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Spatial Interdependence of Local Public Expenditures: Selected Evidence from the Czech Republic

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Abstract Local expenditures in neighbouring municipalities can be spatially interdependent due to spillovers, cooperation effects, competition effects or mimicking. In this paper, we aim to test the spatial interdependence of local public expenditures using data on 205 Czech municipalities. We found positive spatial interdependence in expenditures on housing and culture and negative spatial interdependence for expenditures on industry and infrastructure and environmental protection. Additionally, we observed that political characteristics affect the size of spending; left-wing parties tend to increase expenditures on culture and decrease expenditures on industry and infrastructure; and higher party fragmentation decreases overall capital expenditures and expenditures on housing.

Keywords Spillovers, fiscal competition, local public finance
JEL classification C72, H77, R12

1. Introduction

Recently, a great deal of attention has been devoted to studying the spatial interdependence of local public policies. This aspect of the literature has developed within the scope of fiscal federalism, in particular, within the discussion on the decentralization of fiscal policies as a potential source of competition among local governments.

Local policies are interdependent if fiscal decisions in neighboring jurisdictions play an important role in the decision of domestic jurisdiction. Until recently, these aspects were analyzed only for tax policy and the literature on spatial tax competition developed (see Hayashi and Boadway 2001; Revelli 2002; Bordignon et al. 2003; Allers and Elhorst 2005; Bosch and Solé-Ollé 2007). Recently, the analysis has been extended to public expenditures and one of the reasons behind this was the fact that many local governments do not have large tax competencies.

Fiscal interactions among local governments can be driven by various effects: (i) positive or negative spillovers affecting residents of other districts; (ii) competition between regions to attract residents and businesses; (iii) mimicking driven by yardstick competition and imperfectly informed authorities; and finally, (iv) cooperation and coordination between local governments. These effects are discussed in a greater extent in next section.

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If we empirically test the theoretical hypotheses of the potential drivers of fiscal interactions, the common way to proceed is to estimate the fiscal reaction function, i.e. the parameters that indicate whether any particular local government will change an expenditure level in response to changes in other local governments.

Empirical literature on the spatial interdependence of public expenditures was initiated by a pioneering study by Case, Rosen and Hines (1993), who estimate an empirical model of strategic interaction in expenditures among state governments in the United States. Brueckner (2003) provides the overview of empirical studies dealing with spatial interdependence.

Strategic interaction among local governments is empirically explored in Brueckner (1998). He focuses on the adoption of growth-control measures by municipalities in California and seeks evidence of policy interdependence. Lundberg (2001) tests for the effects of recreational and cultural expenditures in Swedish municipalities and he shows that municipalities with similar expenditure levels are clustered to a greater extent. Revelli (2006a) explores neighborhood effects in social service provisions and proves that the source of spatial autocorrelation in social spending is endogenous mimicking among neighboring localities.

Solé-Ollé (2006) presents a framework for measuring spillovers resulting from local expenditure policies and estimates a reaction function with interactions between local governments using data on Spanish local governments. Borck, Caliendo and Steiner (2007) study fiscal competition between jurisdictions via the size and structure of public spending. They model the reaction functions of jurisdictions on public spending in neighboring regions and estimate these functions for German communities. They found significant positive reactions for facilities encouraging business development, for general administration and for supporting business enterprises.

Foucalt, Madiès and Paty (2008) analyze interactions concerning different categories of local public spending among French municipalities. They found significant interdependence only for cities whose mayors share the same partisan affiliation. Ermini and Santolini (2007) test public spending interdependence among Italian jurisdictions and found significant interaction between their spending both at the level of total expenditure and also for different sub-categories. Werck, Heyndels and Geys (2008) found evidence that cultural expenditures in Flemish municipalities are positively affected by the level of cultural spending of their neighbors. Redoano (2007) contributes with an estimation of the spatial interdependence of fiscal policies, including both taxes and expenditures, in European countries.

In this paper, we contribute to the empirical aspect of this literature. We aim to test the existence of the spatial interdependence of local public expenditures using data on 205 Czech municipalities. We test the hypothesis that municipality councils in their decisions on public expenditures take into account decisions of neighboring municipalities. We focus mainly on expenditures on industry and infrastructure, culture, sports and recreation, housing, utilities and regional development and expenditures on environmental protection.

The paper is organized as follows. Section 2 discusses potential drivers of spatial interdependence, Section 3 presents the data, Section 4 outlines the estimation tech-

nique, discusses potential weighting matrices and gives estimation results, and Section 5 concludes.

2. Theoretical background

Fiscal interactions among local governments can be explained by various effects stemming either from non-cooperative or cooperative behavior. The main sources of the strategic interaction in the non-cooperative setup are spillovers, fiscal competition and yardstick competition.[1]

The positive/negative spatial interdependence of local spending in games with non-cooperative governments is equivalent to local spending being strategic complements/strategic substitutes. The sign of interdependence is very sensitive to the institutional environment, especially by the revenue-sharing of matching grant systems. In addition, when supporting local businesses, the structure of local production matters.

(i) The first and the foremost source is the presence of spillover effects. The benefits of public spending in domestic regions can easily spill over to neighboring regions (Gordon 1983). This additional welfare effect influences local governments' decisions on its public spending in neighboring jurisdictions. We can observe either a positive or negative correlation among neighbors' public expenditures resulting from its substitutability or complementarity, respectively.

The provision of cultural goods such as museums and cinemas, environmental protection or building new infrastructure in one region can increase the welfare of residents in surrounding jurisdictions, because they can utilize these goods and services. The optimal reaction of local government to this positive welfare effect would be to free-ride on neighboring regions, decrease its expenditure on the particular policy and reallocate resources to different policies.

On the other hand, some policies pursued in one region can have negative consequences in a neighboring region because they harm its residents and decrease their utilities. For example, greater business support and subsequent development of industry and infrastructure can deteriorate the environment in surrounding jurisdictions. Consequently, they have to spend more on environmental protection.

(ii) The second source of the strategic interaction can be denoted as fiscal competition. More attractive public goods in neighboring regions can decrease the inflow of potential residents and potential businesses or can cause an outflow of current mobile residents and mobile businesses operating in a domestic region, and therefore decrease the welfare of its residents.

This idea stems from the hypothesis that individuals "vote with their feet" and move to a community that provides the desired level of public goods, given the underlying resource costs.

[1] Revelli (2006b) specifies channels of interaction in line with the above-mentioned sources such as preferences, constraints and expectations.

A higher amount of residents and businesses in a region imply higher revenues for its local government and more public goods. Moreover, businesses provide job opportunities resulting in economic growth in problematic regions, increases in purchasing power of population, and the elimination of negative consequences related to high unemployment.

Thus, local governments have incentives to attract people to settle in their region and encourage new businesses to operate there. This can lead to competition among local governments via specific types of spending resulting in spatial interdependence.

Keen and Marchand (1997) are among the first authors who explore spending competition. They state that under fiscal competition too much is spent on public goods benefiting local business and too little on public goods benefiting residents, which stems from labor immobility. Matsumoto (2000) and Borck (2005) further extend this paper theoretically.

The fact that some municipalities in the Czech Republic care about their population size is demonstrated in the special example of Jihlava, Hradec Králové, Kolín and some other municipalities that have in the past actually paid people to reside there (Kovalík 2006, Macková 2006). However, their behavior was driven by the revenue-sharing system in which revenues per capita are bracketed by the population level. For municipalities at the upper bound of the bracket, the incremental benefit of ending up in a higher bracket is enormous.

(iii) Local governments may also mimic decisions on the public goods provisions of its neighbors. There are two main channels through which this behavior occurs. Firstly, it is explained by yardstick competition: If incompletely informed voters evaluate the performance of their government, they can take the policies pursued by its neighbors as a yardstick (see Salmon 1987; Besley and Case 1995; Revelli 2006a), because they do not have information on the costs of running the office or public service provision.

This reasoning is further extended in Ashworth and Heyndels (2000) in the context of taxation. They construct a specific behavioral hypothesis and argue that voters receive extra rewards from superior policies or extra disutility from inferior policies if compared to policies in neighboring regions.

Secondly, it can be the local government that is incompletely informed. To avoid information costs such as the costs of analyzing the demand of its residents or of elaborating cost-benefit analysis the local government can tend to mimic its own neighbors.

(iv) Finally, we have to consider possible cooperation and coordination. On the contrary to the previous effects that are strategic and all arise from the non-cooperative setup, this one stems from the cooperative game. Neighboring municipalities can work on joint projects; they can jointly finance infrastructure, recreational services, environmental protection or some common networks. Municipalities can also exchange ideas and experiences or learn each from other.

In exceptional cases, municipalities can engage in the deeper process of cooperation and even specialize. However, benefits of specialized public good provisions spread from one municipality to another through spillover channels. Although the initial stimulus counts towards cooperation, as a consequence it is the existence of spillovers that are the cause of spatial interdependence.

Cooperation among municipalities as a source of spatial interdependence is seldom discussed in this literature. One of the few studies on this topic is by Petermann Reifschneider (2006) who constructs models of cooperation between competing jurisdictions.

Czech legislature serves as a good example in giving a legal basis for cooperation among municipalities; municipalities can either cooperate in voluntary associations, form partnerships, or their cooperation can be based on some contract made to fulfill a special task. According to a survey carried by researchers from the Institute of Sociology of the Academy of Sciences in the Czech Republic (see Vajdová et al. 2006), voluntary associations of municipalities are nearly always formed by small municipalities whose own budgets are too tiny to carry forward certain projects. These association are mostly focused on regional development, tourism, environment, waste treatment, energy issues and infrastructure.

Alternative theoretical hypotheses of the potential effects driving spatial interdependence summarized in Table 1 give rise to similar responses in the size of local public expenditures. Therefore, it is very difficult to attribute the observed behavior to a unique theoretical model. In some cases, effects can even fade into one another. Still, there exist some empirical strategies to identify the particular model as shown by Revelli (2006b), but they require additional data.

Table 1. Sources of spatial interdependence

	Cooperative	*Non-cooperative*
Positive	Joint projects, exchange of experiences, learning	Negative spillover/externality Fiscal competition Mimicking
Negative	Specialization	Positive spillover/externality

In this paper, we do not distinguish between various hypotheses driving the spatial pattern, because we do not have the instruments and data for it. However, something can be learned from this observed type of interdependence; for example, negative spatial interdependence can be interpreted above all by the spillover hypothesis, because specialization is very rare.

Some theoretical hypotheses can be also precluded for particular groups of expenditures. For cultural expenditures we hardly see cooperation as suggested by the survey mentioned above. Similarly, for expenditures on municipal services very narrowly focused on the welfare of residents, the cooperation and spillover hypothesis is at least probable. In addition, various models can operate on different spatial scales.

Yardstick competition, spillovers and cooperation tend to take place in close neighborhoods, however fiscal competition can occur also on a greater spatial scale.

3. Data

There were five tiers of government in the Czech Republic in the year 2006; the central government, 14 regions (territorial self-governing districts, NUTS 3), 205 municipalities with extended powers, 393 municipalities with an authorized municipal office and 6,248 municipalities (basic territorial units, NUTS 5).[2]

A municipality with extended powers is at the same time a municipality with an authorized municipal office and a sole municipality. Various types of municipality administration statutes differ in their powers and responsibilities. Municipalities with extended powers control territory with other municipalities and are responsible for social transfers payments, social care, water industry, environment protection and infrastructure in the region.

In our analysis, we used cross-sectional data on municipalities with extended powers in 2006. These municipalities represent small centers in their districts and all the administrative agencies, banks, businesses, culture services are concentrated here. Therefore, they are perfectly suitable for studying spatial interdependence.[3]

The Ministry of Finance provides the complete database of municipality budgets (ARIS) providing a very detailed overview of municipality expenditures.[4] We focus on the overall expenditures and on four expenditure groups that are the most interesting from our point of view: expenditures on housing, utilities and regional development, industry and infrastructure, culture, sports and recreation and environmental protection. Housing, utilities and regional development spending includes expenditures on the development of the housing economy, municipal utilities such as public lighting and local services, town planning, territorial development and administration related to these tasks; industry and infrastructure contains expenditures on industrial support, trade and services support, expenditures on roads, public transportation and on telecommunications; the culture, sports and recreation group includes spending on on cultural activities, sports events, sport clubs and recreational services; finally, environmental protection expenditures include air protection, waste treatment, underground water protection, soil protection and nature protection.

We analyze both capital and current expenditures for each group. Capital expenditures represent investments to buildings and infrastructure which can create spillovers, be instrument for fiscal competition, cause mimicking and municipalities can cooperate within them; therefore, they are the most suitable for our analysis. On the other

[2] Until the end of 2002, the structure was different: instead of 14 regions there were 77 administrating districts. Later, these districts existed only as territorial districts, NUTS 4, with no public administration competencies. After the reform around 20% of the competencies were shifted from districts to the regions, and 80% to municipalities with extended powers.

[3] Other municipalities do have less competencies, along with a tiny and not-so-variable budget. For homogeneity, we exclude the capital city of Prague since its current expenditures per capita are two times higher than the maximum from our sample.

[4] http://www.mfcr.cz/cps/rde/xchg/mfcr/hs.xsl/aris.html

hand, current expenditures mainly reflect how much of a public good is provided; they represent the costs of operating public facilities. Still, there is a limitation of these expenditures, as municipalities differ in cost efficiency or they can force different labor costs. We expect to find a stronger spatial interdependence effect for capital expenditures than for current expenditures.[5]

In the model of the interaction of local public expenditures, we have to include the various socio-economic and political characteristics of local jurisdictions. The economic performance of a municipality can influence its expenditures. Unfortunately, we do not have data on the GDP for this level of government, but we could approximate it by the average gross wage. However, this control can bias results due to its correlation with other demographical variables, such as the share of university-educated people, therefore, it is not used.[6] Budget constraint is important for spending, so we include grants and subsidies per capita. We disregard tax revenues per capita as they are potentially endogenous. Past liabilities can also influence decisions on public expenditures, so we include the one year lagged indicator of debt service.[7]

We also have data on the financial health of municipalities in 2005 in the form of the financial score computed by the Czech Credit Bureau, Inc.[8] This indicator can be potentially correlated with other economic variables, so we should use it with caution.

Additionally, jurisdictional demographic characteristics can affect public spending because they represent the needs and preferences of the population for public goods and services. The demand for public spending is determined by population structure and education. So, we include a share of old people (above 65 years) and young people (below 15 years), or a share of people in a productive age, depending on which one works better, and a share of people above 15 years of age with a university education.[9]

Municipality size in terms of its population can also influence spending; larger municipalities can spend more per capita because of providing more types of services. We furthermore test the impact of the density of a population representing the measure of the rate of urbanization. Denser municipalities can exploit economies of scale. Given our data, it does not hold in the Czech Republic that large municipalities are denser, therefore we include both variables in the estimation.

We also introduce political variables to control for characteristics of local governments ruling in 2006 (and which were elected in 2002). Generally, we would like to know whether the ideology of a local government affects the level of its spending. Unfortunately, it is almost impossible to recognize the political ideology of parties at

[5] The analysis of current expenditures is useful especially in cases when there is a great variability of capital expenditures among municipalities, and some do not spend anything.

[6] In a previous version of the paper, wage was included in the estimation together with unemployment rate, but they were nearly always insignificant.

[7] The indicator of debt service is computed as $ISP = r/t$, where r is the sum of interest payments and installments of stock and bonds, and t is the sum of tax revenues, non-tax revenues and subsidies from the state budget.

[8] The financial score is part of the iRating constructed by CCB, Inc. for each municipality in the Czech Republic. It includes 20 financial indicators; each is evaluated on a scale from minus 25 to plus 25 in a larger sample of all municipalities (not only those with extended powers). The total financial score is the weighted average of all indicators. To avoid negative numbers, we adjust the scale from 0 to 50.

[9] The most recent data of this indicator was collected in the 2001 census.

the municipal level except with the main political parties operating simultaneously at the national level. Therefore, we construct dummy variable indicating that either the Communist party or Social Democratic party, major Czech left-wing parties, was the winner of municipality elections in 2002 and try to verify that left-wing governments have greater incentives to spend more.

Furthermore, we also use party fragmentation. The number of parties and their relative power can also influence decisions on government spending, especially in cases of major investment decisions. We compute a Herfindahl index for party concentration in the local council which is generally used as an indicator of party fragmentation within the council.

And finally, due to spillovers from very large municipalities that can occur for specific expenditures, we form dummy variable indicating municipalities that border on large municipalities with more than 40,000 inhabitants. Variables and summary statistics of expenditures and exogenous variables can be found in Table 2.

Table 2. Summary statistics

Variable	Mean	Std. Dev.	Min	Max
Total expenditures	22809	5415	14866	58053
Capital expenditures	6689	4020	1124	40337
Current expenditures	16121	3126	11248	33206
Housing, utilities and regional development	3447	2920	628	34096
Industry and infrastructure	3428	2219	395	15816
Culture, sports and recreation	2859	1542	457	9947
Environmental protection	1208	593	24	3684
Population	23261	38371	2892	366680
Population density (per km^2)	143.80	174.30	32.00	1592.80
Share of youth	14.46	1.09	12.11	18.86
Share of people in a productive age	71.40	1.32	67.07	75.24
Share of elderly	14.14	1.51	9.69	17.44
Share of university-educated people	6.26	1.85	2.54	17.93
Subsidies per capita	1796.16	1821.42	162.00	15474.00
Debt service indicator	5.81	6.29	0.00	49.56
Financial score	17.47	5.09	6.78	30.77
Left-wing parties	0.17	0.38	0.00	1.00
Party concentration	0.21	0.05	0.12	0.51

Source: Czech Statistical Office (www.czso.cz); CCB, Inc.; Ministry of Finance.
Note: $N = 205$. Expenditures per capita (Czech koruna).

As we can see from Table 2, we can observe large differences in the capital expenditures in municipalities. Some municipalities carry investment projects and some do not. To smooth out the differences and to control for the fact that some municipalities hold investments in one year and some in the following year, we use three-year averages (2004-2006) for capital expenditures.

4. Estimation

To test whether spending is spatially interdependent in Czech municipalities, we aim to estimate a general reaction function (1). In the spatial lag model, the estimated equation for the vector of spending z can be written as

$$z = \beta Wz + \theta X + \varepsilon, \tag{1}$$

where the matrix X represents control variables, the matrix W defines the neighborhood,[10] ε is a vector of errors, and β and vector θ are parameters to be estimated.

There are two major issues arising from the estimation of this spatial lag model as Brueckner (2003) states; endogeneity of the z's and possible spatial error dependence. Endogeneity in this context originates from the fact that for neighboring locations ij, z_j enters on the right hand side of the equation for z_i, but z_i also enters on the right hand side of the equation for z_j. To address the endogeneity problem, we should estimate the model by one of the two main techniques used for spatial processes models:[11] maximum likelihood estimation and instrumental variables estimation.

The second problem of estimating (1) can be the spatial error dependence arising when ε includes omitted variables that are spatially dependent. This effect can be explained by unmodelled shocks that spill over across units of observation and thus result in spatially correlated errors. In this case, the error vector ε satisfies:

$$\varepsilon = \rho V\varepsilon + \xi, \tag{2}$$

where V is the weighting matrix that can be the same as W in (1), ρ is an autoregressive parameter to be estimated and ξ is a random error term typically assumed to be $i.i.d.$[12]

This problem can be solved by using the estimation technique called generalized spatial two-stage least squares procedure (GS2SLS) introduced in Kelejian and Prucha (1998) that consists of three steps; (i) to compute 2SLS estimates in (1);[13] (ii) to derive residuals ε from the first step and estimate ρ in (2) by GMM as suggested by Kelejian and Prucha (1999); (iii) to reestimate (1) by 2SLS after transforming the model via a Cochrane-Orcutt type transformation to account for spatial error correlation.

In our analysis, we use various estimation techniques and compare results. Firstly, we estimate the spatial lag model as is expressed in (1) by maximum likelihood and test for spatial error autocorrelation. In the case it is present we reestimate the model by GS2SLS. If even after that we do not get satisfying results, we estimate the spatial error model in (2) by maximum likelihood.[14]

[10] Note that weights for its own spending on the diagonal w_{ii} are always zero.

[11] Recently, alternative estimation methods using maximum entropy have developed (LeSage and Pace 2004).

[12] Kelejian and Prucha (2008) have recently developed a new technique for how to estimate ρ for heteroscedastic innovations ξ.

[13] As is standard in spatial econometrics literature, we instrument z by X and WX (e.g. Heyndels and Vuchelen, 1998; Sollè-Ollè, 2005; Geys, 2006; Werck, Heyndels and Geys, 2008). The Sargan test of the overidentifying restrictions suggests that our instruments are valid for cases when we get significant effects of control variables.

[14] For maximum likelihood estimation of the spatial lag model, we assume that errors are *i.i.d.*, and of the spatial error model we assume that there is no spatial lag dependence, $z = \theta X + \varepsilon$. ML estimation brings more accurate results than its IV counterpart (Das et al. 2003).

4.1 Neighborhood matrix

The crucial point of study is the construction of a neighborhood weighting matrix. This is fundamental when dealing with spatial correlation since it introduces the potential spatial correlation among units of observations. In our study we consider various matrices. For each matrix, we test for spatial autocorrelation which can be measured by Moran's I statistics (Moran 1948).

All weighting matrices are based on geographical specification. The simplest matrix that can be used is the first-order neighborhood matrix. It positively weights only those municipalities, with which it shares a common border. Borders are not borders of the municipality itself, but of a district which is controlled by the municipality with extended powers.

Additionally, we can construct the neighborhood matrix based on distance bands. For this purpose, we collect spatial coordinates for each municipality and study spatial autocorrelation for different distance bands. Only municipalities lying within a given distance band are weighted positively.

Finally, in our neighborhood matrix we want to express the fact that municipalities can weight decisions on expenditures of similar municipalities more. This matrix is based on the geographical neighborhood defined by the distance band, but the weights are not the same for all neighbors.[15]

Table 3. Moran's I test for various neighborhood matrices

	W	W20	W25	W30	W35	WS20	WS25	WS30	W35
Current expenditures									
II	0.010	0.010	0.001	–0.026	–0.001	0.060	0.044	0.019	0.033
CS	0.028	0.086**	0.070**	0.066**	0.067**	0.093**	0.077**	0.074**	0.071***
HD	0.086**	0.111***	0.050	0.022	0.016	0.118**	0.056*	0.026	0.019
EP	–0.017	0.084*	0.020	0.000	0.022	0.089**	0.023	0.001	0.024
ALL	0.091***	0.198***	0.123***	0.101***	0.066**	0.194***	0.117***	0.095***	0.060**
Capital expenditures									
II	0.115***	0.114**	0.157***	0.126***	0.095***	0.129***	0.162***	0.133***	0.096***
CS	0.133***	0.132***	0.112***	0.107***	0.079***	0.137***	0.117***	0.114***	0.084***
HD	0.041*	0.030	0.054*	0.075***	0.066***	0.036	0.061**	0.082***	0.073***
EP	–0.015	–0.023	–0.032	–0.015	–0.016	–0.017	–0.029	–0.015	–0.017
ALL	0.147***	0.126***	0.145***	0.118***	0.115***	0.144***	0.157***	0.131***	0.123***
ALL	0.038	0.153***	0.101***	0.081***	0.070***	0.155***	0.101***	0.082***	0.072***

Note: *,**,*** denote significance at 10%, 5%, 1% level, respectively. W is the first-order neighborhood matrix; W20, W25, W30 and W35 are matrices based on a given distance band in kilometers; WS20, WS25, WS30 and WS35 denote matrices based on similar characteristics and given distance band. All are nonstandardized. Expenditures groups are denoted as follows: industry and infrastructure (II), culture, sports and recreation (CS), housing, utilities and regional development (HD) and environmental protection (EP). (ALL) means the total expenditures of given type.

[15] We characterize municipalities by K variables: population size, population density, share of young and old people, share of university-educated people, average gross wage and unemployment rate. Each variable x^k, $k \in K$ is normalized from 0 to 1. The weight of the municipality lying within the distance band is given as $w_{ij} = \frac{1}{K}\sum_k (1 - |x_i^k - x_j^k|)$.

Table 3 presents the results of the spatial autocorrelation test Moran's I for various expenditure groups using the various matrices suggested above. We use distance bands from 20 to 35 kilometers, which are the most reasonable.[16] Significant results indicate that municipalities' expenditures cluster in space and we should be suspicious of spatial interdependence. If we compare various types of matrices, we can see that those that take into account the differences of municipalities' characteristics perform the best for almost all expenditures groups. The results also suggest that relevant neighborhood size is different for various expenditures groups and verify that the distinction among current and capital expenditures is important due to the observed diverse spatial autocorrelation pattern.

4.2 Estimation results

In this section, we aim to estimate whether local public expenditures in Czech municipalities are spatially interdependent. We mainly focus on capital expenditures as there is a higher potential of interaction. However, the results in Table 3 illustrate the different spatial patterns in scale for current and capital expenditures on housing, utilities and regional development, therefore we also analyze its current spending. Concerning expenditures on environmental protection, the data on capital expenditures is very weak, because almost 28% of municipalities do not spend anything. Thus, in this case, we study the current and capital expenditures together.

We work with three neighbourhood matrices, WS20, WS25 and WS30, for which we observed highest spatial autocorrelation. We firstly estimate the model by the maximum likelihood spatial lag model and construct Moran's I to test for spatial error autocorrelation. In the case that spatial error autocorrelation is significant, we reestimate the model by GS2SLS.

Table 4. Maximum likelihood estimation: spatial lag model

	WS20		WS25		WS30	
	β	error	β	error	β	error
Current expenditures						
HD	0.077***	0.055	0.036*	0.058*	0.010	0.051*
Capital expenditures						
II	0.008	0.181***	0.030	0.179***	0.012	0.151***
CS	0.047**	0.048	0.046**	0.049	0.046***	0.051*
HD	−0.032	0.112**	0.014	0.071**	0.026	0.049*
ALL	−0.009	0.153***	0.016	0.118***	0.007	0.096***
EP	−0.012	0.140***	−0.002	0.115***	−0.010	0.136***
ALL	0.000	0.091**	0.002	0.077**	0.001	0.066**

Note: *,**,*** denote significance at 10%, 5%, 1% level, respectively.

Table 4 presents partial results out of maximum likelihood estimation. Parameter β

[16] For a distance band of 15 kilometers there are 72 municipalities having no neighbors; for 40 kilometers, the average number of neighbors is greater than 11.

expresses the spatial interdependence effect and the error columns show Moran's *I* test for spatial error autocorrelation. The complete results are available in the Appendix.

The results are in line with the previous Table 3. In cases of strong spatial autocorrelation, we observe high β. Nevertheless, it is mostly insignificant. In the following analysis, we disregard neighborhoods that are less relevant for each expenditure groups. Except for current expenditures on housing, utilities and regional development and capital expenditures on culture, sports and recreation, we have to reestimate all the models by GS2SLS, as we detected a spatial error autocorrelation.

Even if GS2SLS does not help and we might not reject the hypothesis of the zero spatial lag dependence, we use the maximum likelihood error model. In the case of overall expenditures, we do not detect any spatial process, thus we use the simple OLS regression. Table 5 shows the final results.[17]

Table 5. Estimation results

	Current	Capital			Total		
	HD	II	CS	HD	ALL	EP	ALL
Neighborhood	WS20	WS25	WS20	WS30	WS25	WS20	WS25
Model	ML lag	G2SLS	ML lag	G2SLS	ML error	G2SLS	OLS
β	0.077***	−0.085***	0.047**	0.060***		−0.041*	
ρ		0.370*		−0.046*	0.088***	0.058*	
Population	0.001	0.002	0.050**	0.008*	0.013**	−0.001	0.023*
Population density	−0.329	−0.204	0.139	−0.869	−0.974**	−0.331***	−2.826***
Young people	−86.82	−7.376	214.2**	−300.5**	−64.73		−633.5*
People in prod. age						53.27*	
Old people	−69.40	71.31	108.1*	−50.01	210.2**		−141.0
University education	−16.62	183.6***	−19.07	−102.2	213.8*	85.91***	256.9
Subsidies	0.167***	0.101**	0.045	0.720***	0.999***	−0.010	1.462***
Debt service	6.044	6.561		−10.23	14.51		38.59*
Financial score	41.18**			3.096			
Left-wing parties	234.8	−319.9*	298.6*	−123.5	55.97	50.42	−668.4
Party concentration	5615***	1494	−735.5	5971***	5336*	401.7	5517
Large city in neigh.			−219.3*			−106.8	
Altitude						−1.081**	
Large city dummy						386.8**	
Constant	1222	−211.5	−3925	4255*	132.6	−2537	27949***
R^2							0.38
Log likelihood	−1593.19		−1554.04		−1843.37		
Sargan test		8.402		10.635		9.284	

Note: *,**,*** denote significance at 10%, 5%, 1% level, respectively.

Spatial lag dependence was found for all expenditures groups except for overall

[17] Controls have been chosen according to a large sensitivity analysis carried out. Detailed results are available upon request. For environmental expenditures we add two more special variables, such as altitude and a dummy for large cities having more than 40,000 inhabitants.

capital expenditures, for which at least spatial error dependence was detected. Firstly, we look at the sign of interdependence.

Negative spatial interdependence

For expenditures on environmental protection and expenditures on industry and infrastructure, we obtained the negative coefficient of spatial lag. This finding supports the spillover hypothesis. The benefits of public goods provided in neighboring municipalities spill over to the domestic municipality, which can thus reallocate resources to different local policies.

Air and water pollution are classic examples of negative externalities in economic literature. It is costly to eliminate pollution originating from a neighboring municipality and the lower the pollution externality is, the less a municipality has to spend on its elimination. Higher expenditures on environmental protection in neighboring municipalities imply lower domestic spending, and therefore, expenditures are negatively spatially interdependent.

Surprisingly, the spillover hypothesis was also assigned to capital expenditures on industry and infrastructure. Public infrastructure represents mainly networks, such as roads, telecommunications or railways, so it is expected that the higher stock of capital in one jurisdiction will increase the production in other jurisdictions. The domestic workforce can also benefit from firms producing in neighboring regions due to commuting. These spillovers seem to outweigh the potential competition effect, when neighboring regions behave as rivals and compete among each other for firms through these expenditures. Or different competition channels can exist that are not included in these expenditures. Some regions can have a more high-skilled labor force, special government investment incentives for firms, or property tax matters can also exist.[18]

Positive spatial interdependence

Positive spatial interdependence was discovered for current and capital expenditures on housing, utilities and regional development, and for capital expenditures on culture, sports and recreation. Concerning the latter, this spending can have large spillovers as there may be a high degree of substitutability of leisure activities across municipalities. People can be almost indifferent as to whether to consume these goods in domestic or other municipalities. Spillovers then give rise to free-riding and negative spatial interdependence.

In our case, the results suggest opposite and different effects, mimicking or competition, matter.[19] Municipalities hardly aim at attracting new residents via the support of cultural and sport life. More likely, they mimic each other. Due to strong spillovers, information on cultural and sports events spreads easily to neighboring regions, and the absence of any leisure activities in the domestic municipality appears worse when neighboring municipalities provide these services and goods. Thus, higher expenditures on leisure activities in neighboring municipalities can put pressure on the domestic government to increase these expenditures.

Another expenditures group of interest is housing, utilities and regional development spending. Capital spending is mostly related to housing construction. In large

[18] Property tax is the only tax that can be partly set by municipalities, but the differences are not large.

[19] According to the survey mentioned in the theoretical section, cooperation is hardly probable.

neighborhoods, this spending has proven to be spatially interdependent. The main aim of housing construction support is to attract new people to settle in the region. Therefore, the positive spatial interdependency can be attributed to the fiscal competition hypothesis.

Positive interdependence in current expenditures referring to the size of pure municipal services cannot be explained by cooperation, as they are narrowly targeted to the welfare of residents. These expenditures probably do not even influence people's decisions as to whether to reside in the region or not, so a fiscal competition hypothesis can be precluded. Finally, we are left with the last possible effect of mimicking.

Spatial error dependence

For some groups we also find significant spatial error dependence. This effect shows that municipalities face some external shock. Another source of this dependence may come from omitted variables that are related through space.

Specific policies such as business development or other investments can be supported by particular regional governments controlling territory with more municipalities with extended powers. There can also exist state regulation targeting specific regions, such as the "Natura 2000" ensuring protection of birds. Or weather conditions matter, such as floods affecting municipalities lying within large region that are forced to build new infrastructure.

Let us briefly discuss the effects of some control variables. Larger municipalities in terms of its *population* tend to spend more on culture, sports and recreation, housing construction and on overall capital expenditures. This confirms the fact that cultural life concentrates in larger cities that are, at the same time, more capable of carrying out investment projects, such as housing construction. *Population density* negatively affects overall capital spending, which verifies the existence of economies to scale. If the municipality provides some capital goods, then the marginal costs of additional users are close to zero. This effect is also observed for environmental expenditures.

Results prove that for some expenditures groups population structure is important. The *share of young and old people*, for example, positively influences spending on leisure goods. Children's leisure time should be utilized. Another population demographic who enjoy cultural events in their domestic municipality are elderly people; they are more interested in cultural spending because they have a lower opportunity cost of time. The *share of people in a productive age* positively affects environmental spending. The *share of university educated people* also does. These people care more about environmental protection, therefore they can be either those who decide upon environmental policy in local government or those who vote for politicians with a higher preference for good environment. Education is also a significant determinant for overall capital spending and spending on industry and infrastructure. People with a university education could have similar interests as entrepreneurs, or even run their own business.

Concerning *budget constraint*, municipalities mainly do not react on past deficit, but on current budget constraints, given by subsidies in our case. The *financial score* was found to be useful only in the case of current expenditures on municipal services, the greater the financial health of a municipality, the more money is spent on this task.

We can observe interesting effects for political variables. We find evidence that *left-wing parties* tend to decrease expenditures on industry and infrastructure and at the same time increase expenditures on culture, sports and recreation. *Party concentration* also matters. If parties in the municipality council are more concentrated, then spending on housing, utilities and regional development and on overall capital expenditures are higher. More parties in the local council more likely disagree on huge investments projects requiring a lot of political and financial support. This hypothesis is supported by Alesina and Drazen (1991) in their analysis of how political struggles delay reforms, or by the war of attrition model in Alesina et al. (2006).

Additionally, a *large city in a neighborhood* negatively affects the municipality's cultural spending. The municipality tends to free ride on the large city, which has an advantage in providing cultural goods.

Environmental expenditures specific controls were found to be significant. Large cities are centers of business life, which produce higher emissions, so they have to spend more. Results also suggest that municipalities situated at a higher altitude spend less on environmental protection, probably due to a better natural environment.

5. Conclusion

In this paper, we sought evidence of the spatial interdependence of local public expenditures in the Czech Republic. We tested the hypothesis that in their decisions on public spending, municipality councils take into account the decisions of neighboring municipalities. Interaction among municipalities can stem from (i) spillover effects, when residents benefit or are harmed from the public good provided in a neighboring region; (ii) competition, when municipalities aim to attract residents and businesses to their region; (iii) mimicking, driven by yardstick competition or by the incomplete information of councils about costs or the demand for public goods; (iv) and due to cooperation, because neighboring municipalities can work on joint projects.

In our analysis, we focused on overall expenditures and various expenditure groups; industry and infrastructure, culture, sports and recreation, housing, utilities and regional development, and environmental protection.

By using various tests we found the neighborhood matrix that was relevant for a particular expenditure type. The matrices were based on distance band from 20 to 30 kilometers and took into account differences in municipalities' characteristics. Technically, we estimated the municipality's reaction function and used two different techniques: maximum likelihood and generalized spatial two-stage least squares. If the spatial error and lag dependence occurred at the same time, the latter one was more appropriate.

We found positive spatial interdependence in capital expenditures on culture, sports and recreation and current and capital expenditures on housing, utilities and regional development. We argued that municipalities mimic each other in cultural expenditures, as well as in current expenditures on municipal services. Additionally, fiscal competition occurred in capital expenditures on housing construction.

Negative spatial interdependence was observed for environmental expenditures and

for capital expenditures on industry and infrastructure. This effect verifies the spillover hypothesis that the benefits of public goods provided in neighboring municipalities spill over to the domestic municipality. This was surprising for the latter expenditure group, as it did not verify the expected hypothesis of fiscal competition.

The results also bring interesting effects of political variables. We found weak evidence that party fragmentation decreased capital expenditures, so the higher the disagreement among parties in municipality councils, the lower the amount of spending on investment projects. Similarly, party fragmentation decreased expenditures on housing. Left-wing parties tended to spend more on culture, sports and recreation, an area from which mainly residents (and not businesses) benefited. Left-wing voters may also demand these public goods and services more than right-wing voters. On the other hand, these parties seemed to spend less on industry and infrastructure.

Although we aimed to assign theoretical models to observed effects of spatial interdependence, we could not always be sure which model it was driven by. In some cases, various theoretical models could also work simultaneously. In our future research, we will aim to find instruments for how to distinguish these models.

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References

Alesina, A., Ardagna, S. and Trebbi, F. (2006). Who Adjusts and When? On the Political Economy of Reforms. *IMF Staff Papers*, 53, 1–29.

Alesina, A. and Drazen, A. (1991). Why Are Stabilizations Delayed? *American Economic Review*, 81 (5), 1170–1188.

Allers, M. A. and Elhorst, J. P. (2005). Tax Mimicking and Yardstick Competition Among Local Governments in the Netherlands. *International Tax and Public Finance*, 12, 493–513.

Ashworth, J. and Heyndels, B. (2000). Reference Point Effects in Local Taxation: It All Depends on How You Look at It. *National Tax Journal*, 53, 335–341.

Borck, R. (2005). Fiscal Competition, Capital-Skill Complementarity, and the Composition of Public Spending. *FinanzArchiv: Public Finance Analysis*, 61(4), 488–499.

Borck, R., Caliendo, M. and Steiner, V. (2007). Fiscal Competition and the Composition of Public Spending: Theory and Evidence. *FinanzArchiv: Public Finance Analysis*, 63(2), 264–277.

Bordignon, M., Cerniglia, F. and Revelli, F. (2003). In Search of Yardstick Competition: A Spatial Analysis of Italian Municipality Property Tax Setting. *Journal of Urban Economics*, 54, 199–217.

Bosch, N. and Solé-Ollé, A. (2007). Yardstick Competition and the Political Costs of Raising Taxes: An Empirical Analysis of Spanish Municipalities. *International Tax and Public Finance*, 14, 71–92.

Brueckner, J. (1998). Testing for Strategic Interaction among Local Governments: The Case of Growth Controls. *Journal of Urban Economics*, 44, 438–467.

Brueckner, J. and Saavedra, L. A. (2001). Do Local Governments Engage in Strategic Tax Competition? *National Tax Journal*, 54, 215–245.

Brueckner, J. (2003). Strategic Interaction Among Governments: An Overview of Empirical Studies. *International Regional Science Review*, 25, 175–188.

Case, A. C., Rosen, H. S. and Hines, J. C. (1993). Budget Spillovers and Fiscal Policy Interdependence: Evidence from the States. *Journal of Public Economics*, 52, 285–307.

Das, D., Kelejian, H. H. and Prucha, I. R. (2003). Finite Sample Properties of Estimators of Spatial Autoregressive Models with Autoregressive Disturbances. *Papers in Regional Science*, 82, 1–26.

Ermini, B. and Santolini, R. (2007). Horizontal Interaction on Local Councils' Expenditures. Evidence from Italy. Ancona, Université Politecnica delle Marche, Dipartimento di Economia, Working paper No. 278.

Foucault, M., Madiès, T. and Paty, S. (2008). Public Spending Interactions and Local Politics. Empirical Evidence from French Municipalities. *Public Choice*, 137(1), 57–80.

Geys, B. (2006). Looking across Borders: A Test of Spatial Policy Interdependence Using Local Government Efficiency Ratings. *Journal of Urban Economics*, 60(3), 443–462.

Hayashi, M. and Boadway, R. (2001). An Empirical Analysis of Intergovernmental Tax Interaction: The Case of Business Income Taxes in Canada. *Canadian Journal of Economics*, 34(2), 481–503.

Heyndels, B. and Vuchelen, J. (1998). Tax Mimicking in Belgian Municipalities. *National Tax Journal*, 60, 89–101.

Keen, M. and Marchand, M. (1997). Fiscal Competition and the Pattern of Public Spending. *Journal of Public Economics*, 66, 33–53.

Kelejian, H. H. and Prucha, I. R. (1998). A Generalized Spatial Two-Stage Least Squares Procedure for Estimating a Spatial Autoregressive Model with Autoregressive Disturbances. *Journal of Real Estate Finance and Economics*, 17, 99–121.

Kelejian, H. H. and Prucha, I. R. (1999). A Generalized Moments Estimator for the Autoregressive Parameter in a Spatial Model. *International Economic Review*, 40, 509–533.

Kelejian, H. H. and Prucha, I. R. (2008). Specification and Estimation of Spatial Autoregressive Models with Autoregressive and Heteroskedastic Disturbances. Munich, CESifo, Working Paper No. 2448.

Kovalík, J. (2006). Dům duchů v Jihlavě. Respekt, 46.

LeSage, J. P. and Pace, R. K. (2004). *Advances in Econometrics. Vol. 18. Spatial and Spatiotemporal Econometrics.* 1st ed., Amsterdam, Elsevier.

Lundberg, J. (2001). A Spatial Interaction Model of Benefit Spillovers from Locally Provided Public Services. Umea, CERUM, Working Paper No. 31.

Macková, M. (2006). Hradec láká obyvatele, za dva miliony. Prague, Czech Statistical Office, 3.3.2006. http://www.czso.cz/csu/redakce.nsf/itisk/3200303DAE

Matsumoto, M. (2000). A Note on the Composition of Public Expenditure under Capital Tax Competition. *International Tax and Public Finance*, 7, 691–697.

Petermann Reifschneider, A. (2006). *Competition in the Provision of Local Public Goods. Single Function Jurisdictions and Individual Choice.* Cheltenham, Northampton, Edward Elgar.

Redoano, M. (2007). Fiscal Interactions among European Countries. Does the EU matter? Munich, CESifo, Working paper No. 1952.

Revelli, F. (2002). Local Taxes, National Politics and Spatial Interactions in English District Election Results. *European Journal of Political Economy*, 18, 281–299.

Revelli, F. (2006a). Performance Rating and Yardstick Competition in Social Service Provision. *Journal of Public Economics*, 90(3), 459–475.

Revelli, F. (2006b). Spatial Interactions among Governments. In Ahmad, E., Brosio, G. (eds.), *Handbook of Fiscal Federalism*. Cheltenham, Northampton, Edward Elgar, 106–130.

Salmon, P. (1987). Decentralization as an Incentive Scheme. *Oxford Review of Economic Policy*, 3, 24–43.

Solé-Ollé, A. (2006). Expenditure Spillovers and Fiscal Interactions: Empirical Evidence from Local Governments in Spain. *Journal of Urban Economics*, 59(1), 32–53.

Vajdová, Z., Čermák, D. and Illner, M. (2006). Autonomie a spolupráce: důsledky ustavení obecního zřízení v roce 1990. Prague, Institute of Sociology of the Academy of Sciences of the Czech Republic, Sociological Studies No. 2.

Werck, K., Heyndels, B. and Geys, B. (2008). The Impact of Central Places on Spatial Spending Patterns: Evidence from Flemish Local Government Cultural Expenditures. *Journal of Cultural Economics*, 23(1), 35–58.

Appendix

Table A1. Maximum likelihood lag model estimates

	II capital spending			CS capital spending			HD capital spending			ALL capital spending		
Neighborhood	WS20	WS25	WS30	WS20	WS25	WS30	WS20	WS25	WS30	WS20	WS25	WS30
β	0.008	0.030	0.012	0.047**	0.046**	0.046***	− 0.032	0.014	0.026	− 0.009	0.016	0.007
Population	0.005	0.004	0.004	0.050**	0.057**	0.058**	0.004	0.005	0.006	0.011*	0.015**	0.014**
Population density	− 0.440*	− 0.415*	− 0.417*	0.139	0.140	0.143	− 0.302	− 0.306	− 0.337	− 0.992**	− 1.047**	− 1.021**
Young people	135.5	124.7	117.3	214.2**	193.7*	172.4*	− 323.7**	− 320.3***	− 314.2***	− 346.2**	− 316.7*	− 325.6*
Old people	44.98	35.11	39.85	108.1*	107.9*	89.05	− 29.10	− 39.38	− 48.10	65.92	61.01	66.30
University education	274.9***	266.0***	270.6***	− 19.07	− 28.12	− 28.71	− 55.48	− 63.87	− 71.04	190.6	131.3	153.7
Subsidies	0.162***	0.158**	0.158***	0.045	0.043	0.045	0.730***	0.719***	0.717***	1.074***	1.061***	1.061***
Debt service				− 10.57	− 8.763	− 8.824	8.823	8.761	8.732			
Financial score							− 13.18	− 7.398	− 7.777			
Left-wing parties	− 358.2*	− 354.6*	− 291.0	298.6*	298.3*	312.7*	− 131.4	− 151.8	− 146.0	− 171.1	− 97.29	− 95.22
Party concentration	2088	1802	1699	− 735.5	− 793.6	− 768.2	6205*	5397**	5375**	5189*	3606	3649
Large city in neigh.				− 219.3*	− 216.8*	− 207.5*						
Constant	− 3143	− 2901	− 27776	− 3925	− 3633	− 3143	5118*	5023*	4944*	6588*	6527*	6531*
Log likelihood	− 1625	− 1721	− 1731	− 1554	− 1650	− 1656	− 1674	− 1778	− 1706	− 1734	− 1845	− 1854

	HD current spending			EP total spending			ALL total spending		
Neighborhood	WS20	WS25	WS30	WS20	WS25	WS30	WS20	WS25	WS30
β	0.077***	0.036*	0.010	− 0.012	− 0.002	− 0.010	0.001	0.002	0.001
Population	0.001	0.001	0.000	− 0.001	0.000	− 0.001	0.024*	0.025*	0.025*
Population density	− 0.329	− 0.127	0.021	− 0.361**	− 0.357**	− 0.352**	− 2.850**	− 2.673**	− 2.661**
Young people	− 86.82	− 55.07	− 56.27				− 539.4	− 516.7	− 523.5
People in prod. age				56.29*	59.18*	58.66*			
Old people	− 69.40	− 47.73	− 41.92				− 205.6	− 106.7	− 103.3
University education				87.19***	82.45***	85.08***	234.2	203.0	214.1
Subsidies	0.167***	0.157***	0.147***	0.003	− 0.005	− 0.006	1.479***	1.449***	1.446***
Debt service	6.044	4.61	4.31				38.31	38.54	38.60
Financial score	41.18**	35.70**	32.30*						
Left-wing parties	234.8	362.57*	361.20*	− 10.95	39.38	42.25	− 1057.2	− 929.7	− 917.8
Party concentration	5615***	5174***	5233***	475.4	373.6	355.0	9195	5902	5929
Large city in neigh.				− 104.4	− 117.3	− 120.9			
Altitude				− 1.141***	− 0.902**	− 0.992**			
Large city dummy				492.3***	439.8**	428.5**			
Constant	1222	763.9	907.2	− 2858	− 3101	− 2983	26795***	25996***	26043***
Log likelihood	− 1593	− 1697	− 1706	− 1470	− 1568	− 1548	− 1875	− 1995	− 2005

Note: *,**,*** denote significance at 10%, 5%, 1% level, respectively.