



The importance of spatial effects in municipal debt

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ABSTRACT

This article analyses the debt of local governments taking into account the presence of spatial interactions among neighbouring municipalities. To this end, the S2SLS and Spatial lag models were applied to a sample of 527 municipalities located in the Valencian Community (Spain) for the year 2015. The main results reveal a spatial correlation in outstanding debt among municipalities. The gender of the mayor, the grants and transfers received and the average payment period have direct effects on outstanding debt. In turn, the net savings index, inactive population, local income and the strength of the ruling political party have indirect effects on the municipal debt and indirect spatial effects on the debt of the neighbouring municipalities.

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La importancia de los efectos espaciales en la deuda municipal

RESUMEN

Este artículo analiza la deuda de los gobiernos locales teniendo en cuenta la presencia de interacciones espaciales entre los municipios vecinos. Para ello se utiliza una muestra 527 municipios de la Comunidad Valenciana, para el año 2015 y se aplican los modelos espaciales S2SLS y Spatial lag. Los principales resultados obtenidos muestran la existencia de autocorrelación espacial en la deuda viva entre los municipios. Las variables género del alcalde, índice de subvenciones y transferencias recibidas y el periodo medio de pago presentan efectos directos sobre la deuda viva. Mientras que, el índice de ahorro neto, la población no activa, la renta local y la fortaleza política tienen efectos directos en la deuda del municipio y efectos espaciales indirectos en la deuda de los municipios vecinos.

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Introduction

Public debt is an indicator for measuring a country's financial health. In Spain, the volume of debt has steadily increased, notably since the start of the global economic crisis. Given its volume and importance, European and national legislation has had to adapt to the situation, imposing strict limits to be met at central, regional and local levels. The importance of the topic has led to numerous studies in the literature analysing local debt in its different aspects, such as the success or failure of the debt limits, or the determinants of debt, among others. However, few studies analyse the existence of neighbourhood interdependencies on debt decisions. The only contributions we are aware of are Borck, Fossen, Freier and Martin (2015), Kopczevska, Kuda, Walczyk and Kocia (2016), whose studies analyse the spatial effect in the German municipalities and EU countries, respectively.

This paper therefore aims to go beyond the classic approach of indebtedness, by analysing whether neighbouring interdependencies exist in municipal debt decisions, that is, whether an increase in the debt level of one municipality might affect that of the neighbouring municipality. In today's globalised world, the effect of interconnectivity and technological development seems to be that nothing happens randomly. This has motivated some authors to hypothesise that local governments do not make decisions in isolation, but take into account the decisions adopted by their neighbours. Spatial interactions among municipalities and their influence on fiscal policy are increasingly attracting research attention. Authors such as Bastida, Guillamón and Benito (2013b), Ermini and Santolini (2010); Foucault, Madies and Paty (2008) and López, Martínez-Ortiz and Cegarra-Navarro (2017) highlight the existence of similar spatial behaviours in localities in spending, that is, spending levels in one municipality are influenced by the spending decisions adopted by neighbouring municipalities.

In this article, we focus on the determinants of local debt, specifically on the spatial effects of debt among Valencian (Spain) local governments for the year 2015. In this case, the literature is much scarcer. In fact, our study is the first to examine this question for Spanish municipalities. A further contribution of the study is the inclusion of the variable average payment period to suppliers, which has not been analysed in previous research, in order to examine its possible effects on the level of municipal debt.

Our results show the presence of spatial autocorrelation in public debt. Overall, the gender of the mayor, grants and transfers received and average payment period to suppliers show direct spatial effects on current debt. Net savings, inactive population, inhabitants' income level and the political strength of the governing party have direct spatial effects on municipal debt and indirect effects on the debt of neighbouring municipalities.

This study is structured in five sections. Following this introduction, the next section reviews some relevant literature on debt and spatial patterns, and defines the hypotheses to be tested. The third section outlines and justifies the sample and specifies the model. Section four presents the main results, and the conclusions of the analysis are presented in section five.

Previous literature and hypotheses

A review of the literature on local debt

Government debt has been analysed from various different perspectives in recent years. Research interest in public

debt has grown since the onset of the recent economic crisis, which at the same time ushered in far-reaching legislative changes. The extensive literature can be classified into several groups according to the analytical focus taken.

The first group includes studies analysing the determining factors of debt (Balaguer-Coll, Prior & Tortosa-Ausina, 2016; Bastida & Benito, 2005; Benito & Bastida, 2004; Benito, Guillamón & Bastida, 2015a; Cabasés, Pascual & Vallés, 2007; Guillamón, Benito & Bastida, 2011; Pérez-López, Plata, Zafra-Gómez & López-Hernández, 2013; Ribeiro & Jorge, 2014).

A second group explores legal debt limits and their success or failure (Allers, 2015; Benito et al., 2015a; Cabasés et al., 2007; Vallés, Pascual & Cabasés, 2003; Vila, 2012). In a recent article, Olmo (2018) analyses the explanatory factors and the limitations of Spanish debt. His main conclusions suggest that the budget stability regulation, provided for in Law 2/2012, of April 27, on Budgetary Stability and Financial Sustainability, has not had a significant effect on the reduction of accumulated municipal debt. However, the author notes that this regulation has contributed to changing the trend of indebtedness in Spanish municipalities.

Another line of research includes studies on the relationship between electoral cycles and debt as a financial resource (Bastida, Beyaert & Benito, 2013a; Cabaleiro-Casal, Buch-Gómez & Vaamonde, 2014; García-Sánchez, Prado-Lorenzo & Cuadrado-Ballesteros, 2011; Vicente, Ríos & Guillamón, 2013). In this line, Clinger, Feiock, McCabe and Park (2008) examine local debt in U.S. cities by considering turnover among local government officials and its influence on debt. They conclude that debt is not only affected by the economic situation facing local governments, but also by the decisions taken in uncertain political contexts driven by political incentives.

A further area of analysis explores the possible relationship between debt level and fiscal consolidation (Andrews, 2015) or budget transparency and debt (Ríos, Bastida & Benito, 2016).

Other studies analyse the relationship between decentralisation of municipal services and debt levels (Brusca, Montesinos & Mora, 2012; Zafra-Gómez, Pedauga, Plata-Díaz & López-Hernández, 2014) and the creation of special districts and the increase of debt in the United States (Faulk & Killian, 2017). The literature on debt includes the work of Pérez-López, Plata, Zafra-Gómez and López-Hernández (2014), who analyse the setting up of instrumental bodies that allow local governments to exclude part of the debt from their budgets. These authors show how municipalities that outsource more of their services and have a higher number of consortiums also have lower debt levels.

The final field of study, which has attracted less analytical attention at both national and international levels, applies spatial econometrics instruments to examine the existence of similar debt patterns among public administrations (Borck et al., 2015; Kopczevska et al., 2016).

Spatial effects in the financial situation of territorial authorities

The literature on spatial patterns in local taxes provides evidence of tax mimicking among municipalities (Allers & Elhorst, 2005; Cassette, Di Porto & Foremny, 2012; Delgado & Mayor, 2011). The work of Álvarez and Barbero (2016) highlights the importance of spatial effects of tax income on growth in Spanish regional economies, analysing at the same time competition among regions for public resources.

Recent studies have sought spatial relationships between

neighbouring units with reference to specific expenditure items. In Spain, authors such as Bastida et al. (2013b) and López et al. (2017) provide empirical evidence of spatial effects in municipal expenditure. Ermini and Santolini (2010) and Foucault et al. (2008) find similar spatial patterns in Italian and French municipalities, respectively.

In line with the previous research, Kopczevska et al. (2016) carried out a broad study on the existence and magnitude of the spatial effects of debt in EU countries. These authors observe that taxes have a considerable spatial repercussion on debt at the European level, confirming the existence of global effects that influence the fiscal policy of the Eurozone. Pan, Zhang, Zhu and Wójcik (2017) find a pattern of constant debt accumulation in Chinese municipalities due to their increased income from taxes, which represents greater capacity to return the debt they owe. Their main conclusions identify spatial patterns in municipal debt, that is, the issue of bonds as a local financing instrument in one city is related to the amount of bonds issued by neighbouring cities. Borck et al. (2015) study spatial patterns in German municipal debt and uncover a robust spatial correlation. These authors confirm that if one local authority increases its debt level, this has repercussions for its closest neighbour, which in turn increases its own debt.

Finally, Zhang and Gibson (2017) observe spatial dependency in the outsourcing of local services, indicating that decisions to subcontract services to third parties are influenced by the outsourcing decisions taken by their nearest neighbouring local authorities.

Spatial effects in Spanish municipal debt

Economic management in local councils has worsened as a result of the recent economic and financial crisis. Municipalities with high debt levels and budgetary deficit or those receiving insufficient transfers are now opting to outsource their services or are entering into inter-municipal collaboration agreements (Zafra-Gómez et al., 2014). These developments led us to consider that municipal debt level may be influenced by the level of debt in neighbouring municipalities. It is therefore of interest to analyse the variables used in this study from the perspective of municipalities' financial condition. The present study takes this perspective to analyse four budgetary indicators: *grants and transfers received (GRANTS)*, *net saving rate (NSR)*, *capital expenditure (CE)* and *average payment period (APP)*.

Grants and transfers received (GRANTS) may be defined as an indicator that measures a municipality's financial vulnerability, that is, how sensitive it is to external sources of funding from other levels of government. In turn, the *net saving rate (NSR)* is the local authority's capacity to generate additional resources once it has fulfilled its obligations, and may be an indicator of its budgetary sustainability. Zafra-Gómez, López-Hernández and Hernández-Bastida (2009) consider net savings as an indicator of flexibility, which they refer to as the capacity of local authorities to service borrowing with their available resources. For its part, solvency at the services level can be represented by the variable *capital expenditure (CE)*, defined as the capacity of local authorities to provide facilities in order to offer adequate services. Finally, the *average period of payment to suppliers (APP)* is defined as an indicator of cash solvency, that is, the authority's ability to generate liquidity to meet its short-term payment obligations.

Next, we will analyse the effects of these budgetary variables and others of a socio-economic and political nature (Table 1).

Budget variables

Grants and transfers received (GRANTS)

Lago-Peñas (2008) finds that local authorities with higher grants increase their expenditure level, and refers to this effect as "fiscal replacement form of asymmetry". The author notes that, depending on the ruling political ideology, grants are either used to reduce the debt or not. Specifically, grants are used by conservative governments to reduce their deficit because their income from taxes is lower. Pérez-López et al. (2014) state that increase in subsidies correlates negatively with local corporation indebtedness, because their need for financing is reduced. Balaguer (2002), Bastida and Benito (2005), and Pérez-López et al. (2013) report that higher volumes of grants received coincide with debt reduction. However, Guillamón et al. (2011) and Levaggi and Zanola (2003) find a positive relationship between grants received and debt level. Bastida, Benito and Guillamón (2009) find that transfers received increase local expenditure and there are few incentives to use grants to reduce the local tax burden. In light of the above, we propose the following hypothesis:

H1: The volume of grants received has positive/negative effects on local debt.

Net savings rate (NSR)

According to Vallés et al. (2003), local authorities that implement austerity policies in their current expenditure and have an appropriate plan for debt reduction have greater financing capacity; in other words they do not need excessive debt to finance their capital investments. However, in their analysis of nonfulfilment of debt limits, Benito et al. (2015a) conclude that net saving is the most frequently breached limit. Similarly, Vila (2012) analyses the evolution of net savings as a determinant of compliance with legal debt limits, finding a negative evolution. Balaguer (2002), Bastida and Benito (2005), Brusca and Labrador (1998), Vallés et al. (2003) and Pérez-López et al. (2013) find a negative relation between net savings and municipal debt. Given the significance of net saving to debt, we formulate our second hypothesis:

H2: When net saving is higher, local debt is more likely to decrease.

Capital expenditure (CE)

Capital expenditure is financed by capital transfers received, current savings, income from urban development taxes, or long-term loans, which increase municipal debt. In this line, Benito, Vicente and Bastida (2015b) find a significant and positive relationship between capital spending and local debt. The studies by Balaguer-Coll et al. (2016), Bastida and Benito (2005), Benito and Bastida (2004), Vallés et al. (2003), Cabasés et al. (2007), and Pérez-López et al. (2013) conclude that capital investment positively influences local debt, and that local debt is one of its determinants. Zehms (1991) highlights the need to update capital assets and their financing through opportune budgetary allocations in the budgets. According to this study, investment spending, contained in budget reports, informs users about the proportion of expenditure allocated to financing municipal investment. This leads us to the following hypothesis:

H3: When capital expenditure is higher, local debt is more likely to increase.

Table 1
Definition of the variables

	Definition of the variables	Expected sign	Sources
<i>Dependent variable</i>	Log Current Debt (log <i>CD</i>)	Total nominal value of gross liabilities of the public administration sector pending at the end of the year	Ministry of Finance
<i>Budget variables</i>	Grants and transfers (<i>GRANTS</i>)	Grants and transfers received / total population	+/-
	Net Savings Rate (<i>NSR</i>)	Gross savings-amortization expenses/ current revenues (net recognized revenue)	-
	Capital Expenditure (<i>CE</i>)	Capital expenditure / total population	+
	Average Payment Period (<i>APP</i>)	Dummy variable (0: payment within 30 days; 1: payment in excess of 30 days)	+
<i>Socio-economic variables</i>	Population density (<i>DENS</i>)	Number of inhabitants/total extension (in squared kilometres)	-
	Income (<i>INCOME</i>)	Disposable income per capita	+
	Retired people (<i>RET</i>)	Population aged over 65/total population	+/-
<i>Political variables</i>	Gender of mayor (<i>GEN</i>)	Dummy variable (0: male mayors; 1: female mayors)	+/-
	Herfindahl Index (<i>HI</i>)	Values between 0 and 1 depending on the number of councillors for each party in the council. High values denote a lower level of political fragmentation or higher political strength	+/-
	Political Sign (<i>SIGN</i>)	Dummy variable (0: municipalities governed by left-wing parties; 1: municipalities governed by right-wing parties)	+/-

Average payment period (*APP*)

Organic Law 2/2012 on Budget Stability and Financial Sustainability establishes a set of fiscal regulations that affect local administrations through the principles of financial stability and sustainability, the expenditure rule, and the use of budget surplus to pay off debt. To control commercial late payments, the regulation stipulates the average period of payment to local suppliers, setting a final payment date at 30 days of receiving the invoice. If the local administration does not make the payment, it incurs interest on arrears that increases the total debt. In this line, Pons (2017) runs an analysis of variance on the average payment period, as an indicator of debt, of different types of local organisations, finding that a large proportion of the municipalities analysed do not comply with the regulation. Given the innovative nature of the variable *APP*, we test its possible influence on municipal debt with the following hypothesis:

H4: Compliance with the legal limit of period of payment to suppliers reduces current debt.

Socio-economic variables

Income level (*INCOME*)

This variable has been used by Bastida et al. (2013a), Benito et al. (2015b), Cabasés et al. (2007) and McEachern (1978), among others, in their studies on debt. In his study analysing how the electoral cycle influences municipal debt per capita, Bastida (2013a) noted that an increase in the level of income has a positive long-run effect on debt. Cabasés et al. (2007) and McEachern (1978) found that the level of debt is positively associated with a higher economic level. In another study on the housing bubble and its consequences at local government level, Benito et al. (2015b) found that economic level does not affect public debt growth. Most studies find a positive relationship of this variable with debt, indicating that wealthy states can handle new debt; that is, higher per capita income levels lead to higher accumulated public debt due to higher demand from citizens for goods and services (Bastida & Benito, 2005; Clingermayer & Wood, 1995;

Cabasés et al., 2007; Guillamón et al., 2011; Kiewiet & Szakaty, 1996; Vallés et al., 2003). This leads us to formulate the following hypothesis:

H5: Income level affects local debt positively.

Population density (*DENS*)

In the literature on debt, the relationship between population density and local debt growth is unclear, and has led to many diverse conclusions. Bastida et al. (2009) report that economies of scale are more likely to be present in local authority expenditure, the higher the population density. Benito et al. (2015b) state that population density is negatively correlated with debt growth; that is, the need for financing declines as population density increases. Bastida et al. (2013b) conclude that the impact of population density on different types of functional expenditure is negative. This conclusion is explained by the fact that expenditure on street cleaning and lighting in the town or city centre, among other factors, does not vary according to number of inhabitants. These authors find that municipalities with higher population densities have lower current debt levels. However, Andrews (2015) analyses vertical consolidation and financial sustainability in English local authorities, finding that population density is not a factor that determines an authority's "fiscal health". In light of the above, we propose the following hypothesis:

H6: The higher the population density, the greater the possibility that the local debt level will be lower.

Retired people (*RET*)

Social services, resulting from local policies, lead to increased public spending, which in turn affects debt level. Social policies are associated with population segments, in that the existence of vulnerable groups motivates social policies with resulting increased service costs. In this vein, Hagen and Vabo (2005) find evidence that older people have negative effects on public finance surplus; similarly, Rodríguez, Navarro, Alcaide and López (2016) found evidence that citizens over the age of 65 have a negative effect on the financial sustainability of local authorities. Hence, the needs of

the retired population lead to an increase in the public services provided and consequently the level of debt. However, in contrast to these results, [Ellis and Schansberg \(1999\)](#) concluded that population older than 65 was negatively related to the level of state long-term debt. Taking these results into account, we consider the effect of inactive population on the amount of municipal debt an interesting question to examine, and formulate the following hypothesis:

H7: The inactive population has positive/negative effects on local debt.

Political variables

Election data from 2011 were used to define the political variables (political strength, political inclination and gender of the mayor), since current debt is an accumulated amount and its volume is a result of past decisions.

Gender of the mayor (GEN)

[Massolo \(1996\)](#) highlights the importance of analysing the gender variable in municipal studies. According to [Hernández-Nicolás, Martín-Ugedo and Mínguez-Vera \(2018\)](#) councils with women mayors have fewer annual interest and debt repayment obligations and have higher expenditure on security, protection, and social promotion. However, [Brusca, Rossi and Aversano \(2015\)](#) found that mayor's gender was not significant in Spanish and Italian local authorities' per capita debt. [Guillamón et al. \(2011\)](#) and [Gras, Hernandez and Palacios \(2014\)](#) found that the gender of the mayor is not an explanatory factor of Spanish local debt.

[Hamidullah, Riccucci and Pandey \(2015\)](#) point out that not only do men and women have different values of equity, long-term perspective, sense of community and representation, but also differ in their values of efficiency, effectiveness and experience. For their part, [Carozzi and Gago \(2017\)](#) analyse gender and social policies related to support for families, preschool education and work, finding no empirical evidence that women mayors are more likely to introduce such policies. [Clots-Figueras \(2011\)](#) observes that when women are responsible for political management, a positive impact is seen in educational performance in urban areas of India.

[Ferraz and Tejedo-Romero \(2016\)](#) find that women's role in local Spanish politics was greater in the 2011 elections than in the previous 2007 local elections. [Iltan, Oliver and O'Connor \(2007\)](#) studied the restructuring of the Canadian public sector and women's new political and economic role. [Green and Homroy \(2018\)](#) evidence the positive and economically significant effects of women directors' involvement on company boards and committees. [Bagues and Campa \(2017\)](#) identify increased gender quotas in local authorities, but find no statistically significant evidence of change in the composition of public finance. The above arguments lead us to formulate the following hypothesis:

H8: The mayor's gender can affect local debt.

Herfindahl Index (HI)

Research analysing political strength and its consequences for local debt has reached varying conclusions. [Ashworth, Geys and Heyndels \(2005\)](#) find that more politically fragmented local governments have higher public deficits and debt, due to the strategic use of debt by political coalitions. [Roubini and Sachs \(1989\)](#) find that governments with a larger number political parties in coalition have higher levels of public deficit; that is, the weaker the government, the higher the deficit will be. Their analysis of strategic debt shows that

local governments probably prefer to take on higher debt as a legacy for future governments, concluding that the effects of political fragmentation have a long-term influence on municipal debt. [Guillamón et al. \(2011\)](#) show that the concentration of local government power influences debt level. [Tovmo \(2007\)](#) and [Rattsø and Tovmo \(2002\)](#) conclude that political fragmentation does not affect public deficit, and therefore debt. [Borge \(1996\)](#) finds robust effects of political fragmentation on municipal debt, although politically strong governments are not confirmed to have lower debt levels. [Hagen and Vabo \(2005\)](#) conclude that stronger political leadership leads to higher fiscal performance and, therefore, improved – that is, higher – budget balance. This lack of consensus motivates our objective to test the effects of political strength on local debt.

To measure the degree of political competition in the municipalities analysed, we use the Herfindahl index, which takes values between 0 and 1, depending on the number of councillors from each party represented in the council, with higher values indicating a lower degree of political fragmentation and, therefore, a lower degree of competition or higher degree of political strength. Following [Guillamón et al. \(2011\)](#), we define the Herfindahl index by means of the following expression:

$$\frac{\sum_{i=1}^n S_i^2}{S^2} \quad (1)$$

where S_i is the number of councillors of party i in the local government; and S is the total number of councillors. Taking into account the above arguments, we formulate our next hypothesis:

H9: Greater political fragmentation in local governments can increase/decrease local debt.

Political sign (SIGN)

The study by [Rattsø and Tovmo \(2002\)](#) shows that left-wing parties are more likely to increase spending, without raising income through taxes, as a result of their social policies; this positively contributes to the public deficit, which increases local debt. [García-Sánchez et al. \(2011\)](#) find evidence for partisan budgetary cycles, noting that parties with a left-wing ideology incur greater debt than conservative parties due to their political ideology. These authors show that left-wing incumbents increase debt significantly more than conservative governments during election periods in order to improve their re-election chances. [Kiewiet and Szakaty \(1996\)](#) find that conservative-run councils have lower levels of debt.

In contrast, authors such as [Cabaleiro-Casal et al. \(2014\)](#) note that ideology has a significant influence on debt level, confirming that councils governed by political parties with no clear ideological identity have lower debt levels. However, these authors are unable to confirm significant differences between conservative and left-wing parties in terms of debt levels. For their part, [Bastida and Benito \(2005\)](#), [Benito and Bastida \(2004\)](#), [Guillamón et al. \(2011\)](#) and [Pérez-López et al. \(2013\)](#) conclude that political inclination does not have a significant influence on municipal debt level. Finally, [Bastida et al. \(2009\)](#) demonstrate that parties' political ideology has no clear influence on municipal expenditure, deducing from this that ideology does not affect indebtedness. The above arguments lead us to our final hypothesis:

H10: The political sign may or may not influence municipal debt.

Data and specification of the model

Sample and definition of variables

This study was carried out using a sample of town councils from the Valencian Community (Spain) for which information was available for the year 2015. The sample comprised 527 municipalities, representing 97% of all the municipalities in the region. Table 2 displays the distribution of per capita debt in the municipalities of the Valencian Community, showing that small municipalities have higher debt levels per capita than medium-sized or large municipalities.

Table 2
Distribution of municipalities and local debt (year 2015)

Population size	Municipalities		Local debt	
	Number municipalities	% municipalities	Debt per capita	% Debt per capita
Below 1,000	208	39.47%	73043.37	35.56%
1,001–3,000	123	23.34%	40842.54	19.88%
3,001–5,000	41	7.78%	19767.08	9.62%
5,001–10,000	57	10.82%	26682.17	12.99%
10,001–20,000	33	6.26%	11352.83	5.53%
20,001–50,000	50	9.49%	23134.39	11.26%
50,001–100,000	11	2.08%	8282.71	4.03%
Over 100,000	4	0.76%	2315.95	1.13%
Total	527	100%	205421.05	100%

The dependent variable that we analyse in this paper is current debt (*CD*), which can be defined as the stock of government liabilities at the end of the period, measured at nominal value. Currency and deposits, loans and debt securities are the instruments that are included in the definition of general government gross debt in Council Regulation (EC) No 479/2009 as amended by Commission Regulation No 220/2014 (Maastricht debt). They are defined in terms of the ESA 2010 classifications¹.

Data for 'current debt' and 'budget variables' were taken from the Ministry of Finance. Data for the variable 'per capita income' are from the Klein Institute database. Information on people over the age of 65, number of inhabitants, and square kilometres for each locality came from the Spanish National Statistics Institute. Data for the variable 'gender of the mayor' was provided on request by the central government's Transparency Portal. Finally, data on the political variables came from the Spanish Ministry of the Interior and the Ministry of the Presidency and for the Territorial Administrations. Descriptive statistics of these variables are provided in Table 3.

Table 4 reports the frequencies of the dummy variables (*APP*, *GEN* and *SIGN*), together with their percentage of the variable 'local debt'. The table shows that the majority of local governments do not meet the stipulated average payment period for local suppliers (*APP*). Local governments that pay their suppliers on time are also those with the lowest levels of per capita debt. Most Valencian municipalities are led by men (mayor's gender *GEN*), and those with women mayors have higher per capita debt levels. The political ideo-

¹The definition of current debt can be found on the website of the Ministry of Finance (*Ministerio de Hacienda*, in Spanish): <http://www.hacienda.gob.es/es-ES/CDI/Paginas/SistemasFinanciacionDeuda/InformacionEELs/DeudaViva.aspx>

Table 3
Descriptive statistics (2015)

Variable	Mean	Std. Dev.	Min	Max
Log (CD)	4.199	2.825	0.000	8.852
GRANTS	0.406	0.149	0.062	0.938
NSR	0.091	0.166	-0.832	0.498
CE	300.853	455.373	2.880	5007.601
APP	0.474	0.500	0.000	1
DENS	541.984	1965.978	0.520	26644.430
INCOME	13666.380	20965.160	7578.296	471403.100
RET	0.241	0.083	0.091	0.577
GEN	0.194	0.396	0.000	1
HI	0.450	0.133	0.174	1
SIGN	0.676	0.469	0.000	1

logy variable (*SIGN*) reveals that conservative parties outnumber left-wing parties, and their debt levels are higher.

Table 4
Frequency of variables *APP*, *GEN* and *SIGN* in relation to local debt (2015)

Variable	Dummy	Mean	Std. Dev.	Percentage	Freq.
APP	0	202.263	285.039	47.440	250
	1	559.045	780.881	52.560	277
GEN	0	384.496	650.832	80.650	425
	1	411.868	503.404	19.350	102
SIGN	0	360.961	501.226	32.450	171
	1	403.642	676.229	67.550	356

Model specification

Following the basic modelling strategy in the work of Elhorst (2010), we apply the ordinary least squares (OLS) model to test for spatial dependence. Standard econometric estimation methods are not suitable when spatial autocorrelation is present, due to bias and inconsistency in the estimates (Chasco, 2003; Hall, Karadas & Schlosky, 2016). This is because of the endogeneity that characterises spatial models, which can be defined as linear models that represent spatial effects of dependency or spatial autocorrelation. When tests are applied to detect autocorrelation, namely Moran's I, Lagrange multiplier lag, Lagrange multiplier error and Lagrange multiplier SARMA, they are shown to be significant: that is, substantive and residual autocorrelation is observed. Table 5 reports the results of these tests. Both the LM (lag) test and the robust LM (lag) test show that spatial dependence is substantive and is adapted to the SAR model, as specified by Anselin (2005). The test performed on the residual model shows spatial dependence, but its robust version rejects this hypothesis. These results were confirmed by the robust SARMA test.

The non-normal distribution of the residuals precludes the application of the strategy to estimate the model with the maximum likelihood (ML) method, presented in the spatial literature by Elhorst (2010), and LeSage and Pase (2009, 2010, 2014). We therefore use spatial lag and two-stage least squares (S2SLS) models as proposed in Bastida et al. (2013b). To estimate the spatial lag model, we include the spatially lagged dependent variable W_y as a further explanatory variable, in line with Chasco (2013). The spatial lag is

Table 5
Spatial interactions of municipality debts

Variables	Models				Spatial effects		
	S2SLS		Spatial lag		Direct effects	Indirect effects	Total effect
ρ W log (CD)	0.3028 ***	(0.1201)	0.3215 ***	(0.1207)			
GRANTS	-1.5647 *	(0.9468)	-1.5694 *	(0.8354)	-1.6014e+00 *	-7.1154e-01	-2.3130e+00 *
NSR	-3.0823 ***	(0.6249)	-3.0889 ***	(0.5791)	-3.1521e+00 ***	-1.4005e+00 *	-4.5525e+00 ***
CE	-0.0003	(0.0002)	-0.0003	(0.0003)	-3.1425e-04	-1.3963e-04	-4.5388e-04
APP	1.6068 ***	(0.2572)	1.6101 ***	(0.2436)	1.6430e+00 ***	7.3001e-01	2.3730e+00 ***
INCOME	0.0000	(0.0000)	0.0000 ***	(0.0000)	6.1071e-06 ***	2.7185e-06 **	8.8255e-06 ***
DENS	-0.0000	(0.0001)	-0.0000	(0.0001)	-3.3600e-05	-1.4929e-05	-4.8529e-05
RET	-5.0533 ***	(1.6823)	-4.9078 ***	(1.7132)	-5.0053e+00 ***	-2.2280e+00 *	-7.2333e+00 ***
GEN	0.4083	(0.2609)	0.4005 *	(0.2346)	4.0841e-01 *	1.8180e-01	5.9021e-01
HI	-4.1699 ***	(1.0236)	-4.1175 ***	(1.0504)	-4.2016e+00 ***	-1.8668e+00 *	-6.0684e+00 ***
SIGN	0.2178	(0.2214)	0.2229	(0.2144)	2.2731e-01	1.0118e-01	3.2849e-01
CONSTANT	7.8154 ***	(0.9468)	7.6971 ***	(0.9501)			
Anselin-Kelejian Test	0.1577		0.1618				
R ²	0.3093		0.3122				
Moran's I (error)	2.6170 ***						
LM (lag)	8.9340 ***						
Robust LM (lag)	3.6460 **						
LM (error)	5.6020 ***						
Robust LM (error)	0.3150						
LM (SARMA)	9.248 ***						

* p < 0.1 **; p < 0.05; ***p < 0.01. Standard error in parenthesis.

included in the analysis in order to achieve the consistency that is not yielded by the OLS model and, at the same time, incorporate in the model the influence of the variables omitted in the OLS model. We take into account the presence of endogeneity in the model by constructing the spatial lag, since this functions in the same way as including the endogenous variable in the simultaneous equations framework, according to Chasco (2013). In accordance with the above, in the spatial literature this model is referred to as the simultaneous autoregressive spatial model.

We use the Anselin-Kelejian test to check the existence of spatial autocorrelation in the residuals. The results show no spatial autocorrelation in the error term. Therefore, the most suitable model, once again, is the mixed autoregressive model of spatial regression, known as the lag model, which is expressed as follows:

$$y = \rho W_y + X\beta + u \quad (2)$$

where:

y : vector of observations of the dependent variable.

ρ : spatial autoregressive coefficient corresponding to the spatially lagged variable.

W_y : vector of spatial lags of the dependent variable (spatial lag of the variable y).

W : matrix of spatial weights.

X : matrix of observations of the independent variables.

β : vector of the independent variable parameters.

u : vector of random disturbances.

For our case we define the following model:

$$\begin{aligned} \log(CD_i) = & W_{\log(CD)} + \beta_1 \text{GRANTS}_i + \beta_2 \text{NSR}_i + \\ & \beta_3 \text{CE}_i + \beta_4 \text{APP}_i + \beta_5 \text{INCOME}_i + \beta_6 \text{DENS}_i + \\ & \beta_7 \text{RET}_i + \beta_8 \text{GEN}_i + \beta_9 \text{HI}_i + \beta_{10} \text{SIGN}_i + u_i \end{aligned} \quad (3)$$

As there is no theoretical model that specifies the most suitable matrix for each case, in the spatial autocorrelation test we used four types of weight functions for spatial contiguity matrix: queen contiguity (w1sdv), minimum distance (dminsdv) k -nearest-neighbour (knn5sdv), and inverse distance (dinvsdv). The results of the log likelihood ratio (LR) test² led us to select the 5 nearest-neighbour matrix, which best adapted to the spatial model, in line with Elhorst (2010). The k -nearest-neighbour criterion considers the geometric distance between regions taking into account the k nearest neighbours of each observation. To construct the matrix selected, we used information on the centroids and identified the nearest centroid as the neighbour until the established number of neighbours is obtained, following Herrera (2015). This criterion ensures that all the municipalities have the same number of neighbours and also avoids the problem of isolation of neighbours or municipalities with too many neighbours. Having chosen the nearest neighbour criterion, the municipalities were represented with the binary technique that assigns values of $W_{ij} = 1$ when i and j are neighbours and $W_{ij} = 0$ otherwise. Econometric treatment of the data requires matrix standardisation by rows. The distances based on the spatial weight matrix are used to interpret the interactions of the neighbours, calculated with UTM coordinates (latitude and longitude). Euclidean distance was used to construct the matrix; that is, distance based on a straight line and not kilometres.

Arraiz, Drukker, Kelejian and Prucha (2010), Drukker, Egger and Prucha (2013) and Kelejian and Prucha (1998, 1999, 2010) the most prominent scholars in the spatial literature, have developed the two-stage least squares estimation technique with instrumental variables and the spatial lag model. In their work, Anselin (1988) and Bastida et al. (2013b) propose using spatial two-stage least squares (S2SLS) by constructing an instrument fitted to the variable

²Log likelihood for each matrix is: w1sdv (-1197.2560); dminsdv (-1199.4940); dinvsdv (-1197.5780); knn5sdv (-1196.8860).

W_y . Chasco (2003) and Kelejian and Robinson (1993) argue that the spatially lagged exogenous variables are the appropriate instrumental variables for spatial analysis, which requires the use of first-order contiguous matrices. For these reasons, we use the logarithm of the current debt as the instrumented variable, and the lagged independent variables are the instruments.

To calculate the spatial effects, we take into account the multiplier of the matrix:

$$(I - \rho W)^{-1} \beta_k \quad (4)$$

where:

I represents the identity matrix of the order, in this case order 1.

ρ represents the spatial parameter³ that lies between -1 and 1.

W represents the matrix.

β_k is the vector of the independent variable parameters.

Results

Table 5 presents the results of the LM tests, Moran's I and the SARMA test that initially identified the existence of spatial autocorrelation. The LM tests, developed by Anselin (1988), show that a priori the spatial lag model is the most suitable, as it is confirmed by the robust LM test (Anselin, Bera, Florax & Yoon, 1996). Although in our case the LM test for the residuals is significant, the robust LM test rejects the spatial error model as the most suitable model. These results were confirmed by the Anselin-Kelejian test, the results of which show no spatial autocorrelation in the residuals. We therefore adopt the spatial lag model as the most suitable option for this study.

We also take into account the possible problem of endogeneity by following the instrumental variables (IV) or spatially lagged variables approach. Table 5 displays the main results. The effects of the spatial iteration of current municipal debt, represented by $\rho = 0.32$, are significant and positive. We can therefore confirm that if current debt rises in one municipality, its five nearest neighbours will also experience an increase in their debt levels. Our results are in line with the findings of Borck et al. (2015).

In addition, the interpretation of the results of the spatial models does not directly depend on the matrix units, since their interpretation is not based on the coefficients, due to the feedback effects from the ρ coefficients, according to Hall et al. (2016). That is, if an explanatory variable in one municipality undergoes changes, these changes will affect the dependent variables in the other municipalities. We therefore obtained the direct (on the diagonal of each matrix) and indirect (off the diagonal of each matrix) total effects according to Elhorst (2014a, b) and LeSage and Pace (2009). The direct effect reflects how a change in a variable in municipality i affects its current debt, and vice versa. The indirect effect represents the effect of the change in an independent variable in municipality i on the current debt of its neighbours j and vice versa (Elhorst, 2014a; López et al., 2017).

Similarly, spatial feedback effects occur due to their expansion; in other words, the spatial effects not only affect immediate neighbours, but also their neighbours' neighbours. For this reason we limited the expansion effect to the five nearest

neighbours⁴ through the first-order identity matrix. Having detected the existence of spatial autocorrelation we cannot interpret the spatial effects in the same way as the coefficients in the OLS model due to the presence of the spatial multiplier in the matrix.⁵

It is also important to note that the direct and indirect effects are different for each municipality and direct interpretation would be difficult since the sample in the present case comprises 527 municipalities. This problem is addressed by LeSage and Pace (2009), who provide the average indicators for each of the effects.

Continuing with the analysis of Table 5, the variable *grants and transfers received (GRANTS)* presents a direct spatial effect; that is, an increase in the *GRANTS* in one municipality has a negative effect on its current debt. Balaguer (2002), Bastida and Benito (2005), Benito et al. (2015a) and Pérez-López et al. (2013) found the same results. However, this increase does not affect the current debt of neighbouring municipalities. Local governments' involvement in local taxation systems (personal income tax, VAT, property tax, etc.) and grants received from other government bodies to finance services, investment in assets and public works are alternative sources of funding to taking on debt.

Our results reveal that the coefficient of the *net savings rate (NSR)* is significant and negative. Thus, H2 is supported, in the same line as Vallés et al. (2003). That is, if a municipality's net savings rate increases, its current debt will fall, and to a lesser extent, its neighbours' current debt will also decrease. Net savings represents local government sustainability in that if a municipality can meet its current expenses with its current income, it will not need to get into debt. Our results are in line with Balaguer (2002), Bastida and Benito (2005), Brusca and Labrador (1998), Vallés et al. (2003) and Pérez-López et al. (2013). These studies analyse this variable as a determinant of municipal debt, but without considering its potential spatial effects.

In a context of economic crisis, local investment may not be significant due to the stricter controls to which it is subjected.⁶ We deduce that local governments with high levels of debt postpone major investments in order to stabilise their growth and avoid excessive deficits. For this reason, we find no significant results of spatial autocorrelation for per capita *capital expenditure (CE)*. Neither does *population density (DENS)* present evidence of spatial autocorrelation in debt. However, when we analyse the linear model with OLS budget variables, these are statistically significant, in line with the literature on local debt (Bastida et al., 2009 & Benito et al., 2015b).

One of the main contributions of this study is the introduction of the *average payment period to suppliers (APP)* into the analysis. The results show that this variable is highly representative and significant, showing that compliance with the legal limit of APP to suppliers (payment within 30 days) reduces current debt, thus supporting H4, although it does not affect the debt of neighbouring municipalities. To date, given that the payment period for local government suppliers has been introduced very recently, the only other contribution we are aware of is the article by Pons (2017). This author studied APP as an indicator of commercial debt, and his findings point to significant variations of APP among the

⁴The results proved to be robust with the rest of the matrices.

⁵Calculated as the partial derivative of the dependent variable with respect to changes in the explanatory variables (Elhorst, 2014a).

⁶The limitations on municipal investments are regulated the Organic Law 2/2012, of April 27, on Budgetary Stability and Financial Sustainability (*Ley Orgánica 2/2012, de 27 de abril, de Estabilidad Presupuestaria y Sostenibilidad Financiera*) in the "expenditure rule".

³Kelejian and Prucha (1998, 1999) and Elhorst (2014a,b).

different local government groups analysed, highlighting the high levels of non-compliance with the payment limits established in current legislation, and municipalities' failure to report their information.

The variable *per capita income* (*INCOME*) is significant and has positive direct and indirect effects on accumulated debt, supporting H5. Municipalities with higher per capita income have higher levels of current debt, coinciding with studies by Guillamón et al. (2011), Kiewiet and Szakaty (1996) and Vallés et al. (2003). The results of the present study are in the same line and extend the findings of these authors. In addition, higher income levels in one municipality positively affect its neighbours' debt levels, as the variable with indirect effects is more significant ($p < 0.05$), although with little economic effect. This is due to the demand from citizens for more public services in relation to the higher taxes they pay.

Retired people (*RET*), comprising people over the age of 65, has negative effects on local and neighbouring debt due to the indirect and direct effects of spatial spillover. This variable has greater economic importance since it has the highest indirect effect, but with a low level of significance ($p < 0.1$). Our results are in line with Borck et al. (2015), who include older citizens as a measure of the labour force. This stakeholder group can be analysed from the perspective that they do not pressurise municipalities to provide a greater number of services.

The variable *gender of the mayor* (*GEN*) presents positive spatial autocorrelation and direct effects, confirming that gender (woman) has positive effects on debt level. Hypothesis 8 is therefore confirmed. However, its coefficient shows a lower positive effect on debt because it is not reflected in the total effect. These results could be related to spending policies. In the literature, authors such as Funk and Philips (2018) found that in municipalities where women are mayors the composition of local government expenditures is different. Consequently, we believe that this aspect could affect local debt.

Political strength (*HI*) shows negative spatial effects, both direct and indirect, on local debt. Our results coincide with those of Bastida et al. (2013a), Hagen and Vabo (2005) and Roubini and Sachs (1989). According to the literature, party political majorities enable local governments to resist pressure on debt from different stakeholder groups. This is because political decisions taken by majority governments on expenditure and investment budgets are not dependent on coalitions with other political parties.

Finally, the political ideology of the party, whether conservative or liberal, does not influence the evolution of local debt, since this variable (*SIGN*) has no significant effects at either local or neighbourhood level. Our results coincide with those of Bastida and Benito (2005), Benito and Bastida (2004) and Pérez-López et al. (2013) in that political ideology does not influence local debt level.

Conclusion and discussion

The aim of the present study was to analyse the spatial relationships in public debt among municipalities in the Valencian Community (Spain). Using spatial techniques, we observe the existence of spatial dependency of neighbouring councils for current debt. Thus, our findings indicate that debt should not be ignored when considering interactions between municipalities. The influence of the spatial effects observed in the debt could contribute to future decisions on inter-municipal cooperation between small authorities. Such cooperation reduces unnecessary costs in the provision of

public services as a result of economies of scale (Ferraresi, Migali, & Rizzo, 2018; Zafra-Gómez, Prior, Plata-Díaz & López-Hernandez, 2013) and consequently could help to reduce the debt.

When analysing the determinants of local debt, on the one hand there are variables that have direct and significant effects on the debt of your municipality, such as the volume of grants and transfers received, the average payment period and the gender of the mayor. The volume of *grants and transfers received* has direct negative effects at a local level; in other words, it contributes to reducing local debt. However, the *average payment period* has a direct positive effect on the municipality's debt. This variable may be analysed as a financial indicator of cash solvency, demonstrating that local governments which do not pay their suppliers within the stipulated period are also those with higher debt levels. In other words, if a local government fulfils its short-term payment obligations it avoids interest on default payments, which in turn would cause an increase in its debt levels. Likewise, we find a similar pattern for the *gender of the mayor*, which has a direct positive effect on the level of current debt; that is, women mayors call for greater recourse to debt, although this influence is not highly significant.

On the other hand, there are other variables that not only have direct effects on municipal debt, but also have indirect effects on the debt of neighbouring municipalities. This is the case of variables such as net saving and political strength, which have a negative direct and indirect effect on debt. A higher *net savings rate* has a negative influence on a municipality's accumulated debt and in turn, reduces the debt of its neighbours. Thus, if a local government has greater capacity to generate additional resources (savings) once it has fulfilled its obligations, its budgetary sustainability will be greater. Likewise, the analysis of *political strength*, reveals stronger governments can take decisions on public finances without having to depend on the support of minority parties, and therefore incur fewer costs and as a result, have lower debts. In the same line, in their study of Norwegian local municipalities Kalseth and Rattsø (1998) observed that the more concentrated the political leadership, the lower the administration costs. This pattern could have imitative effects among the citizens of neighbouring municipalities, as shown in the results of our study.

In turn, debt is affected by the socio-economic variables of neighbouring municipalities, such as number of pensioners and income level. The *number of pensioners* has negative effects on local and neighbouring debt. These results may suggest that spatial dependence of debt could be defined by the characteristics, needs and preferences of the municipality's inhabitants. Because the higher welfare benefits this population group receives are paid directly by the central government (pensions and health), they do not require some of the social benefits directly provided through local expenditure, therefore reducing the need to resort to borrowing. However, the *capita income* has a positive direct and indirect effect; that is, it affects current municipal debt and at the same time, affects debt levels in neighbouring municipalities due to higher demands for the provision of public services. From an economic perspective, our findings demonstrate that the economic level of a region influences the municipal debt of its neighbours. This result could be explained as imitative behaviour (López et al., 2017). That is, if the inhabitants of a locality have a higher economic level, they will demand better local services and benefits that, in turn, will be demanded by their municipal neighbours.

Finally, it is also important to note that *capital expenditure*

is not significant. This result may be because municipalities have not had to borrow to finance the low investment in infrastructure, due to the economic crisis and its consequent restrictions on debt. An interesting future line of research would be to analyse the spatial effects of this variable over a longer time horizon, and to break down the total investment to take into account the type of investment and its possible spatial effects on debt.

Another future research line could be to evaluate the long-term evolution of spatial relationships in local debt and extend the study to cover all Spanish municipalities. However, in our study we focus only on the Valencian municipalities due to the lack of some data for municipalities in the rest of Spain. It would also be interesting to break down current municipal debt into short-term and long-term payment obligations, which would allow us to analyse the spatial effects taking into account the term of the payment of the debt.

Conflict of interests

The authors declare no conflict of interests.

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