the assumption that tax interactions between municipalities are simultaneous and symmetrical - in period t municipality i is influenced by the tax rates of neighbouring municipalities, and each of the neighbouring municipalities are influenced by the tax decisions of municipality i in the same way - the variable $W\tau_{jt}$ was considered to be endogenous. This implies that:

$$E\{\varepsilon_{it-1}\, W\tau_{jt}\} \neq 0 \quad (15)$$

It can, therefore, be concluded that only the lagged values of the variable $W\tau_{jt}$ are valid instruments for the equation of first differences.

Bearing in mind that the use of an excessive number of instruments can jeopardise the estimation, namely leading to over-adjustment of the endogenous variables[31], resulting in upwardly biased estimates, and weakening the Hansen results, each moment condition underlying the Sys-GMM procedure (Costa *et al.,* 2015) was not applied to each available time period and lag. In turn, a single moment condition is applied to each period and regressor. In other words, in order to limit the number of instruments, they were collapsed[32] (Roodman, 2006), resulting in a total of between 55 and 62 instruments for each regression.

The consistency of the GMM estimates is based on two assumptions: the error term is serially uncorrelated. Otherwise, the instruments are not valid, and the lagged instruments used are sufficient to explain the model (Roodman, 2009). Hence, to ascertain the absence of first-order serial correlation in levels in a dataset expressed in differences, such as in SYS-GMM analysis, it is imperative to verify the

[31] By using a large number of instruments, there is a risk of overfitting the instrumented variables, making it impossible to remove their endogenous components and consequently biasing the coefficient estimates about the non-instrumented estimators (Roodman, 2009).

[32] The "collapsed" matrix comprises a single instrument for every lag of the instrumental variable, as opposed to having one instrument for each period and lag of the instrumental variables (Bazzi and Clemens, 2013).

absence of second-order correlation in differences (Ferraresi *et al.,* 2018). Therefore, the test was carried out for first-order autoregressive serial correlation in the residuals (AR (1)) - which is expected to be negative and significant - and second order - AR (2) to confirm that the residuals of the equation estimated with the first differentiation are not correlated in the second order. For all estimations, the test for second-order autocorrelation does not reject it, so it is necessary to use lags of the dependent variable from at least two previous periods as instruments.

The Sargan and Hansen tests evaluate the exogeneity of the instruments and therefore their validity. However, since the Sargan test is not valid in the presence of heteroscedasticity or autocorrelation, the Hansen test was prioritised over the Sargan test. Thus, in all estimations, the Hansen test validates the instruments used.

In order to choose the most appropriate method between the difference GMM and the System-GMM, additional moment conditions were tested concerning the first differences estimates, *i.e.* the difference between the Hansen test statistic of the System-GMM estimate and the statistic of the first differences estimate was calculated. The test statistic would then be:

$$HansenTest_{Sys-GMM} - HansenTest_{first-differences} =$$

$$35.27 - 21.09 = 14.18$$

with the null hypothesis being that the additional moment conditions associated with the level equations are valid. The test statistic is asymptotically distributed as χ_q^2 , where q corresponds to the difference between the degrees of freedom of each Hansen test - in this case, it corresponds to 13 degrees of freedom. Since the critical value, for a significance level of 5%, is higher than the test statistic (14.18 < 22.36), we do not reject the null hypothesis of the validity of the additional instruments used in the System-GMM estimation. Therefore, since the Hansen's test for the additional moment conditions validated the use of System-GMM estimation over the estimation of the first difference, all the regressions were estimated using System-GMM. It is important to note that the results of the first difference are consistent with the System-GMM estimation.

The results in Table 9 indicate that there is fiscal interaction with regards to the Variable Participation Rate in the Personal Income Tax - the variable $W\tau_{jt}$ is always statistically significant and positive. The baseline result is presented in column (1) which will be used to compare the different spatial weighting matrices. Thus, upon analysing this estimation, we conclude that the elasticity of the variable participation rate in one's own personal income tax in relation to the Variable Participation Rate in Personal

Income Tax of neighbouring municipalities is statistically significant and positive - in other words, a one percentage point increase in the Variable Participation Rate in the Personal Income Tax of neighbouring municipalities gives rise, ceteris paribus, to an increase in the Variable Participation Rate in the Personal Income Tax of municipality *i* of around 0.29 percentage points. In other words, the positive and statistically significant coefficient of the tax interaction variable suggests the existence of tax competition on mobile tax bases, *i.e.* municipal policies related to the Variable Participation Rate in the Personal Income Tax are defined based on the explanatory variables and the choices of the Variable Participation Rate in the Personal Income Tax of adjacent municipalities - there is a positive spatial interdependence when choosing the rate.

The statistical significance and positive coefficient for the lagged dependent variable show that the VPIT is persistent over time, which means that current values positively depend on past values. This is in line with the theory of inertia in the adjustment of budgetary commitments and the incremental routines of budget preparation, which produce slowness in the setting behaviour of local taxes. Furthermore, it is possible to conclude that the Variable Participation Rate in the municipalities' Personal Income Tax is relatively stable throughout the period since the municipal authorities tend to apply their own previous decisions, especially in what regards the nominal rate (Ramajo *et al.*, 2020).

It is also possible to conclude that central government transfers and municipal debt are statistically significant, and the coefficients show the expected signs - an increase in per capita transfers from the central government is associated with a reduction in tax rates as municipalities become less dependent on the Variable Participation Rate in the Personal Income Tax. On the other hand, municipalities with high levels of debt tend to increase tax rates in order to cope with the debt. The negative coefficient of the total dependency ratio indicates that municipalities with a high proportion of elderly and young people are more socially vulnerable and less able to set higher tax rates. Although the unemployment rate, the average monthly employee earnings, the population density, and the municipal own revenues are not statistically significant[33], the decision was made to keep these variables in the estimation since, according to the literature they may influence the dependent variable and their estimated coefficients show the expected signs. It may be desirable to preserve these variables since past experience has shown their importance, regardless of their statistical significance.

[33] The persistence of time series data and the incorporation of lagged values of the dependent variable as explanatory variables could explain why demographic variables, which tend to change gradually over time, may not have a significant impact.

In column (2), the first lag of the spatial interaction variable - $W\tau_{jt-1}$ - was added in order to see if the strategic interaction would be persistent over time; however, since it is not statistically significant, we eliminated the first lag of the spatial interaction variable from the model. In columns (3) and (4), we added a variable that reflects the change in the law related to the non-communication and non-decision of the VPIT to the Tax and Customs Authority. The $LawC_i$ variable corresponds to a dummy, equal to 1 between 2015 and 2019 - the years in which the Municipal Assembly's failure to deliberate and communicate the rate of variable participation in the personal income tax meant that municipalities lost their right to the Variable Participation Rate in the Personal Income Tax [34] - and zero in the remaining years. This variable was added in order to understand the impact of the change in the law on the municipalities' decision-making process regarding the choice of the rate of Variable Participation Rate in Personal Income Tax. It can be concluded that in the years in which the lack of deliberation and communication of the rate of VPIT implied the loss of the municipalities' right to VPIT, the municipalities' average personal income tax rate is lower than in the other years, with the first two years - 2015 and 2016 - showing the sharpest drop. This result may be due to the fact that the change in the law came as a surprise to the municipalities, and there was a period of adaptation. It should also be noted that the tax interaction during the years in which the law was changed decreased, since the sign of the estimated coefficient for the interaction variable $W\tau_{jt}.LawC$ is negative (column 4).

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[34] According to Law no. 73/2013, of September 3rd, municipalities that failed to deliberate and/or notify the Tax and Customs Authority would lose their right to the Variable Participation Rate in the Personal Income Tax, *i.e.* the rate of Variable Participation in the Personal Income Tax would be zero.

Table 9 - Estimation Results with System-GMM using W^T

Dependent Variable	1 **VPIT**	2 **VPIT**	3 **VPIT**	4 **VPIT**
Estimation	SYS-GMM	SYS-GMM	SYS-GMM	SYS-GMM
$VPIT_{i,t-1}$	0.675*** (0.0435)	0.677*** (0.0472)	0.652*** (0.0570)	0.632*** (0.0546)
$W\tau_{jt}$	0.295** (0.140)	0.858* (0.506)	0.342** (0.142)	0.510*** (0.160)
$W\tau_{jt-1}$		-0.537 (0.485)		
PopDens	-1.46e-07 (1.89e-07)	-1.53e-07 (1.80e-07)	-1.16e-07 (2.22e-07)	-1.10e-07 (2.12e-07)
Depend	-0.00452** (0.00227)	-0.00446* (0.00247)	-0.00352 (0.00252)	-0.00440* (0.00248)
Unemp	-0.00473 (0.00759)	-0.00404 (0.00751)	-0.0116 (0.00887)	-0.0135 (0.00863)
Income	-0.00495 (0.00440)	-0.00330 (0.00441)	-0.00462 (0.00437)	-0.00550 (0.00435)
Transf	-0.000961* (0.000571)	-0.000710 (0.000550)	-0.00106* (0.000617)	-0.00122** (0.000590)
OwnRev	0.000419 (0.000924)	-2.89e-05 (0.00114)	-0.000557 (0.00101)	-0.000358 (0.00104)
Debt	0.000629** (0.000273)	0.000607** (0.000273)	0.000732** (0.000307)	0.000783*** (0.000292)
Trend			0.000141 (0.000101)	0.000195* (0.000103)
LawC			-0.000658** (0.000310)	0.0107** (0.00494)
$W\tau_{jt}.LawC$				-0.268** (0.115)
Time fixed Effects	Yes	Yes	No	No
Observations	2,745	2,745	2,745	2,745
No. of Instruments	62	62	55	55
p-value AR (1)	0.000	0.000	0.000	0.000
p-value AR (2)	0.364	0.372	0.375	0.348
Hansen Test (*p-value*)	0.759	0.739	0.099	0.211

Data Source: CNE, DGAL, IEFP, INE, SI| **Note**: Robust standard errors are given in parenthesis. | Levels of significance at which the null hypothesis is rejected: *** p<0.01, ** p<0.05, * p<0.1 | | The time fixed effects and the municipality's fixed effects were controlled | The SYS-GMM estimations present two-step results | AR(1), AR(2) refer to first and second-order autocorrelation tests | The variables *PopDens, Depend, Unemp, Income, Transf, OwnRev and Debt* are lagged by one period.| The variables *Income, Transf, OwnRev and Debt* are lagged by one period. | Due to collinearity problems between the years' fixed effects and variable *LawC,* the trend variable was used to control for time.

6.2.1. Alternative Weighting Matrices

Robustness tests were conducted to confirm the results obtained in the previous section. In order to test the robustness of the use of the spatial weighting matrix, this section will re-estimate the baseline model (column 1 of Table 9) using four alternative weighted neighbourhood matrices, described in section 4.1: binary (W^{bi}), 30 km (W^{30}), 50 km (W^{50}) and 100 km (W^{100}). The results are shown in Table 10, where column 1 shows the results considering all municipalities as neighbours (W^{T}) – there is no maximum distance beyond which the weights are set to zero - and columns 2 to 4 show the results considering all municipalities which distance themselves from a given municipality up to 100, 50 and 30 kilometres, respectively, as neighbours. Finally, column 5 shows the results for the binary matrix, which assigns a value of 1 to municipalities that share a border and 0 otherwise.

The Sys-GMM estimator was used to estimate the various models using the different spatial weighting matrices. A similar Sys-GMM strategy was implemented throughout the different regressions, making it easier to compare the results obtained for the different weighting matrices. It is also important to note that the Sys-GMM strategy implemented in this section is similar to the Sys-GMM strategy implemented in section 6.2., to make it easier to compare the results for the different models. In addition, all the regressions included the same control variables used in the baseline model in the previous section, and the same endogenous and exogenous variables were considered. Lastly, the Hansen tests validated the choice of instruments.

The $W\tau_{jt}$ coefficient is positive and statistically significant in all the spatial distance-based weighting matrices, except for the binary matrix. It is possible to infer the robustness of the results presented in the previous section and reinforce the conclusion that there is fiscal interaction between neighbouring municipalities in relation to the Variable Participation Rate in Personal Income Tax. The fiscal spatial interaction variable's coefficients are similar for three distance-based spatial weighting matrices, with the coefficient of the W^{T} matrix being the highest and the coefficient of the (W^{30}) matrix being the lowest. The coefficient of the binary matrix (W^{bi}) is not statistically significant. The remaining results are similar for all the regressions.

Table 10 - Estimation Results for Different Matrixes using System-GMM

	1	2	3	4	5
Matrix	Total ($\boldsymbol{W^T}$)	100 ($\boldsymbol{W^{100}}$)	50 ($\boldsymbol{W^{50}}$)	30 ($\boldsymbol{W^{30}}$)	Binary ($\boldsymbol{W^{bi}}$)
Dependent Variable	**VPIT**	**VPIT**	**VPIT**	**VPIT**	**VPIT**
$VPIT_{i,t-1}$	0.675*** (0.0435)	0.650*** (0.0499)	0.671*** (0.0536)	0.687*** (0.0515)	0.673*** (0.0498)
$W\tau_{jt}$	0.295** (0.140)	0.146** (0.0733)	0.118** (0.0480)	0.0638* (0.0363)	-0.00510 (0.00979)
PopDens	-1.46e-07 (1.89e-07)	-1.17e-07 (2.93e-07)	-3.26e-08 (2.22e-07)	3.18e-08 (2.05e-07)	-1.18e-07 (2.93e-07)
Depend	-0.00452** (0.00227)	-0.00322 (0.00252)	-0.00200 (0.00298)	-0.000616 (0.00238)	0.000946 (0.00353)
Unemp	-0.00473 (0.00759)	-0.00573 (0.00838)	-0.00520 (0.00729)	-0.00455 (0.00691)	-0.0113 (0.0109)
Income	-0.00495 (0.00440)	-0.00686 (0.00547)	-0.00881 (0.00560))	-0.00965* (0.00543)	-0.00442 (0.00592)
Transf	-0.000961* (0.000571)	-0.00135* (0.000703)	-0.00127* (0.000744)	-0.00146** (0.000681)	-0.00122 (0.000873)
OwnRev	0.000419 (0.000924)	2.00e-05 (0.00101)	0.000323 (0.00128)	-0.000574 (0.00138)	-0.00243 (0.00240)
Debt	0.000629** (0.000273)	0.000697** (0.000301)	0.000558* (0.000295)	0.000514* (0.000285)	0.000564 (0.000346)
Time Effects	Yes	Yes	Yes	Yes	Yes
Observations	2745	2745	2745	2745	2745
No. of Instruments	62	62	62	62	62
p-value AR (1)	0.000	0.000	0.000	0.000	0.000
p-value AR (2)	0.364	0.426	0.515	0.538	0.786
Hansen Test (*p-value*)	0.759	0.498	0.609	0.649	0.413

Data Source: CNE, DGAL, IEFP, INE, SI| Note: Robust standard errors are given in parenthesis. | Levels of significance at which the null hypothesis is rejected: *** p<0.01, ** p<0.05, * p<0.1 | The time fixed effects and the municipality's fixed effects were controlled |The SYS-GMM estimations present two-step results | AR(1), AR(2) refer to first and second-order autocorrelation tests | The variables PopDens, Depend, Unemp, Income, Transf, OwnRev and Debt are lagged by one period. | The variables Income, Transf, OwnRev and Debt are expressed in logarithms.

6.2.2. Testing for Sources of Spatial Interdependence

The results discussed in the previous section allow us to conclude that there is strategic interaction between tax decisions at the local level - the coefficient of the variable $W\tau_{jt}$ is always positive and statistically significant. Therefore, the main objective of this section is to identify the source of fiscal interactions between municipalities, namely whether municipal interdependence is determined by yardstick competition and/or spillover effects.

Yardstick Competition Hypothesis

The central assumption of yardstick competition theory is the asymmetry of information between voters and political decision-makers - voters do not have complete information about the competence of the political decision-maker - and they compare the public and fiscal policies implemented by their municipality with those of neighbouring municipalities in order to judge the performance of the political decision-maker (Ferraresi *et al.*, 2018). Thus, the effects of yardstick competition depend on the specific characteristics of the local electoral accountability process (Solé-Ollé, 2003). If yardstick competition is taking place, in election and pre-election years, local jurisdictions react more to their neighbours' fiscal policies, imitating the neighbouring municipality's behaviour to signal their competence and win elections. This behaviour of imitating the fiscal policies of neighbours is more pronounced if local representatives are not term-limited, as they are interested in gaining voters' trust (Bordignon *et al.*,2003; Ferraresi *et al.*, 2018). Furthermore, the ideological orientation of political representatives in jurisdictions can significantly influence their strategic interactions. When left-wing parties hold power, imitation behaviour is anticipated to be less prominent because voters tend to penalize left-wing parties less for tax hikes. Consequently, they are less responsive to neighbouring jurisdictions' efforts to lower taxes (Solé Ollé, 2003).

In order to test the existence of yardstick competition, the following model was estimated, including a variable that reflects the interaction between the spatial tax variable and alternative political variables - $PoliticalVariable_{it} * W\tau_{jt}$:

$$\tau_{it} = \beta_1 + \gamma\tau_{it-1} + \alpha \sum w_{ij}\,\tau_{jt} + \delta\left(PoliticalVariable_{it} * W\tau_{jt}\right) + \theta PoliticalVariable_{it} + \beta_2 mun_{it-1} + year_t + id_i + \varepsilon_{it} \quad (16)$$

Equation (16) was estimated using the System-GMM estimator and four different political variables - electoral and pre-electoral years, term limitation and the mayor's political orientation – thus evaluating the robustness of the results by considering alternative weighted neighbourhood matrices based on geographical distance. The results are shown in Table 11, with the results for the total matrix (W^T). All the regressions included the same control variables used in the models in the previous section. However, only the coefficients associated with variables $VPIT_{i,t-1}$, $W\tau_{jt}$ and their interactions with the political variables are shown. The results for the different spatial weighting matrices and all the control variables can be found in Appendix B.

We began by specifying the model using the election year dummy ($ElectYear$) as a political variable since a positive and significant coefficient of the interaction variable between the Variable Participation Rate in the Personal Income Tax and election years indicates the presence of yardstick competition. However, the interaction term ($W\tau_{jt} * ElectYear$) is not statistically significant for any of the spatial weighting matrices. In addition, the presence of yardstick competition was evaluated, considering the interaction between pre-election years and the VPIT, since opportunistic behaviour on the part of the mayor can occur during pre-election years. Again, the interaction term never turned out as being statistically significant.

In addition to the $ElectYear$, variable, another possibility was explored by interacting the VPIT with the dummy variable $PartyIdeology$ – a variable equal to one if the mayor is left-wing and zero if he is right-wing. In this case, in the presence of yardstick competition, the interaction is expected to be negative since left-wing parties are less sensitive to the initiatives of neighbouring jurisdictions to reduce taxes. However, the results presented in Table 11 do not support the existence of yardstick competition in the choice of the VPIT, since the interaction coefficient $W\tau_{jt} * PartyIdeology$ is not statistically significant for any of the spatial weighting matrices.

Finally, the model was specified using the $TermLimit$ dummy variable as a political variable, interacting with VPIT. In this case, the interaction is expected to be negative in the presence of yardstick competition since local representatives that are term limited have no electoral concerns. The results show that the coefficient of the $W\tau_{jt} * TermLimit$ is not statistically significant for any of the spatial weighting. This result, together with those obtained through other political variables, indicates that yardstick competition does not seem to be the cause of the observed strategic interaction.

Table 11 - Estimation Results for the Yardstick Competition Model

Matrix	1 Total $(\boldsymbol{W^T})$	2 Total $(\boldsymbol{W^T})$	3 Total $(\boldsymbol{W^T})$	4 Total $(\boldsymbol{W^T})$
Dependent Variable	**VPIT**	**VPIT**	**VPIT**	**VPIT**
$VPIT_{i,t-1}$	0.674*** (0.0440)	0.674*** (0.0448)	0.668*** (0.0423)	0.687*** (0.0431)
$W\tau_{jt}$	0.290** (0.129)	0.291** (0.135)	0.199 (0.174)	0.274* (0.144)
$W\tau_{jt} * ElectYear$	-0.0631 (0.194)			
$W\tau_{jt} * PreElectYear$		0.00117 (0.261)		
$W\tau_{jt} * PartyIdeology$			-0.0137 (0.158)	
$W\tau_{jt} * TermLimit$				0.00797 (0.00669)
Time Effects	Yes	Yes	Yes	Yes
Observations	2745	2745	2745	2745
No. of Instruments	65	64	70	70
p -value AR (1)	0.000	0.000	0.000	0.000
p-value AR (2)	0.406	0.421	0.413	0.337
Hansen Test (*p-value*)	0.795	0.731	0.798	0.841

Data Source: CNE, DGAL, IEFP, INE, SI| Note: Robust standard errors are given in parenthesis. | Levels of significance at which the null hypothesis is rejected: *** p<0.01, ** p<0.05, * p<0.1 | | The time fixed effects and the municipality's fixed effects were controlled | The SYS-GMM estimations present two-step results | AR(1), AR(2) refer to first and second-order autocorrelation tests | The dummy for municipal elections cannot be included in the regression because time effects are controlled for with year dummies. | All the regressions included the same control variables used in the model in the previous section.

Spillover Hypothesis and the Size of Municipalities

In order to certify the robustness of the previous results, additional tests were conducted to see if the size of the municipalities influences spatial dependence. The reasoning is based on the hypothesis that smaller municipalities have more significant spatial interaction, while larger ones are less influenced by the fiscal choices of their neighbours (Bocci *et al.*, 2019).

Thus, in order to verify the existence of a link between spillover effects and municipal size, equation (12) was estimated, including a variable that reflects the interaction of the spatial tax variable with the municipal population - $W\tau_{jt} * Population_{it} * 10^{-4}$:

$$\tau_{it} = \beta_1 + \gamma\tau_{it-1} + \alpha \sum w_{ij}\, \tau_{jt} + \lambda\left(W\tau_{jt} * Population_{it} * 10^{-4}\right) + \beta_2 mun_{it-1} + year_t + id_i + \varepsilon_{it} \quad (17)$$

The equation was estimated using the System-GMM estimator, and the robustness of the results was tested using alternative weighted neighbourhood matrices based on geographical distance. The results are shown in Table 12. All the regressions included the same control variables used in the model in the previous section, but only the coefficients associated with the variables $VPIT_{i,t-1}$, $W\tau_{jt}$ and $W\tau_{jt} * Population_{it} * 10^{-4}$ are presented. The results with all the control variables can be found in Appendix C.

Upon analysing the results, it can be concluded that the interaction coefficient is negative and statistically significant, for four distance-based spatial weighting matrices – W^T, W^{100}, W^{50} and W^{30}. So, we can conclude that the spatial interaction of fiscal policies between municipalities becomes weaker the larger the demographic size of the municipalities. As a rule, more populous municipalities provide public services to others besides their taxpayers, namely citizens of neighbouring municipalities, so they are less interested in imitating the tax policies of their neighbours since they have different spending needs - large municipalities do not react to changes in the extraordinary revenues of adjacent municipalities, because the knock-on effect on their residents is negligible (Bocci *et al.*, 2019). On the other hand, fiscal interaction is more pronounced in small municipalities, which are more sensitive to the political and fiscal choices of their neighbours.

Table 12 - Estimation Results for Tax Interaction and Size of Municipalities

Matrix	1 Total ($\boldsymbol{W^T}$)	2 100 ($\boldsymbol{W^{100}}$)	3 50 ($\boldsymbol{W^{50}}$)	4 30 ($\boldsymbol{W^{30}}$)	5 Binary ($\boldsymbol{W^{bi}}$)
Dependent Variable	**VPIT**	**VPIT**	**VPIT**	**VPIT**	VPIT
$VPIT_{i,t-1}$	0.633*** (0.0495)	0.632*** (0.0490)	0.633*** (0.0496)	0.639*** (0.0492)	0.624*** (0.0493)
$W\tau_{jt}$	0.524** (0.212)	0.231** (0.108)	0.169* (0.0904)	0.142* (0.0807))	0.000134 (0.0182)
$W\tau_{jt} * Population_{it} * 10^{-4}$	-0.0274** (0.0120)	-0.0446*** (0.0170)	-0.0417** (0.0188)	-0.0365** (0.0185)	-0.00242 (0.00373)
Time Effects	Yes	Yes	Yes	Yes	Yes
Observations	2745	2745	2745	2745	2745
No. of Instruments	68	68	68	68	68
p-value AR (1)	0.000	0.000	0.000	0.000	0.000
p-value AR (2)	0.178	0.177	0.194	0.253	0.188
Hansen Test (*p-value*)	0.377	0.377	0.403	0.81	0.532

Data Source: CNE, DGAL, IEFP, INE, SI| Note: Robust standard errors are given in parenthesis. | Levels of significance at which the null hypothesis is rejected: *** p<0.01, ** p<0.05, * p<0.1 || The time fixed effects and the municipality's fixed effects were controlled| The SYS-GMM estimations present two-step results | AR (1), AR (2) refer to first and second-order autocorrelation tests. | All the regressions included the same control variables used in the model in the previous section.

7. Conclusion

We are dealing with strategic interactions when municipalities do not act in isolation, *i.e.* the decisions of a given municipality are significantly influenced by neighbouring jurisdictions. Strategic interaction among municipalities is a widely studied topic in economic literature. Several theoretical models have been established based on various interpretations of this phenomenon, including yardstick competition and strategic spillover effects.

The main objective of this dissertation is to assess the existence of and driving forces behind strategic fiscal interactions between Portuguese municipalities, regarding the Variable Participation Rate in Personal Income Tax. For this purpose, data was used between 2009 and 2020 for all 278 municipalities in mainland Portugal. The System-GMM estimator was used, making it possible to consistently estimate a model that includes a spatial component, the dependent variable's time lag, and a set of endogenous control variables. In addition, different spatial weighting matrices were used to evaluate the robustness of the results.

The empirical results allow us to conclude that the tax decisions of municipalities are not isolated, as they are both affected by socioeconomic variables and significantly influenced by the tax decisions of neighbouring municipalities. In particular, a 1 percentage point increase in the Variable Participation Rate in Personal Income Tax of neighbouring municipalities leads to an increase of, on average, 0,29 percentage points in the Variable Participation Rate in Personal Income Tax of a given municipality. The robustness of the results was confirmed, since the results are not dependent on the choice of the spatial weighting matrix, as they are remarkably similar for the four distance-based geographical distance matrices used.

In addition, to identify the origin and type of strategic fiscal interdependencies, two additional models were estimated to determine whether municipal interdependencies are determined by yardstick competition and/or spillover effects. In order to assess the existence of yardstick competition, a model was estimated, that included a variable that reflected the interaction of the spatial fiscal variable with the political variables. There was no evidence of yardstick competition having originated the observed strategic interaction. In order to understand whether benefit spillovers could be behind the strategic effects, a model was estimated that included the interaction of a municipality's size with the strategic interaction term. It was concluded that the spatial interaction of tax policies between municipalities becomes weaker the larger the demographic size of those same municipalities, likely due to the negligible knock-on effect on their residents. On the other hand, fiscal interaction is more pronounced in small municipalities, and

these are more sensitive to the political and fiscal choices of their neighbours. Thus, it is possible to conclude that Portuguese municipalities react to the definition of the Variable Participation Rate in the Personal Income Tax of neighbouring municipalities due to spillover effects.

In addition, this dissertation presents empirical evidence of the influence of socioeconomic factors on municipal decisions regarding the Variable Participation Rate in Personal Income Tax. Transfers from the Central Administration and the municipal debt are decisive factors in defining the Variable Participation Rate in Personal Income Tax. Municipalities receiving higher per capita transfers from the central government tend to set lower tax rates - an increase in per capita transfers from the central government is associated with a reduction in the tax rate, as municipalities become less dependent on the Variable Participation Rate in Personal Income Tax. On the other hand, municipalities with high levels of debt tend to increase tax rates to cope with that same debt. In addition, municipalities with a high proportion of elderly and young people tend to set lower tax rates probably because they are more socially vulnerable.

As administrative, and fiscal decentralization is currently a central topic on the Portuguese political agenda, inferring whether strategic interaction between Portuguese municipalities is a reality can help reformers design a better institutional framework. Evidence that small municipalities are more sensitive to neighbouring municipalities' political and fiscal choices could have implications for the institutional resizing of medium-sized municipalities to achieve a better and more efficient administrative performance. Furthermore, it can be concluded that Portuguese municipalities consider their neighbours' choices when setting tax rates.

Although the results obtained in this dissertation are relevant and valuable, it should be noted that this research is still ongoing. Since the empirical study of strategic interactions between municipalities and spatial econometrics are topics which are constantly changing, and with the regular appearance of new developments and discoveries in this area, there is a need for existing analyses to be reviewed and improved. Therefore, for future research, it would be interesting to use alternative matrices to the spatial weights matrix and have the distance limit to be used in the neighbourhood matrix estimated together with the rest of the model. It would also be interesting to assess how the results react to the inclusion of other control factors. Finally, it would be relevant to assess which aspects would be more attractive for families and companies to settle in a given municipality.

8. References

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Appendix A

Table 13 - Correlation Table

	VPIT	PopDens	Depend	Unemp	Income	Transf	OwnRev	Debt	Elect
VPIT	1								
PopDens	0.0799	1							
Depend	-0.232	-0.172	1						
Unemp	0.0506	0.0524	-0.146	1					
Income	0.128	0.437	-0.232	-0.159	1				
Transf	-0.251	-0.341	0.693	0.0212	-0.414	1			
OwnRev	-0.111	0.119	0.0501	0.0219	0.283	-0.102	1		
Debt	0.0886	-0.124	0.153	0.273	-0.180	0.247	0.0887	1	
Elect	0.0566	-0.000200	-0.0145	0.0449	-0.0569	0.000200	-0.0239	-0.0136	1

Appendix B

Table 14 - Estimation Results for the Yardstick Competition Model – Election Year

Matrix	1 **Total** $(\boldsymbol{W^{T}})$	2 **100** $(\boldsymbol{W^{100}})$	3 **50** $(\boldsymbol{W^{50}})$	4 **30** $(\boldsymbol{W^{30}})$	5 **Binary** $(\boldsymbol{W^{bi}})$
Dependent Variable	**VPIT**	**VPIT**	**VPIT**	**VPIT**	**VPIT**
$VPIT_{i,t-1}$	0.674*** (0.0440)	0.665*** (0.0444)	0.667*** (0.0436)	0.676*** (0.0418)	0.686*** (0.0469)
$W\tau_{jt}$	0.290** (0.129)	0.0998* (0.0565)	0.0868** (0.0408)	0.00523 (0.0304)	0.00231 (0.00290)
$W\tau_{jt} * ElectYear$	-0.0631 (0.194)	-0.0721 (0.0986)	-0.0497 (0.0620)	-0.00782 (0.0454)	0.00188 (0.00342)
PopDens	-1.11e-07 (1.90e-07)	-7.52e-08 (1.90e-07)	-1.14e-07 (1.78e-07)	-1.11e-07 (1.65e-07)	-1.19e-07 (1.81e-07)
Depend	-0.00421* (0.00217)	-0.00327 (0.00217)	-0.00355* (0.00202)	-0.00409** (0.00189)	-0.00488** (0.00202)
Unemp	-0.00465 (0.00758)	-0.00306 (0.00749)	-0.00491 (0.00683)	-0.00447 (0.00653)	-0.00125 (0.00355)
Income	-0.00574 (0.00445)	-0.00545 (0.00405)	-0.00552 (0.00376)	-0.00259 (0.00382)	-0.000276 (0.00674)
Transf	-0.00105* (0.000557)	-0.00113** (0.000543)	-0.00109** (0.000506)	-0.000702 (0.000488)	-0.000402 (0.000454)
OwnRev	0.000394 (0.000884)	0.000452 (0.000835)	0.000731 (0.000765)	0.000844 (0.000899)	0.000934 (0.000944)
Debt	0.000632** (0.000284)	0.000612** (0.000297)	0.000558** (0.000264)	0.000401 (0.000279)	0.000347 (0.000263)

Time Effects	Yes	Yes	Yes	Yes	Yes
Observations	2745	2745	2745	2745	2745
No. of Instruments	65	72	72	72	72
p-value AR (1)	0.000	0.000	0.000	0.000	0.000
p-value AR (2)	0.406	0.515	0.445	0.539	0.523
Hansen Test (*p-value*)	0.795	0.761	0.883	0.462	0.453

Data Source: CNE, DGAL, IEFP, INE, SI| Note: Robust standard errors are given in parenthesis. | Levels of significance at which the null hypothesis is rejected: *** p<0.01, ** p<0.05, * p<0.1 || The time fixed effects and the municipality's fixed effects were controlled | The SYS-GMM estimations present two-step results | AR(1), AR(2) refer to first and second-order autocorrelation tests | The dummy for municipal elections cannot be included in the regression because time effects are controlled for with year dummies. | The variables PopDens, Depend, Unemp, Income, Transf, OwnRev and Debt are lagged by one period. | The variables Income, Transf, OwnRev and Debt are expressed in logarithms.

Table 15 - Estimation Results for the Yardstick Competition Model – Pre-Election Year

	1	2	3	4	5
Matrix	**Total** ($\boldsymbol{W^T}$)	**100** ($\boldsymbol{W^{100}}$)	**50** ($\boldsymbol{W^{50}}$)	**30** ($\boldsymbol{W^{30}}$)	**Binary** ($\boldsymbol{W^{bi}}$)
Dependent Variable	**VPIT**	**VPIT**	**VPIT**	**VPIT**	**VPIT**
$VPIT_{i,t-1}$	0.674***	0.656***	0.668***	0.683***	0.693***
	(0.0448)	(0.0453)	(0.0441)	(0.0444)	(0.0462)
$W\tau_{jt}$	0.291**	0.129*	0.0986**	0.0778**	0.00953*
	(0.135)	(0.0715)	(0.0444)	(0.0373)	(0.00525)
$W\tau_{jt} * PreElectYear$	0.00117	0.0763	-0.0587	-0.0818	-0.00455
	(0.261)	(0.129)	(0.0875)	(0.0524)	(0.00356)
PopDens	-1.31e-07	-7.54e-08	-1.24e-07	-5.99e-08	5.54e-08
	(1.79e-07)	(1.88e-07)	(1.87e-07)	(1.71e-07)	(2.32e-07)
Depend	-0.00418*	-0.00296	-0.00290	-0.00342*	-0.00510**
	(0.00220)	(0.00220)	(0.00195)	(0.00208)	(0.00214)
Unemp	-0.00376	-0.00143	-0.00325	-0.00308	0.00102
	(0.00746)	(0.00775)	(0.00727)	(0.00692)	(0.00682)
Income	-0.00520	-0.00524	-0.00573	-0.00587	-0.00293
	(0.00418)	(0.00414)	(0.00414)	(0.00389)	(0.00402)
Transf	-0.000999*	-0.00110*	-0.00110**	-0.000996*	-0.000497
	(0.000558)	(0.000579)	(0.000555)	(0.000536)	(0.000496)
OwnRev	0.000318	0.000277	0.000820	0.000887	0.00120
	(0.000917)	(0.000862)	(0.000862)	(0.000872)	(0.000990)
Debt	0.000641**	0.000621**	0.000529**	0.000506*	0.000460*
	(0.000277)	(0.000291)	(0.000260)	(0.000271)	(0.000264)

Time Effects	Yes	Yes	Yes	Yes	Yes
Observations	2745	2745	2745	2745	2745
No. of Instruments	64	71	71	71	71
p-value AR (1)	0.000	0.000	0.000	0.000	0.000
p-value AR (2)	0421	0.528	0.484	0.452	0.471
Hansen Test (*p-value*)	0.731	0.637	0.751	0.658	0.552

Data Source: CNE, DGAL, IEFP, INE, SI| Note: Robust standard errors are given in parenthesis. | Levels of significance at which the null hypothesis is rejected: *** p<0.01, ** p<0.05, * p<0.1 || The time fixed effects and the municipality's fixed effects were controlled | The SYS-GMM estimations present two-step results | AR(1), AR(2) refer to first and second-order autocorrelation tests | The dummy for municipal elections cannot be included in the regression because time effects are controlled for with year dummies. | The variables PopDens, Depend, Unemp, Income, Transf, OwnRev and Debt are lagged by one period. | The variables Income, Transf, OwnRev and Debt are expressed in logarithms.

Table 16 - Estimation Results for the Yardstick Competition Model – Term Limit

	1	2	3	4	5
Matrix	**Total** ($\boldsymbol{W^T}$)	**100** ($\boldsymbol{W^{100}}$)	**50** ($\boldsymbol{W^{50}}$)	**30** ($\boldsymbol{W^{30}}$)	**Binary** ($\boldsymbol{W^{bi}}$)
Dependent Variable	**VPIT**	**VPIT**	**VPIT**	**VPIT**	**VPIT**
$VPIT_{i,t-1}$	0.687***	0.680***	0.686***	0.688***	0.681***
	(0.0431)	(0.0405)	(0.0478)	(0.0434)	(0.0469)
$W\tau_{jt}$	0.274*	0.134*	0.0970*	0.0572	0.00537
	(0.144)	(0.0741)	(0.0512)	(0.0362)	(0.00471)
$W\tau_{jt} * TermLimit$	-0.171	-0.138	-0.0908	-0.0188	-0.0112*
	(0.156)	(0.120)	(0.121)	(0.0680)	(0.00623)
$TermLimit$	0.00797	0.00646	0.00474	0.00110	0.00273*
	(0.00669)	(0.00526)	(0.00535)	(0.00300)	(0.00153)
PopDens	-1.46e-07	-1.63e-07	-1.42e-07	-1.08e-07	-5.84e-08
	(1.84e-07)	(1.92e-07)	(1.94e-07)	(1.72e-07)	(2.27e-07)
Depend	-0.0044**	-0.00395*	-0.00345	-0.00418*	-0.00438**
	(0.00231)	(0.00225)	(0.00226)	(0.00227)	(0.00218)
Unemp	-0.00457	-0.00301	-0.00277	-0.00446	-0.00445
	(0.00730)	(0.00735)	(0.00757)	(0.00749)	(0.00640)
Income	-0.00409	-0.00312	-0.00393	-0.00387	-0.00223
	(0.00417)	(0.00419)	(0.00438)	(0.00376)	(0.00366)
Transf	-0.000913*	-0.000811	-0.000800	-0.000815	-0.000574
	(0.000539)	(0.000532)	(0.000543)	(0.000497)	(0.000426)
OwnRev	0.000467	0.000397	0.000682	0.000694	0.000720
	(0.000923)	(0.000980)	(0.000917)	(0.000868)	(0.000928)
Debt	0.000583**	0.000572**	0.000391	0.000507*	0.000429
	(0.000273)	(0.000268)	(0.000279)	(0.000267)	(0.000268)

Time Effects	Yes	Yes	Yes	Yes	Yes
Observations	2745	2745	2745	2745	2745
No. of Instruments	70	74	74	74	74
p-value AR (1)	0.000	0.000	0.000	0.000	0.000
p-value AR (2)	0.337	0.390	0.407	0.379	0.499
Hansen Test (*p-value*)	0.841	0.837	0.522	0.691	0.474

Data Source: CNE, DGAL, IEFP, INE, SI| Note: Robust standard errors are given in parenthesis. | Levels of significance at which the null hypothesis is rejected: *** p<0.01, ** p<0.05, * p<0.1 | | The time fixed effects and the municipality's fixed effects were controlled | The SYS-GMM estimations present two-step results | AR(1), AR(2) refer to the first and second-order autocorrelation tests | The variables PopDens, Depend, Unemp, Income, Transf, OwnRev and Debt are lagged by one period. | The variables Income, Transf, OwnRev and Debt are expressed in logarithms.

Table 17 - Estimation results for the Yardstick Competition Model – Party Ideology

	1	2	3	4	5
Matrix	**Total** ($\boldsymbol{W^T}$)	**100** ($\boldsymbol{W^{100}}$)	**50** ($\boldsymbol{W^{50}}$)	**30** ($\boldsymbol{W^{30}}$)	**Binary** ($\boldsymbol{W^{bi}}$)
Dependent Variable	**VPIT**	**VPIT**	**VPIT**	**VPIT**	**VPIT**
$VPIT_{i,t-1}$	0.668***	0.664***	0.677***	0.670***	0.682***
	(0.0423)	(0.0412)	(0.0434)	(0.0449)	(0.0469)
$W\tau_{jt}$	0.199	0.0837	-0.00836	0.0125	0.00527
	(0.174)	(0.113)	(0.00772)	(0.0521)	(0.00751)
$W\tau_{jt} * PartyIdeology$	-0.0137	0.0351	0.0529	0.0916	-0.00150
	(0.158)	(0.138)	(0.103)	(0.0804)	(0.00266)
$PartyIdeology$	0.00110	-0.00128	-0.00217	-0.00309	0.00759
	(0.00676)	(0.00588)	(0.00435)	(0.00338)	(0.0101)
PopDens	-1.75e-07	-1.54e-07	-5.53e-08	-1.47e-08	1.78e-07
	(1.92e-07)	(1.91e-07)	(1.96e-07)	(1.70e-07)	(2.52e-07)
Depend	-0.00496**	-0.00444*	-0.00361*	-0.00404*	-0.00552**
	(0.00232)	(0.00230)	(0.00210)	(0.00216)	(0.00229)
Unemp	-0.00721	-0.00517	-0.00836	-0.00605	-0.00561
	(0.00775)	(0.00781)	(0.00772)	(0.00751)	(0.00804)
Income	-0.00245	-0.00261	-0.00603	-0.00595	-0.00435
	(0.00416)	(0.00402)	(0.00387)	(0.00396)	(0.00363)
Transf	-0.000702	-0.000777	-0.00106**	-0.000999*	-0.000568
	(0.000538)	(0.000552)	(0.000529)	(0.000547)	(0.000473)
OwnRev	0.000230	4.03e-05	0.000321	0.000498	0.00130
	(0.000921)	(0.000833)	(0.000729)	(0.000721)	(0.000947)
Debt	0.000650**	0.000695***	0.000653**	0.000585**	0.000546**
	(0.000255)	(0.000256)	(0.000261)	(0.000265)	(0.000255)

Time Effects	Yes	Yes	Yes	Yes	Yes
Observations	2745	2745	2745	2745	2745
No. of Instruments	70	74	74	74	74
p-value AR (1)	0.000	0.000	0.000	0.000	0.000
p-value AR (2)	0.413	0.428	0.341	0.416	0.381
Hansen Test (*p-value*)	0.798	0.895	0.835	0.684	0.679

Data Source: CNE, DGAL, IEFP, INE, SI| Note: Robust standard errors are given in parenthesis. | Levels of significance at which the null hypothesis is rejected: *** p<0.01, ** p<0.05, * p<0.1 || The time fixed effects and the municipality's fixed effects were controlled | The SYS-GMM estimations present two-step results | AR(1), AR(2) refer to first and second-order autocorrelation tests |The variables PopDens, Depend, Unemp, Income, Transf, OwnRev and Debt are lagged by one period. | The variables Income, Transf, OwnRev and Debt are expressed in logarithms.

Appendix C

Table 18 - Estimation Results for Tax Interaction and Size of Municipalities

Matrix	1 **Total** $(\boldsymbol{W^T})$	2 **100** $(\boldsymbol{W^{100}})$	3 **50** $(\boldsymbol{W^{50}})$	4 **30** $(\boldsymbol{W^{30}})$	5 **Binary** $(\boldsymbol{W^{bi}})$
Dependent Variable	**VPIT**	**VPIT**	**VPIT**	**VPIT**	**VPIT**
$VPIT_{i,t-1}$	0.633*** (0.0495)	0.632*** (0.0490)	0.633*** (0.0496)	0.639*** (0.0492)	0.624*** (0.0493)
$W\tau_{jt}$	0.524** (0.212)	0.231** (0.108)	0.169* (0.0904)	0.142* (0.0807))	0.000134 (0.0182)
$W\tau_{jt} * Population_{it} * 10^{-4}$	-0.0274** (0.0120)	-0.0446*** (0.0170)	-0.0417** (0.0188)	-0.0365** (0.0185)	-0.00242 (0.00373)
$Population_{it}$	0.00108** (0.000546)	0.00170** (0.000779)	0.00136 (0.000889)	0.000973 (0.000846)	-0.000225 (0.000850)
L.PopDens	-1.22e-07 (3.56e-07)	5.06e-07 (5.31e-07)	1.15e-06 (7.38e-07)	1.30e-06 (9.96e-07)	7.69e-07 (1.39e-06)
Depend	-0.00377 (0.00291)	-0.00260 (0.00328)	-0.00171 (0.00386)	-0.000665 (0.00483)	-0.000320 (0.00493)
Unemp	0.00895 (0.0101)	0.0120 (0.0111)	0.0175 (0.0135)	0.0301* (0.0161)	0.0187 (0.0174)
Income	0.0110 (0.00715)	0.0136 (0.00859)	0.0162 (0.0100)	0.0254** (0.0113)	0.0214* (0.0114)
Transf	-0.000157 (0.000702)	-0.000587 (0.000848)	-0.00112 (0.00105)	-0.000801 (0.00134)	-0.00214 (0.00139)

OwnRev	-0.00154 (0.00139)	-0.00106 (0.00123)	-0.000892 (0.00162)	-0.00186 (0.00242)	-0.00382 (0.00248)
Debt	0.000873*** (0.000295)	0.000801*** (0.000301)	0.000717** (0.000350)	0.000684 (0.000426)	0.000805* (0.000438)
Time Effects	Yes	Yes	Yes	Yes	Yes
Observations	2745	2745	2745	2745	2745
No. of Instruments	68	68	68	68	68
p-value AR (1)	0.000	0.000	0.000	0.000	0.000
p-value AR (2)	0.178	0.177	0.194	0.253	0.188
Hansen Test (*p-value*)	0.377	0.377	0.403	0.81	0.532

Data Source: CNE, DGAL, IEFP, INE, SI| Note: Robust standard errors are given in parenthesis. | Levels of significance at which the null hypothesis is rejected: *** p<0.01, ** p<0.05, * p<0.1 || The time fixed effects and the municipality's fixed effects were controlled | The SYS-GMM estimations present two-step results | AR (1), AR (2) refer to first and second-order autocorrelation tests. | The variables PopDens, Depend, Unemp, Income, Transf, OwnRev and Debt are lagged by one period. | The variables Income, Transf, OwnRev and Debt are expressed in logarithms.