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Danger: local corruption is contagious!

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DANGER: LOCAL CORRUPTION IS CONTAGIOUS!

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Abstract

Corruption is a major problem, and not only in developing countries. It impedes economic growth, weakens the rule of law and undermines the legitimacy of institutions. Although it has been studied at national level from different perspectives, there is a recent growing body of research on local corruption. As far as we know, these latter studies focused on corruption and its effects on votes. However, a further question arises as to whether there is a mimetic effect on neighbouring municipalities? We employ data from Spain, and the boom in local corruption in the 2000s, to respond to this question. Specifically we have constructed a panel database (2001-2010) on local characteristics, economic factors and corruption at local level in order to achieve this. Our spatial econometrics methodology supports the hypothesis that corruption is not local-specific, and leads to two opposing outcomes: on the one hand, local corruption is contagious and the probability of being 'infected' increases by 3.1 per cent for each corrupt neighbouring municipality; on the other hand the likelihood of a municipality being taken to court increases by 6.7 per cent for each neighbouring municipality accused. Although the former is alarming, the latter provides hope in the fight against local corruption.

Keywords: Local corruption; spatial econometrics; contagion effects.
JEL Codes: D72, D73, K42.

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INTRODUCTION

Corruption is a major problem, and not only in developing countries. It impedes economic growth (Mauro, 1995), weakens the rule of law and undermines the legitimacy of institutions. Corrupt governments or officials can only be 'punished' periodically at the ballot box (or not).[4]

In Spain corruption is a growing problem as can be seen in CIS' surveys from the 1980's until the present day.[5] These surveys show that recently between 35% and 40% of those surveyed believe that corruption is one of the main problems of the nation, after unemployment. This opinion is not only unique to Spain. As can be seen in the recent report of the European Commission (2014), 76% of respondents believe that corruption is widespread in their country. This percentage is even higher in countries such as Greece (99%), Italy (97%), Lithuania and the Czech Republic (95%). Therefore, it is a problem that people view with great and growing concern.

The World Bank defines corruption as "*the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests*" (Kaufmann et al, 2010). It additionally emphasizes the "*capacity of the government to effectively formulate and implement sound policies"*. In developed countries, corruption is above all, political corruption (Jiménez, 2013), commited by government officials who use their powers and trade in influence for illegitimate private gain. This is the kind of corruption on which we focus in this investigation.

Although studies have analyzed the possible spread of corruption among countries (Becker et al, 2009), and the effect of local corruption on variables such as voting intentions (Jiménez and García, 2012; or Ferraz and Finan, 2008), we were unable to identify any paper in the literature that has analyzed the possible spatial spread of *local* corruption.[6]

This paper aims to fill this gap by providing empirical evidence on whether there is spatial contagion in cases of corruption (whether it is at the time it is commited or when the legal system detects it; this will be expanded upon and clarified below). First it seeks to identify if corruption has a knock-on effect in neighbouring municipalities. In this case, an act of corruption would not only generate welfare losses in the municipality that carries it out, but also in neighbouring municipalities, since it increases the likelihood that these municipalities commit corrupt acts in the future. Second, if the imputation of a municipality for the realization of a corrupt act increased the likelihood of nearby municipalities being charged, this would mean that there is some positive externality in the

[4] See detailed references in section two.

[5] CIS is the Spanish acronym for the Sociological Research Centre, a public organization that is part of the Ministry of the Presidency and undertakes statistical public opinion surveys.

[6] As we will explain at next section, there are some papers that analyze this topic but not at local level.

legal investigation. Once the law identifies a case of corruption, there is an increased likelihood of nearby municipalities being charged in the future.

Providing empirical evidence of the existence of this spatial pattern is the main contribution of this paper. To perform the empirical analysis we have constructed a single database that includes all cases of imputed municipal corruption in Spain from 2000 to 2011.[7]

The empirical results show the existence of a clear pattern of spatial clustering in the corruption cases that have been identified by the legal system. These results allow us to draw conclusions for public policy, such as the need for greater control of municipal actions to avoid negative spillover to other municipalities. These controls can be greater for a public body, and may necessitate greater transparency in municipal activities, so that citizens of a particular town have greater control over their leader.

After this brief introduction, section two outlines the scarce academic literature on this topic. Section three describes how the database was constructed. Section four details the empirical strategy that drew on a geographical information system (GIS) data and a spatial data estimations model. Finally section five is devoted to results and policy implications.

LITERATURE REVIEW

Corruption is a complex phenomenon that can be approached from multiple perspectives, from the decision of an individual to engage in a corrupt act (Dong et al, 2012) to complex information asymmetry models that seek to reduce corruption levels (Ryvkin and Serra, 2012). Within this vast literature we distinguish three elements that we shall analyze in depth.

First is the analysis of factors that can influence the level of corruption in a country. One element in this analysis is the level of political decentralization. Economic theory predicts a contradictory relationship between the level of economic and political decentralization, and the level of corruption. Some of the reasons that lead us to relate political decentralization with a higher level of corruption include the idea that good bureaucrats (Brueckner, 1999), or the best professionals in central government (Persson and Tabellini, 2000), are less likely to be attracted to local municipalities, and there is a possible double marginalization, which would generate an excess of corruption (Shleifer and Vishny, 1993).

However, it is also argued that competition between local governments to engage citizens (Brennan and Buchanan, 1980) in part due to their proximity and capacity to provide better information (Persson and Tabellini, 2000), or the ease of supervision and control of local bureaucrats, should lead to a reduction in the level of corruption. Empirically various scholars have attempted to address this question. For example, Fisman and Gatti (2002)

[7] Using a US legal system approach, this term is similar to 'indicted' or 'implicated'.

have used empirical evidence to argue that greater decentralization leads to a lower level of corruption in the country. This effect is maintained, they contend, even when the level of decentralization is considered endogenous in the models. More recently, Fan et al (2009) found a positive relationship between the number of bureaucratic levels (as a proxy of the level of decentralization) and the level of corruption, but only for less developed countries.

A second element that can affect the level of corruption in a country is the level of economic freedom. Countries with more economic freedom, supported by private initiative, tolerate corruption much less, which lead them to have a lower level. Pieroni and D'Agostini (2013) show econometrically that countries with greater economic freedom (as measured by policy competition, employment regulation or protection of property rights) have lower levels of perceived corruption.

A third element analyzed in the economic literature is the level of international integration. As countries integrate economically it is possible that increased trade flows, foreign direct investment or the number of transnational companies mean that good business practices and anti-corruption practices are transmitted to the country, thereby reducing the level of corruption. Sandholtz and Gray (2003) proved the existence of this relationship empirically, and concluded that economic integration would help significantly reduce the level of corruption. This same study showed a positive relationship between the level of corruption in a country and the level of its neighbours. As in Sandholtz and Gray (2003), Goel and Nelson (2007) found a positive relationship between the level of corruption in neighbouring states and the level of corruption in the state analyzed. The authors use U.S. state level data over the period 1995-2004 to identify the factors that affect the average conviction rate for corruption in the states under study. Finally, Dong and Torgler (2012), found evidence on the spread of local corruption in China.

A second topic analyzed in depth in the literature is the relationship between the level of corruption and the political cost, in terms of votes, for the political parties involved. Focusing on the case of Spain, that has been widely used following the local corruption boom in the noughties, Fernández-Vázquez and Rivero (2010) evaluated the effect of corruption cases on local election results in Andalucía (the most populous Autonomous Community in Spain) in the period 2003-2007 using the ordinary least squares method. However they did not find any electoral effect resulting from these cases. Costas-Pérez et al (2012) also analyze this topic using data from Spain (period 1999-2007) by employing a difference-in-difference estimator. They conclude that the average vote loss after a corruption scandal was approximately 4%, although the punishment is greater in cases that receive widespread media attention (up to 9%).

Finally, Jiménez and García (2012) expand the analysis of local corruption incidents to the period 2000-2011, including not only local cases but also regional ones. Their research leads to two main conclusions: that following imputation in a local corruption case, voting abstention increases by an average of 1.8 percentage points; and that there are partisan effects by voters regarding local corruption.

This article focuses on the third widely analyzed topic in the literature such as the spatial spread of corruption among the different agents under study[8]. Like in health or in crime rate analyses (see for example, Messner and Anselin, 2004), the study of corruption needs an econometric model that allows for countries interdependence. Becker et al (2009) undertook this approach[9] and employed their results to argue that corruption spreads across national borders because of business activity (economic integration) or by demonstration effects, among others. Using a cross-section of 123 countries the authors employed a spatial lag estimation of perceived corruption. They found that the endogenous variable in a country *i* is an adjacency or inverse-distance related function of perceived corruption in other countries. The authors conclude that, although own country characteristics are more important than those of a country's neighbours, there is evidence of contiguous effects of corruption. They argue therefore that it is a regional phenomenon.[10] Similarly Seldadyo et al (2010) using spatial econometric models found a significant positive relationship between the level of governance of a country and the level of governance in neighbouring countries. The authors show how the level of governance of the 10 closest neighbouring countries significantly influences the level of governance in a particular country.

Although corruption is a heavily analyzed topic and that spatial dependence in agents' decision-making has been tested empirically, there are not in the literature, at least to our knowledge, any empirical articles that analyze if there is contagion in corruption at local level. This fact is surprising considering that spatial dependence in the level of corruption at the macroeconomic level (when the level of perceived corruption in the country in general is analyzed) has been tested econometrically. This is the reason that we decided to look for 'spillovers' at local level, ie local corruption contagion. If this effect is proven, then it provides new arguments to justify public spending increases for judges, police and supervising agencies in order to prevent it. These arguments are based on the positive externality of preventing new cases of corruption. To our knowledge, this is the first empirical analysis of cross-border spillover of corruption at local level using longitudinal data and a spatial dynamic panel model.

THE DATABASE AND THE CLUSTERIZING OF LOCAL CORRUPTION

The database consists of annual data on all Spanish municipalities with a population greater than 1,000, in the period 2000 to 2011 (n=3,413). It includes three main types of variables:

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[8] Spatial dependence on public decisions (taxes, public expenditure, etc.) has been analyzed in papers such as Brueckner (2003).

[9] Seldadyo et al (10) make a similar analysis but they focused on governance.

[10] Márquez et al (2011) replicate the analysis but using more observations and different explanatory variables. They found a weak spatial correlation, and therefore concluded that corruption is not contagious. See also Attila (2008) for a similar example.

local corruption cases (the year in which they occurred and the year of legal imputation), municipalities' characteristics and geographical data. The former relates to the number of corruption cases under judicial investigation by municipality in Spain, in the period 2000-2011. These cases include not only those in which the mayor is involved, but also cases involving any other person(s) under investigation who are directly related to the party considered. We define an alleged offence as *a case of corruption* only when the accused has been imputed or impeached by the legal system. For all cases, we take into account not only the imputation date but also the date when the offence was committed.[11]

Regarding the municipalities' characteristics, we have included data provided by the Spain Economic Yearbook 2013 by La Caixa.[12] Data on population and economic activity have also been taken into account. With regard to geographical data, we have created two squared matrixes for the 3,413 municipalities: an adjacency matrix and a distance matrix. The adjacency matrix is a 0/1 matrix containing a 1 if the row municipality i is adjacent to the column municipality j. The distance matrix contains distances between each pair of municipalities, calculated from the respective coordinates (longitude and latitude). We used a spatial tool developed with the ArcGIS Model Builder in order to automatically detect adjacencies.[13]

The variables included in the analysis are the following:

(i) *Corrupted$_i$*: binary variable that takes the value 1 if there has been a case of corruption in the municipality i at any moment in the period 1999-2011. In some estimations, we use the dynamic version of the variable, which takes the value 1 if the municipality has had a legal case of corruption before that year or starting that year. Source: Own elaboration (see previous paragraphs).

(ii) *Imputated*: binary variable equal to 1 if a new case of corruption started in the municipality i at year t. We also consider the date when the offence was committed (see the estimations included in Table 3.)

(iii) *Bi-annual rate of population$_{it}$*: this variable is the average of two different growth rates, i) the annual variation of population from year $t-1$ to year t, and ii) the annual variation of population from year $t-2$ to $t-1$, for every municipality i. Costas-Pérez et al (2012) also employed this method, but they used four-year lagged growth rates.

(iv) *Local property gross tax base (IBI)$_{it}$*: this variable refers to the gross tax rate of the local property tax in every municipality for each year of the database. We include it to capture the degree of urban development and its value, as recommended by

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11 We use the same database that was constructed by Jiménez and García (2012). The database has been self-elaborated.

12 http://www.anuarieco.lacaixa.comunicacions.com/

13 We acknowledge the assistance of Rafael Suárez with this question.

Fernández-Vázquez and Rivero (2010). Source: *Ministerio de Hacienda y Administraciones Públicas*.

(v) *Density of population*$_{it}$: this is the density of population of the municipality *i* at year *t*. Source: *La Caixa* municipal database.

(vi) *Index on Economic activity*$_{it}$: this is an index that summarizes buying power by local consumers. It is a relative index on economic activity formed by all trade tax revenues (*Impuesto de actividades económicas*, IAE) paid by firms on each city. It measures the municipality's percentage contribution of the national trade tax revenues for the year 2011. Source: *La Caixa* municipal database.

(vii) *Island*$_i$: binary variable that takes value 1 if the municipality *i* is located on an island.

(viii) *Area*$_i$: municipality area in km^2. Source: *La Caixa* municipal database.

Table 1 shows the descriptive statistics by municipality. We consider two types of municipality: corrupt (C) - those in which there has been at least one allegation of local corruption in the period 1999-2010 and non-corrupt (NC).

Data show that corrupted municipalities have higher rates of population turnover, and are richer in properties, with greater density and size, than non-corrupted municipalities. The data also show that the municipalities free from cases of corruption form a heterogeneous group. This is partly due to the fact that there are more than 3,000 uncorrupted municipalities (against close to 200 corrupted).

Table 1. Descriptive statistics by municipality (2004, 2008, 2010)

Variable	Mean		Standard Deviation		Minimum		Maximum	
	C	NC	C	NC	C	NC	C	NC
Demographical change	0.026	0.017	0.037	0.04	-0.10	-1	0.29	0,94
Properties local gross tax rate (IBI)	2011364	283023	1e7	1532308	0	0	1.6e8	7.5e7
Density of population	765.13	348.4	1712.4	1254.7	5.73	0	17151.4	22401
Index on economic activity	131.5	22.4	521.5	91.2	2	0	7387	3935
Island	0.12	0.04	-	-	0	0	1	1
Area (km^2)	143.2	92.3	201.5	124.1	1	0	1675	1750

Source: Own elaboration.
Note: C: Corrupted municipality; NC: Non-corrupted municipality.

As we shall see, in Spain indictments of corruption have a clear geographical pattern, with clusters of contigous municipalities showing a history of indictments. That pattern could be the effect of various causes, each with different consequences for anti-corruption policy. We will distinguish three types of causes:

1) *Justice organization*: in some judicial districts prosecutors are more active. Spatial patterns would not therefore be the consequence of more corruption, but the result of more criminal investigation and judicial control in the area. Nevertheless, in Spain there is a special Anti-Corruption Prosecutor located in Madrid that "investigates and examines the processes of particular importance, relating to economic and other offences committed by public officials in the exercise of their rights related to the phenomenon of corruption charges" (see Ministry of Justice webpage).

2) *Common context and common shocks*: neighbouring municipalities share cultural, historic and institutional settings and perhaps some specific market characteristics (such as high demand for land because, for instance, of the potential for tourism). Neighbouring municipalities could, for example, share a touristic expansion area, or beaches. They could also share local firms (such as building companies, banks, etc.) that might gradually develop management styles based on corruption. They might also share political organizations and political party colours. As the press reports, generally the geographic domain of political influence of a *Godfather* in Spain covers the province. For that reason we controlled provinces in our models. In the past, shared social capital served to spread 'evil', such as the case of Nazism in Germany (Satyanath et al, 2013). In some other cases, crimes spread over several contigous municipalities; for instance the Mafia has been known to offer money for municipal licenses to build and to urbanize land that extends over several coastal municipalities.

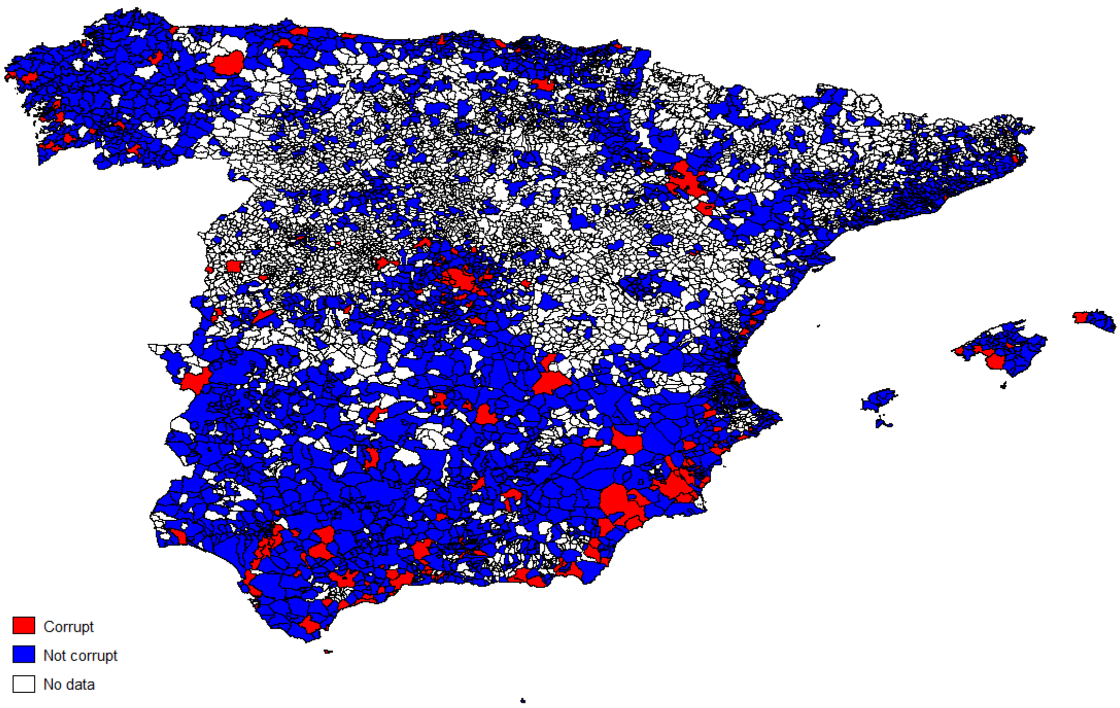
3) *True interaction*: that is diffusion of corruption through direct interaction or contagion (emulation effects, envy of neighbours' unpunished enrichment, yardstick competition etc.; see Becker et al, 2009, for information about the state at national level).

The following figure 1a shows all the municipalities included in the database. Red municipalities are corrupt, while blue ones are not. These graphs illustrate several interesting points. Firstly, the geographical distribution of small municipalities across Spain in non-coastal regions (remember that those cities with less than 1,000 inhabitants are not included. While they represent more than 60 per cent of total municipalities in Spain, they include less than 5 per cent of the total population).[14]

Secondly, that local corruption has occurred across almost all regions in Spain, (which is why no regional pattern appears). And finally, and most importantly, that some of the red areas are clustered (i.e., there is a local geographical pattern among the municipalities accused.

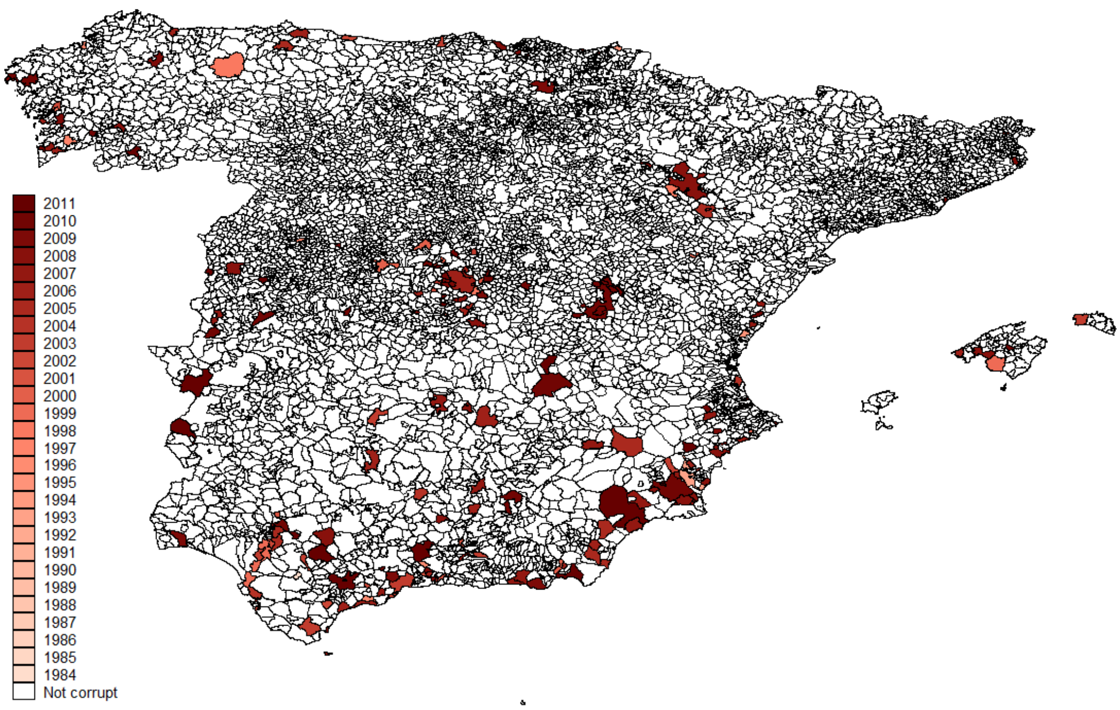
[14] Those regions are mainly Castilla-León, Castilla La Mancha, Madrid and Aragón.

Figure 1a. Local corruption. Mainland Spain and the Balearic Islands, 2000-2011.



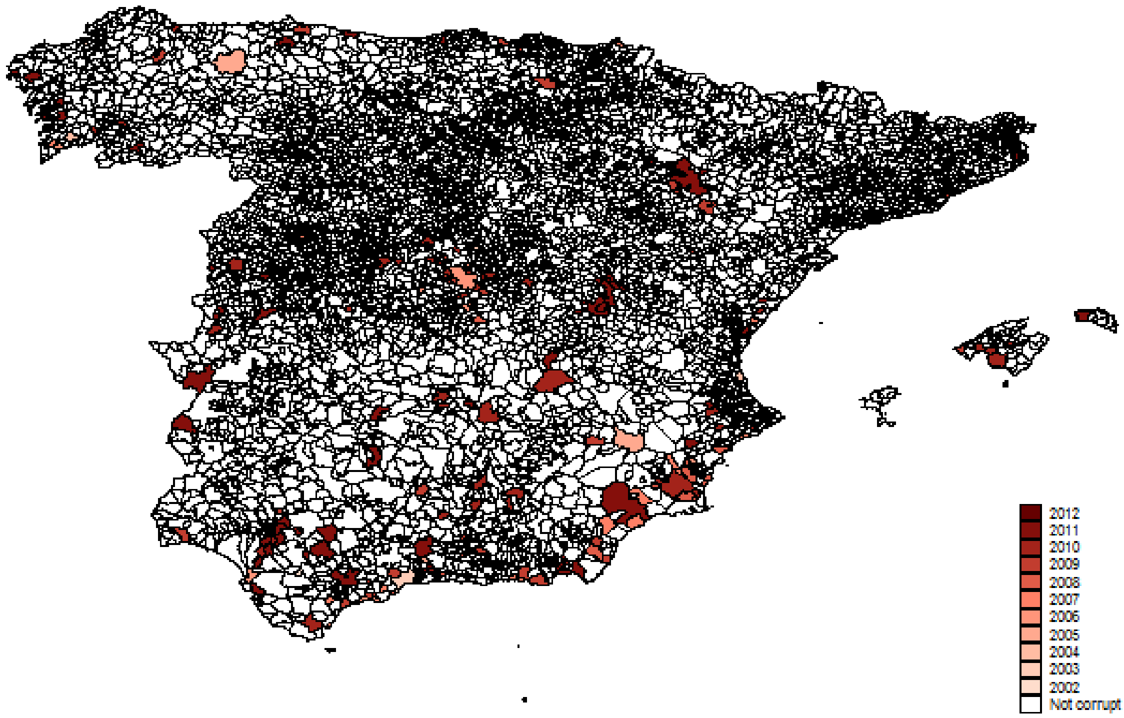
Source: Own elaboration. We include only municipalities with more than 1,000 inhabitants.

Figure 1b. Accused municipalities analyzed by the year the corrupt act was committed. Mainland Spain and Balearic Islands, 1984-2011



Source: Own elaboration.

Figure 1c. Accused municipalities by year of imputation. Mainland Spain and Balearic Islands, 2002-2012

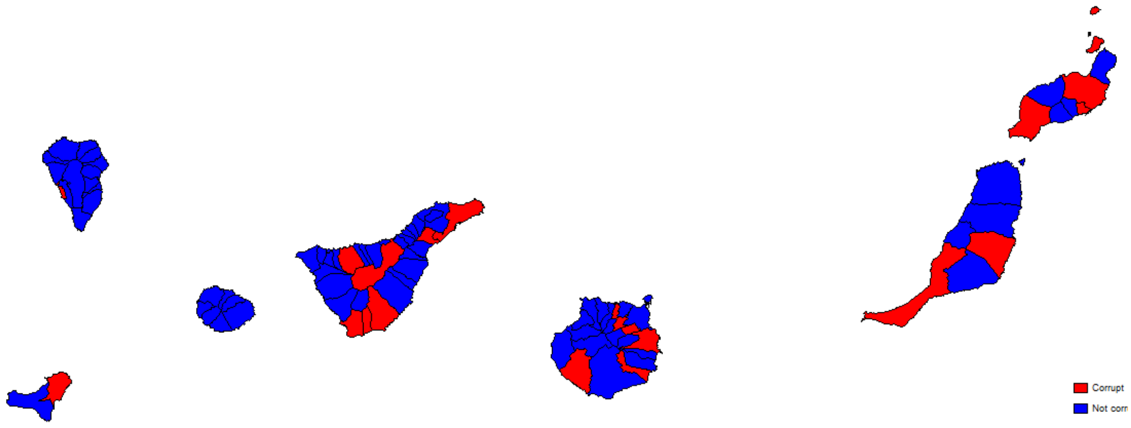


Source: Own elaboration.

Figures 1b and 1c seem to illustrate patterns of spatial spreading. It seems that if a municipality's politicians are accused of corruption, this is often followed, after one or more years, by contiguous municipalities.

For the Canary Islands, the local pattern is even more evident as can be seen in the following figures.

Figure 2a. Local corruption. Canary Islands, 2000-2011.

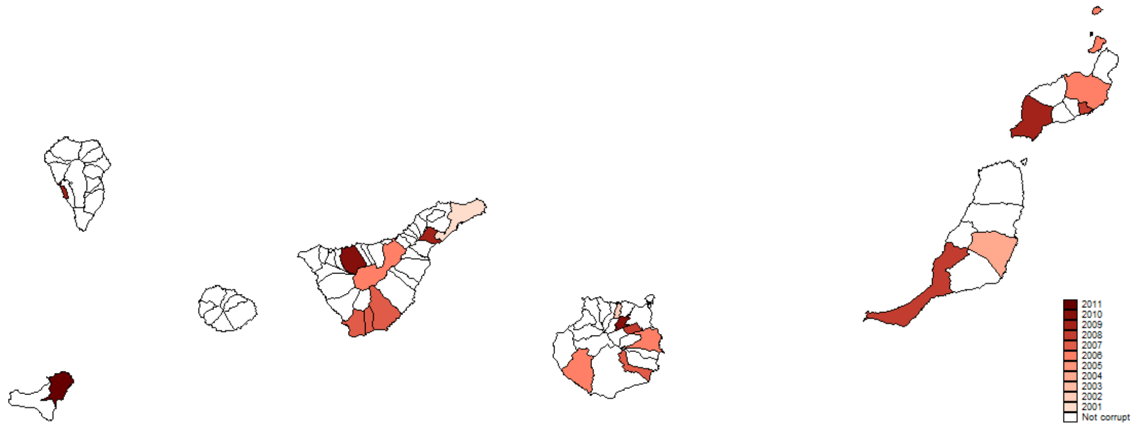


Source: Own elaboration.

Figure 2b. Accused municipalities by year that the corrupt act was committed. Canary Islands, 1994-2011.

Source: Own elaboration.

Figure 2c. Accused municipalities by year of imputation. Canary Islands, 2001-2011.



Source: Own elaboration.

Before modeling econometrically, it would be useful to test for the presence of spatial patterns in the distribution of corruption. A classical test used frequently is the Moran test, but this is designed for quantitative variables and should not be applied to binary data. A *t-test* comparing the percentage of corrupted municipalities out of all the adjacent municipalities shows significant results (F=93.94, p= 0.0000). On average, non imputated municipalities have 6.6% of their neighbours imputated, while 17.7% of the municipalities adjacent to the imputed ones have also been imputed. Therefore, statistical association is clearly showing a pattern of spatial correlation in the local corruption phenomenon in Spain. However, in order to analyze this further a more detailed econometric analysis needs to be implemented.

EMPIRICAL STRATEGY

As noted above, our main goal is to test whether local corruption in Spain is contagious (i.e. whether it shows a spatial pattern, so that if a municipality suffers a corruption case today, then the probability of having a new case of corruption in adjacent municipalities in that year or afterwards significantly increases). For analytical reasons we separately identify: 'corruption contagious' and 'imputation contagious'. Corruption contagious refers to the fact that the act of corruption itself may be contagious. By imputation contagious, on the other hand, we mean that it is possibly more probable for the law to detect cases of corruption in a municipality after detection or imputation in some adjacent municipality or municipalities.

To achieve this goal, we shall apply an econometric model that allows for cross-sectional interdependence. However, we not only performed a cross-sectional analysis, but also implemented a dynamic approach, which greatly increases the number of observations and allows us to model the starting of a corruption case as a function of the neighbours contemporary or past cases of corruption. This issue, to our knowledge, has not been applied in any of the previous references we have detailed in section 2.

Manski (1993) described the reflection problem when estimating social interactions as "*similar to that of interpreting the almost simultaneous movements of a person and his reflection in a mirror. Does the mirror image cause the person's movements or reflect them?*". The longitudinal nature of our data allows us to estimate the effect of social interactions (contagion), thereby avoiding the problem of reflection (Manski, 1993). Politicians of a municipality who commit an act of corruption in a given year can infect politicians neighbouring municipalities that year and in subsequent years. Corruption clusters of municipalities could arise because the municipalities in the area share common contextual conditions that favor or disfavour corruption: history, culture, institutions or economic conditions (such as tourist affluence).

Our spatial econometric approach assumes that the channel of interdependence is positively related to adjacency or inversely with distance. So, the formal expression of our model is the following (as for example detailed in Becker et al, 2009):

$$\begin{aligned}&\text{Prob}(p_i = 1 \mid X_i, W_i, C_i) = \Phi\left(\beta_0 + \lambda \sum_{j=1}^{N-1} w_{ij} p_j + \sum_{i=1}^{K} \beta_i X_i + \varepsilon_i\right) \\ &\textit{where} \\ &\varepsilon_i = \rho \sum_{j=1}^{N-1} w_{ij} \varepsilon_j + \nu_i\end{aligned} \qquad [1]$$

where p_i is a binary variable that takes value 1 if the municipality i has suffered a local corruption case. W_i is the matrix of geographical weights for municipality i and C_i is the Nx1 vector of binary data on corruption. Due to the binary structure of the endogenous variable, we implement *binomial probit* estimation models. **Φ** stands for the cumulative standard normal probability. Exogeneous covariates that contribute to explaining the likelihood of being accused are denoted by X_i; and the most important variables are w_{ij} and the structure of error term. The former is an adjacency-related weight that takes value 1 if the municipality *i* is a neighbour of *j*. The latter is split into two terms: a spatial correlation in the residuals (measure by ρ) and an *iid* error term.

Regarding the former, w_{ij} is an adjacency-related weight with the following two properties: $\sum_{j=1}^{N} w_{ij} = 1$ and w_{ii}=0. However, we use three different approaches to this matrix: firstly, we consider a municipality-by-municipality matrix, which takes value 1 if two municipalities are neighbours; secondly we use a normalization approach that divides all unitary entries by the sum of all neighbours for each municipality; finally we apply an inverse euclidean distance matrix, calculated from the coordinates (longitude and latitude) of the centre of the municipalities.

The contagion term in equation [1], $\lambda \sum_{j=1}^{N-1} w_{ij} p_j$, can be written using matrix notation $W_i C_i$, where W_i contains the weights, based in distance or adjacency, for municipality *i* and C_i is the column 0/1 vector with $\{c_{ij}\} = 1$ if municipality *j* has been imputed. Therefore, we can write eq[1] using the matrix notation:

$$\text{Prob}(p_i = 1 \mid X_i, W_i, C_i) = F(l\, W_i C_i + X'_i\, b + e_i) \quad [2]$$

In all cases, the general equation [2] includes as explanatory variables (X) demographical variables, property taxes, density of population, area, economic activity and the dummy for island, as defined in section 3. As neighbour's corruption (vector C_i) may be endogenous, and contagion is mutual, we used instrumental variables. The instruments, as in Becker et al (2009), are WX, W^2X, W^3X. In a dynamic context (panel models) our instruments may satisfy the exclusion restriction for identification. However it is recognized that the cross-section version of the model could suffer from the reflection problem.

RESULTS

First, we estimate the binomial probit using cross section data for the last year considered (2010). The endogenous variable in this case takes value 1 if the municipality considered has ever been accused across the full period (and 0 in other case). Covariates considered are for the year 2010.

Three Instrumental Variable estimations have been undertaken over 3,047 municipalities (we exclude those that present some missing values). The standard errors have been adjusted for error correlations among municipalities in the same province. The main explanatory variable is the neighbour's corruption.

Table 2 shows results for the three matrixes considered: adjacency -i.e., the number of neighbours that have been accused at any time in the period 2001-2010-; adjacency normalized and inverse distance matrix.

Table 2. Static Probit estimation. Instrumental variables.

Explanatory variables	**Adjacency**	**Normalized adjacency**	**Distance weights**
Neighbour corruption	0.439 (0.10)***	2.165 (0.57)**	2.089 (0.87)**
Demographical change	1.063 (2.04)	1.183 (1.94)	1.373 (1.97)
Property gross tax base	3e-8 (4e-8)	3e-8 (4e-8)	3e-8 (4e-8)
Population density	2e-5 (4e-5)	1e-7 (4e-5)	2e-6 (4e-6)
Index on economic activity	-1e-4 (7e-4)	2e-4 (8e-4)	1.9e-4 (8e-4)
Island	0.258 (0.115)**	0.237 (0.11)**	0.245 (0.12)**
Area	6e-4 (2e-4)***	9e-4 (2e-4)***	9e-4 (2e-4)***
Constant	-2.111 (0.06)***	-2.142 (0.06)***	-2.142 (0.07)***
Observations	3,047	3,047	3,047
Wald chi2(7)	198.76***	136.75***	126.67***
Wald test of exogeneity (Prob>chi2)	0.04	0.16	0.24

Note: *** 1%, ** 5%, *10% significance test. Standard errors are shown in brackets.

Wald test of exogeneity (last row of Table 2) shows that instruments are valid. The most important general conclusion of the models is that corrupted neighbours increase the likelihood of a corrupted municipality. In fact, the adjacency model shows that for each corrupted neighbour a municipality has its score (in the standard Normal distribution scale) increase by 0.44 units. That is a large effect and it is invariant for both the imputation date and for the date when the offence was committed.

The only significant covariates are the dummy for municipalities located on islands, which are more likely to be corrupted; also size is a significant variable as larger municipalities are more likely to be imputed.

However, estimations in Table 2 do not consider the potential time effect, i.e. the dynamic behaviour of local corruption in Spain. To solve this problem we consider the panel structure of data. In this case, the endogenous variable p_{it} takes value 1 if the municipality i has a local corruption case starting in year t. As once a municipality has been imputated there is 'no way back' (that is, p_{it}=1 after the imputation year), and as those observations do not add any information to the sample likelihood, we skip them from the panel estimation sample.

Consequently, Table 3, reporting the panel data estimation, outperfoms cross-section analysis due to the likelihood of a municipality being accused if a neighbouring municipality has been previously accused. We used Arellano´s first differences Instrumental Variables estimation method. The model is linear, its dependent variable is the binary p_{it}. and the instruments are defined as above.

Moreover we separate estimations firstly for different matrix structures (as in Table 2), and secondly for the date of imputation (see the imputation column in Table 3) and when the offence was committed (see the corruption column in Table 3). The latter data helps us identify not only whether a contagious effect exists but also whether *crime* or *punishment* is more important.

Table 3. Panel data. First differenced Instrumental Variables (Arellano)

	Adjacency		Normalized adjacency		Distance weight	
Explanatory variables	**Imputation**	**Corruption**	**Imputation**	**Corruption**	**Imputation**	**Corruption**
Neighbour accused (or imputation)	0.067 (0.009)***	0.031 (0.058)***	0.383 (0.049)***	0.166 (0.05)***	0.365 (0.051)***	0.148 (0.05)***
Demographical change	-0.032 (0.015)**	-0.006 (0.017)	-0.028 (0.015)*	-0.012 (0.017)	-0.031 (0.015)**	-0.011 (0.017)
Property gross tax base	2e-9 (8e-10)***	-2e-10 (9e-10)	3e-9 (8e-10)***	-3e-11 (9e-10)	3e-9 (8e-10)***	-1e-11 (9e-10)
Population density	1e-4 (2e-5)***	1e-4 (2e-5)***	1e-4 (2e-5)***	1e-4 (2e-5)***	1e-4 (2e.5)***	1e-4 (2e-5)***
Index of economic activity	-5e-6 (2e-5)	-8e-5 (3e-4)**	-5e-6 (2e-5)	-8e-5 (3e-4)**	-4e-6 (2e-5)	-8e-5 (3e-5)**
Constant	0.004 (6e-4)***	0.002 (6e-4)***	0.004 (6e-4)***	0.002 (6e-4)***	0.004 (6e-4)***	0.002 (6e-4)***
Observations	27,417	27,417	27,417	27,417	27,417	27,417
Wald chi2(5)	109.69***	58.77***	115.48***	40.95***	105.56***	38.65***
R^2 (within/between/overall)	0.03/ 0.003/ 0.003	0.008 / 0.0008 / 0.0001	0.03 / 0.003/ 0.003	0.005 / 0.0005 / 0.0001	0.03 / 0.003 / 0.003	0.005 / 0.0006 / 0.0001

Note 1: *** 1%, ** 5%, *10% significance test. Standard errors are shown in brackets.

Panel data estimation yields several interesting outcomes. Firstly, that corruption appears more frequently in municipalities with: a higher property gross tax rate (ie among wealthier populations), but with a lower index of economic activity; a greater density of population; and, a population that is falling. It seems that businessmen decide to tempt local politicians (and they in turn decide to accept) in rich towns or cities that are in decline demographically. Due to the high collinearity of the economic variables used as controls, and the small variation through time in each municipality, these estimates lack reliability.

The most important result is the significance and coefficient of corruption/imputation in the neighbourhood: *ceteris paribus*, the contagious effect exists both for corruption and for imputation (from the perspective of both corruption and the law). Regarding the former, each corrupted municipality you have as a neighbour increases the likelihood of a crime of corruption being commited by 3.1 per cent.

However, the good news is that, by using the imputation date, each imputed municipality you have as a neighbour increases the likelihood of exposing a case with legal action by 6.7 per cent. This positive derivative offsets the contagion problem and makes it much easier for authorities to locate cases of local corruption and to allocate law enforcement resources in certain areas. This is not the first time that this contagious effect has been identified. Becker et al (2009) concluded that "a change in a country's institutions to reduce corruption will also reduce corruption in neighbouring countries". From another perspective, Carrell et al (2008), found that one additional college cheater creates 0.55 to 0.80 new college cheaters (they studied self-reported academic honour violations from the classes of 1959 through 2002 at three major U.S. military service academies).

In our case, as in Carrell et al (2008) the contaigous effect could be an effect of the evolving social norm of tolerance for corruption, and/or an effect of congestion in enforcement of local governments.

CONCLUSIONS

Although corruption is a major problem in developing countries, a new version of this social problem has arisen in recent years in developed ones: political corruption. And this problem not only affects central and/or regional governments, but also local ones.

Academic literature has analyzed the effects of corruption on key topics such as economic growth, liability, voting behaviour, etc. But, as far as we know, a geographical analysis at local level had not been undertaken prior to this study. In this regard, our main aim has been to test whether spatial interdependence exists in local corruption cases. Confirmation of this fact will be important to help authorities identify new corruption cases and to to allocate resources among judges, anticorruption agencies, etc.

A report by the EU (European Commission, 2014) observes that there is great variation between good and bad governance across Spain. The geographic variation of cases of political corruption might be a consequence of the contagious phenomenon we measure in this article. Using data from Spain, and based on the local corruption boom in the 2000s, a panel database (2001-2010) on local characteristics, economy and cases of imputation for corruption at local level has been constructed. Our empirical strategy has been to undertake a spatial econometric model that allows for cross-sectional interdependence. However, we not only performed a cross-sectional analysis, but also implemented a dynamic approach that greatly increases the number of observations and allows us to model the start of a corruption case as a function of the neighbours past or contemporary cases of corruption.

Our spatial econometrics methodology supports the hypothesis that corruption is not local-specific and two opposite outcomes arise: on the one hand, local corruption is contagious and the probability of being infected increases by 3.1 per cent for each neighbouring municipality corrupted; on the other hand the likelihood of being taken to court increases by 6.7 per cent for each neighbouring municipality accused. Although the former is alarming, the latter provides hope in the fight against local corruption.

A limitation of the study is that we analyse accusations; not only those cases resulting in a guilty verdict (data not available). Nevertheless, they represent the large majority of the corruption cases in Spain.

These results allow us to make some policy recommendations. Spatial contagion in corrupt behaviour indicates the importance of combating local corruption, which not only generates welfare losses to the municipality, but also results in negative spillovers for nearby municipalities. Broader territorial agencies responsible for combating local corruption could contribute to reduce the problem. This help could be in the form of bureaucratic supervision from a higher organism, such as establishing transparency standards so that, for example, citizens of a particular municipality are more able to control their leaders. Regarding the spatial contagion of corruption, it should be recommended to the courts that once a case of municipal corruption is detected, it is worth investigating nearby municipalities, as the probability of them also having acted corruptly is greater. In any case, as our results reflect not only spillover effects (contagion), but also the effect of contextual conditions, combating local corruption also requires individual actions that could be specific to each municipality. However, on the other hand, this study has only measured contagion between municipalities; it has not taken into consideration contagion within a municipality.

This research could be complemented by other studies and extended in some ways, for example by gathering additional information. We plan to check for determinants of indictments, such as pressure from the local press (investigative journalism), and seek to differentiate by the intensity of corruption (in terms of euros). We also plan to test if contagion of corruption is more probable between politicians from the same political party.

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