Institut d'Economia de Barcelona

Document de treball de l'IEB 2010/43

URBAN SPRAWL AND MUNICIPAL BUDGETS IN SPAIN: A DYNAMIC PANEL DATA ANALYSIS

Miriam Hortas-Rico

Fiscal Federalism

Documents de Treball de l'IEB 2010/43

URBAN SPRAWL AND MUNICIPAL BUDGETS IN SPAIN: A DYNAMIC PANEL DATA ANALYSIS

Miriam Hortas-Rico

Postal Address:
Institut d'Economia de Barcelona
Facultat d'Economia i Empresa
Universitat de Barcelona
C/ Tinent Coronel Valenzuela, 1-11
(08034) Barcelona, Spain
Tel.: + 34 93 403 46 46
Fax: + 34 93 403 98 32
ieb@ub.edu
http://www.ieb.ub.edu

URBAN SPRAWL AND MUNICIPAL BUDGETS IN SPAIN: A DYNAMIC PANEL DATA ANALYSIS [*]

Miriam Hortas-Rico

ABSTRACT: Urban sprawl has recently become a matter of concern throughout Europe, but it is in southern countries where its environmental and economic impact has been most severe. This low-density, spatially expansive urban development pattern can have a highly marked impact on municipal budgets. Thus, local governments may see sprawl as a potential source of finance, in terms of building-associated revenues and increased transfers from upper tiers of government. At the same time, sprawl leads to increased levels of expenditure, as it may raise the provision costs of certain local public goods and requires greater investment in extending basic infrastructure for new urban development. What, therefore, is the net fiscal impact of urban sprawl? Do local governments consider the long-run net fiscal impact of new urban growth or do they simply focus on its short-term benefits, ignoring future development costs? This paper addresses these questions by analysing the dynamic relationship between urban sprawl and local budget variables. To do so, we estimate a panel vector autoregressive model using data for 4,000 Spanish municipalities for the period 1994-2005. Computed Generalised Impulse Response Functions show: (i) that sprawl considerably increases demand for new infrastructure, (ii) that the capital deficit generated by this new infrastructure is covered in the main by intergovernmental transfers and, to a lesser extent, by revenues linked to the real estate cycle, and (iii) that sprawl leads to a short-term current surplus, as the increase in current revenues offsets the increase in current expenditures due to public service provision for new developments. Overall, these findings point to a moral hazard problem for local governments in which inordinate intergovernmental transfers and development revenues encourage excessive urban sprawl.

JEL Codes: H1, H72, R51

Keywords: Urban sprawl, local public finance, dynamic panel data.

Miriam Hortas-Rico
Universidad Complutense de Madrid & IEB
Departamento de Economía Aplicada VI
Facultad de Ciencias Económicas y Empresariales
Campus de Somosaguas - Ed. 6 - Dp. 2
28223-Pozuelo de Alarcón (Madrid)
E-mail: miriamhortas@ccee.ucm.es

[*] I acknowledge financial support from SEJ2006-15212 research funding. I am greateful to participants at several seminars and conferences, and in particular, I am indebted to Professor Albert Solé-Ollé for his excellent supervision and valuable comments.

1. Introduction

Since the mid-90s Spain has undergone intense urbanization. The country's cities have sprawled, resulting in a pattern of discontinuous, low-density urban development. According to data from the Spanish Ministry of Housing, some 600,000 dwellings per year were initiated between 1996 and 2005, a figure that almost doubled annual domestic demand for new homes[1]. Moreover, most of this building activity took the form of scattered, spatially-expansive urban growth. Consequently, between 1987 and 2005 the proportion of artificial land rose by 54.86%, reflecting primarily the expansion in land for new infrastructure and developments located at the urban fringe[2]. Yet, marked differences are evident in the spatial distribution of this growth across the country, with it being particularly intense in Mediterranean coastal areas (i.e., in the tourist zones of Catalonia, Valencia, Murcia, Andalusia and the Balearic Islands that had not been developed in the 80s, which grew, on average, by 50% during this period) and within the urban area of Madrid, where dispersed residential land grew, on average, by 25%[3].

Initially population growth was considered the main cause of sprawl, as cities needed to expand to accommodate new residents. However, over the last 20 years only moderate increases in population have been accompanied by a sizeable expansion of urban areas[4], suggesting that factors other than population growth are more likely to be driving the process today. Individual housing preferences combined with higher income levels, the reduction in transport costs and the improvement in road networks ensure that the demand for land at the urban fringe is in a constant state of growth (Mieskowski and Mills, 1993; Brueckner and Fansler, 1983; McGrath, 2005). Moreover, high levels of political fragmentation (Carruthers, 2002; Carruthers and

---

[1] Between 1996 and 2006 dwellings for about 16 million people were initiated in Spain (considering 2.84 residents per household), while the population grew by only 5.5 million people (Spanish Ministry of Housing and National Statistics Institute).

[2] Data provided by the *Corine Land Cover Project* (1990, 2000 and 2006), Spanish Ministry of Public Works.

[3] The increase in the proportion of developed land along the Mediterranean coast is basically the result of an increase in demand for second homes, while within the urban area of Madrid it reflects an increase in the mobility of the city's residents, attracted by lower housing prices, and with a preference for single detached homes and for the higher environmental quality of life available in areas surrounding the main city.

[4] As data from the European Environmental Agency (EEA, 2006) show, during this period population has grown by only 6 percent while built-up areas increased by 20 percent.

Ulfarsson, 2002) and competition between municipalities have also been instrumental (EEA, 2006)[5].

In Spain, however, various additional factors may be considered determinants of this change in land use: first, an economic growth model based on sectors with intense land-consumption demands, including construction, transport and tourism; second, the increasing foreign and domestic demand for second homes, motivated by rising income levels together with favourable mortgages and low interest rates[6], and encouraged by increasing speculation in the housing market (representing nearly one third of total housing demand); third, the considerable investment in public transport and infrastructure undertaken by public authorities over the last two decades; and, fourth, poorly defined land-use regulations together with the absence of control and intergovernmental coordination on matters relating to urban planning, which has given local authorities plenty of room to manoeuvre in their urban growth decision-making. Indeed, a number of studies recognise that the absence of region-wide cooperation and weak centralised urban planning policies result in excessive city growth (see, e.g., Carruthers and Ulfarsson, 2002). Finally, certain public subsidy and investment policies, in particular those whose design implies the allocation of resources according to the infrastructure deficit generated by population growth, seem to have fostered sprawl[7].

Urban sprawl can have several desirable outcomes ranging from the fulfilment of residents' preferences for larger, single-family detached housing and greater proximity to open spaces, to segregation from some of the problems that blight the inner city, such as pollution, crime and congestion. Despite its attractions, sprawl has been blamed for the social costs it incurs for an urban area, including traffic congestion, air

---

[5] Brueckner (2000, 2001), Brueckner and Kim (2003), Burchfield et al (2006), Burchell et al (1998, 2002), Glaeser and Khan (2004) and Nechyba and Walsh (2004), among others, also offer an explanation of the many factors that might be considered the driving force behind this phenomenon.

[6] Between 1990 and 2000 the number of second homes increased by 40%, as a percentage of total homes (Housing and Population Census, National Institute of Statistics).

[7] In Spain, land-use regulatory responsibilities are shared by different levels of government. The central government establishes the land-use regulation benchmark (as regards the protection of areas designated "non-developable"), while regional governments are responsible for passing municipal land-use plans. In practice, local authorities enjoy considerable freedom in determining a municipality's urban planning. During the 90s, increasing the land supply was deemed to be the remedy for excessively high housing prices, and so successive land-use reforms focused on facilitating the conversion of land from rural to urban uses (Fernández, 2008; Bilbao *et al*., 2006).

pollution, social segregation, loss of farmland and a reduction in open-space amenities, among others[8]. Consequently, the intensity and the impact of recent, rapid land-use change mean urban sprawl has become a contentious and widely-debated topic among academics, urban planners and the general public[9]. Specifically, one of the main costs of this phenomenon has been identified as the impact of sprawl on local public finance. This spatially expansive and low-density growth increases the provision costs of local public services, including refuse collection, police and fire protection, public transport and road cleaning services, given that sprawl tends to undermine scale economies and increase costs inefficiently (Carruthers, 2002; Carruthers and Ulfarsson, 2003, 2008). Spatially expansive development patterns are also associated with higher costs because of the considerable levels of investment required to extend basic infrastructure (roads, sewerage, electricity) over greater distances so as to reach relatively smaller numbers of residents (Carruthers, 2002). Yet, this new urban development pattern also seems to be a source of potential funds for Spain's local governments, in terms of revenues associated with building activity and increased grants from upper tiers of governments. Moreover, in the case of Spain, urban developers are under the obligation to hand over a portion of newly developed land to the municipality (Aguinaga, 2002; Fernández, 2008, Maldonado and Suárez-Pandiello, 2008). According to the data available, development revenues (i.e., planning permits, construction taxes, taxes on land value improvements, public land sales and asset revenues) grew considerably over the period 1994-2005, increasing their weight within total non-financial revenues by 10%[10]. As a result, these revenues have displaced the property tax and become the main and most attractive source of finance for local governments[11]. Additionally, the limited capacity of local management to obtain and handle resources means many municipalities face

[8] See Brueckner (2000, 2001), Downs (1999), Ewing (1997) Glaeser and Khan (2004) and Sierra Club (1998) for a review of the consequences of sprawl.

[9] See, for instance, EEA (2006), European Parliament (2009), Greenpeace España (2009). This relevance has also been recognized in press, i.e. the articles "La costa es ya un cementerio de hormigón" (El País 27/07/2009) and "El satélite que divisó el ladrillo" (El País 13/04/05).

[10] Note that neither the tax on land value improvements nor the construction tax is likely to be justified from an economic point of view. However, as explained in Slack (2006) and Bird and Slack (1991), local governments levy development charges to cover the growth-related costs associated with new development. These charges provide the municipality with revenues to finance the infrastructure needs arising from this growth. Therefore, the existence of such charges is justified on the ground that growth should pay for itself rather than being a burden for existing taxpayers. See also Brueckner (2001) for further details on the internalisation of the full costs generated by new developers.

[11] See Pou (2007) and the article "Las grandes ciudades españolas apoyan sus ingresos en el negocio urbanístico" (Expansión 22/05/2007).

financial difficulties as they strive to satisfy their residents' demands. This being the case, sprawl can be a good funding instrument for municipal authorities[12].

In the light of the above, it might be concluded that as land-use changes occur, the balance of municipal revenues and expenditures changes as well. Given this relationship, local authorities need to be aware of the long-term financial implications of their land-use decisions and the need to re-examine the role played by state and regional governments in regulating the outcome of this growth pattern. Thus, this paper seeks to provide evidence regarding the net fiscal impact of sprawl on local public finance. The availability of disaggregated budget data at the local level for 4,000 Spanish municipalities for the period 1994-2005 allows a dynamic analysis to be undertaken, based on the estimation of a panel vector autoregressive model. We first explore how sprawl interacts with local budgets by breaking the non-financial deficit down into several components: current spending, tax revenues, current transfers, capital spending, capital transfers and development revenues. Unobserved individual effects and a set of time dummies are included in all the regressions. The estimation procedure relies on the application of GMM techniques in order to ensure consistent and efficient estimates. Having been correctly specified, the model allows the Generalised Impulse Response Functions to be computed, so as to determine the way in which municipal budgets adjust to an urban sprawl shock and the role that is played by upper tiers of government in this process. Overall, with these findings we seek to contribute to the existing empirical literature on the consequences of sprawl, as well as orienting public policy in terms of its local land-use decision-making.

The rest of this article is organized as follows. In the next section we provide a brief overview of the empirical literature analysing the fiscal impact and the dynamics of municipal finances. In the third section we outline the analytical framework. The fourth section describes the methodology and the data used in carrying out the empirical analysis, and discusses the main results. Finally, the last section concludes.

---

[12] In fact, a preliminary analysis of the data showed that localities facing higher financial burden and lower net savings in the early 90s fuelled urban expansion more intensely than did those without such financial problems.

2. Previous literature

A review of the literature indicates that the research question raised here has not been previously addressed. The most similar studies are perhaps those that undertake fiscal impact analyses - a method that estimates the likely cost-revenue impact of a particular land-use development pattern based upon recent experiences in a given location. This tool was standardized by Burchell and Listokin (1978) and has subsequently been widely adopted by local policy-makers in making their land-use decisions[13]. Drawing on these methods, analysts determine the net difference between the public expenditures that is likely to be incurred when providing roads and other services to a new urban development and the corresponding revenues. They also examine the fiscal impact of alternative development scenarios (e.g., testing different densities or spatial patterns).

However, only a handful of studies have used cost functions derived from cross-section regression analyses to determine the impact of either population growth (Ladd, 1992, 1994) or alternative residential developments (Carruthers, 2002; Carruthers and Ulfarsson, 2003, 2008; Heikkila and Craig, 1991; Kelsey, 1996; Bunnell, 1998;) on the fiscal position of local governments. For the Spanish case, only Hortas-Rico and Solé-Ollé (2010) have analyzed the impact of this urban development pattern on the provision costs of certain local public services. They provide evidence of the positive and non-linear impact of low-density development patterns on the provision costs of various local public services. In particular, their results suggest that in municipalities with a spatially expansive urban development pattern, the provision costs of public services increase initially as a result of rising road construction costs and general administration costs, and then, as the urban sprawl advances, costs continue to rise as a result of increasing expenditure in the provision of community facilities, housing, local police and culture.

As noted above, however, an impact on local revenues can also be expected, and as such the net fiscal impact on local budgets remains undetermined. Any analysis of the impact of sprawl on local budgets should be undertaken using a dynamic panel data approach, since the effect on expenditures and revenues might present a different time profile. The typical way to proceed involves examining the intertemporal linkages

[13] See Kotchen and Schulte (2009) for further details.

between the variables of interest. This implies analysing vector autoregressive models in a panel data framework, combining the tools that are typically adopted in a time series context with the techniques applied to panel data models.

A few empirical studies have been undertaken with a sole focus on the intertemporal linkages of a local budget. The first to address this issue was Holtz-Eakin *et al.* (1988), in which the authors described an instrumental variables technique to estimate and test panel vector autoregression models with unobserved heterogeneity. Subsequently, several authors have implemented this technique in analysing local government behaviour. Holtz-Eakin *et al.* (1989), Dahlberg and Johansson (1998, 2000), Moisio and Kangasharju (1997) and Moisio (2000), using US, Swedish and Finnish municipal data, respectively, provide evidence of significant intertemporal linkages over a short-time period between budget variables. In the case of Spain, Solé-Ollé and Sorribas (2009), in line with a few other papers (Buettner and Wildasin, 2006; Buettner, 2007), examine whether local government budgets undergo any adjustments following a budget shock, focusing on the role played by intergovernmental grants in this process. The paper, therefore, adopts the same theoretical framework, but addresses a quite distinct question regarding the dynamic relationship between local budgets and urban sprawl. Moreover, here we work with richer data, in terms of both the number of locations included in the sample and the level of disaggregation of the budget data.

3. The Spanish Municipal Sector: an overview.

Spain is a decentralized country composed of three different levels of government: the central government, 17 regional governments named Autonomous Communities and about 8,000 local governments. The latter are characterized by their high degree of fragmentation (about 60% of existing municipalities have fewer than 1,000 inhabitants and represent just 5% of the total population), which implies a structure of many independent units of government with very small populations, and limited public resources and management capacity. Table 1 summarizes the composition and evolution of local budgets in Spain during the period considered in the present study.

*The expenditure side***.** In Spain, the responsibilities assumed by local government are distributed in accordance with a population headcount, i.e., national legislation establishes the services that municipalities must provide their residents according to their size. The public provision of basic services (refuse collection, street cleaning, water supply, sewer system and street lighting, among others) is compulsory for all municipalities. Then, as the population rises, a number of other responsibilities have to be assumed: parks, public libraries, solid waste treatment, local police, social services, public transport and environmental protection. In practice, municipalities tend to provide more services than are actually required by law so as to satisfy residents' demands. Note, however, that the list of responsibilities assumed by Spain's local governments is limited to very traditional functions performed elsewhere and does not extend to include services that consume large amounts of resources, such as education, health or social services.

The revenue side. The local provision of these public services is financed primarily from local taxes (which include the property tax, local business tax and local motor vehicle tax) and the non ear-marked grants that local governments receive from upper levels of government. In fact, direct taxes, user charges and current transfers account for more than 60 percent of total municipal revenues (see Table 1).

Yet, the limited management capacity of local government to obtain and handle resources means that many municipalities face financial difficulties when trying to meet their expenditure needs. On the one hand, Spanish local governments are able to modify the tax rates of all the taxes assigned to them, albeit subject to compulsory minimum tax rates and ceilings set by the central authority. However, the main local taxes (property tax, business tax and motor vehicle tax) have fairly inelastic tax bases and are considered inequitable and, as such, are somewhat unpopular, impeding municipalities from making any short-term adjustments. On the other hand, local debt is limited since 2001 by compliance to the Budget Stability Law. Thus, a number of local governments maintain the investment levels required to satisfy their residents' demands by relying either on immediate financing derived from urban expansion or on transfers from upper tiers of government[14].

[14] Note that grant financing has several associated perils, in terms of moral hazard problems (so that local governments, aware that intergovernmental grants insure against budget shocks, tend to implement overly risky policies), incentives to soften budget constraints (providing in their turn incentives to run up excessive local deficits which authorities assume will be covered by future grants), the diffusion of accountability or the stimulation of rent-seeking and clientelism (see Devarajan *et al.*, 2009, and Persson and Tabellini, 1997, for more comprehensive explanations).

However, it would appear that the decision to depend on building activity as a source of finance is not a consequence of the failure of other fiscal sources to generate revenues but a local political option. In other words, municipal authorities have not reached their tax autonomy ceiling as determined by other taxes but rather they have opted to increase their dependence on immediately significant and less unpopular revenues linked to the real estate cycle.

Table 1. Municipal budgets in Spain, 1994-2006 (%)

	1994	**2005**
(a) Local Non-financial Expenditures		
Current Expenditure:		
I. Wages and salaries	30.41%	29.93%
II. Purchases of goods and services	24.36%	30.14%
III. Debt service	6.92%	1.51%
IV. Current grants	6.07%	7.47%
Capital Expenditure:		
VI. Real investment	*17.17%*	23.03%
VII. Capital grants	2.07%	2.73%
Total	87.01%	94.82%
(b) Local Non-financial Revenues		
Current Revenue:		
I. Direct taxes	27.20%	26.69%
Property taxes	13.96%	15.23%
Motor vehicle taxes	4.46%	4.61%
Tax on land value improvements	1.84%	3.05%
Business taxes	6.60%	3.01%
II. Indirect taxes	2.58%	5.53%
Construction taxes	2.55%	4.65%
III. User charges (includes planning permissions)	16.19%	17.56%
IV. Current transfers	27.69%	26.50%
V. Asset revenues	2.06%	2.36%
Capital Revenue:		
VI. Real investment sales (includes public land sales)	2.12%	6.42%
VII. Capital transfers	6.02%	7.31%
Total	83.87%	92.37%
Development revenues	14.2%	23.5%

Notes: (i) Economic classification of Spanish municipal budgets by sections. (ii) *Development revenues* include taxes on land value improvements, construction taxes, planning permits, asset revenues and public land sales.
Source: Spanish Ministry of Economy.

As a result, more volatile sources of revenue have replaced the property tax as the main source of municipal finance. As can also be seen in Table 1, development revenues have increased considerably over the past fifteen years, almost doubling their share within local non-financial revenues. The same can be said of intergovernmental capital grants, the role of which has also been enhanced as a source of municipal revenues over the period considered[15].

4. Econometric model and estimation method

As stated above, the aim of this paper is to investigate the dynamic relationship between public finance and urban sprawl at the municipal level. A vector autoregressive methodology is suited to this purpose given the absence of an a priori theory regarding the relationship between the variables in the model [16]. The methodology is based on a framework that allows all variables to be considered as endogenous within a system of equations, in which the short-run dynamic relationships can subsequently be identified (Lutkephol, 2005)[17].

Thus, the model for testing this hypothesis is very similar to that adopted in Holtz-Eakin *et al*. (1989) and in Dahlberg and Johansson (1998, 2000) for analyzing the intertemporal linkages between local budget variables. According to these papers and assuming endogenous urban sprawl, the reduced form of a panel vector autoregressive model can be expressed, using matrix notation, as follows:

$$X_{it} = \alpha_{0t}^{X} + \sum_{j=1}^{p} \phi_j^X X_{i,t-j} + f_i^X + u_{it}^X \qquad (1)$$

[15] In Spain, nearly all current transfers originating from central government are non-earmarked (primarily the Revenues Sharing Grant), while most current transfers from the ACs are ear-marked (transfers for which each municipality must apply in order to access funding). Besides, capital transfers are ear-marked grants that mainly finance capital expenditure projects proposed by local governments. Since no general funds are provided in Spain to pay for facilities and infrastructures, the ACs have set up Local Works Programs. Their goal is to co-operate in the provision of facilities and services that are of municipal competence. The municipality needs to present a project in response to a regular invitation and, if accepted, the grantor covers a proportion of the project's costs. The allocation of these funds is highly discretional on the part of the grantor, and they usually serve to compensate communities in financial trouble, especially the small ones, whose expertise and technical capability is sometimes limited.

[16] As noted in Greene (2006), VARs are not just the reduced form of a structural model, since researchers report that simple, small-scale VARs without a possibly flawed theoretical foundation have proved as good as, or better than, large-scale structural equation systems.

[17] Note that a cross-sectional analysis only captures the contemporaneous impact of the variables, while working with panel data allows the researcher to investigate the dynamics of the process, as it considers both inter-individual differences and intra-individual dynamics. Moreover, dynamic panel data models, in which lagged values of the dependent variables are included as regressors, also take into account the short-run reactions of the variables included in the model.

where X_{it}=(CD_{it}, KD_{it}, $sprawl_{it}$)' is the vector of jointly determined dependent variables, in which $sprawl_{it}$ denotes the urban sprawl measure and CD_{it} and KD_{it} are current and capital non-financial deficit respectively. The subscripts *i* denote cross-sectional units (municipalities), $i = 1, \ldots, N$, subscripts *t* time periods, $t = (p+1), \ldots, T$, and *p* the lag length. α_{0t} is the time dummy, included in the model to account for common shocks that affect all municipalities in the same way[18], ϕ_j is the *m* x *m* coefficient matrix, where *m* is the number of endogenous variables, f_i is the unobserved heterogeneity or individual effect that controls for municipal specific characteristics and u_{it} is the idiosyncratic error, assumed to be white noise and independent across individuals[19].

In order to disentangle the adjustments made by the various budget components to an urban sprawl shock, we present an extended specification of the model given by expression (1), by disaggregating each component of the non-financial deficit.
Let the non-financial deficit (NFD_{it}) be defined by the following expression:

$$NFD_{it} = CD_{it} - KD_{it} = (CE_{it} - TX_{it} - CT_{it}) - (KE_{it} - KT_{it} - DR_{it}) \qquad (2)$$

where CE_{it} denotes current expenditures, TX_{it} tax revenues, CT_{it} current transfers, KE_{it} capital expenditures, KT_{it} capital transfers and DR_{it} development revenues[20].
According to (2), the model given by (1) can be reconsidered so that the following model can be specified:

$$W_{it} = \alpha_{0t}^{W} + \sum_{j=1}^{p} \phi_j^{W} W_{i,t-j} + f_i^{W} + u_{it}^{W} \qquad (3)$$

where W_{it}=(CE_{it}, TX_{it}, CT_{it}, KE_{it}, KT_{it}, DR_{it}, $sprawl_{it}$)'.

[18] The inclusion of year-fixed effects in the specification should control for all common innovations in municipalities and, hence, estimation results should only capture how idiosyncratic shocks on sprawl affect the budget variables of the system. This could be a problem if the sprawl shocks were common to all municipalities. However, we do believe this is not the case, since a preliminary analysis of the data shows that the sprawl impact differs according to localities.
[19] In the reduced form all right-hand side variables are predetermined at time *t*. As there are no time *t* endogenous variables included as regressors, any variable has a direct contemporaneous effect on the other variables of the system. However, since the vector of innovations may be contemporaneously correlated, a shock to an equation affects all other endogenous variables in time t, as is shown when computing the Generalised Impulse Response Functions.
[20] The composition of each of these variables is explained in the *Data Section*. See the previous section for further details on the *Development Revenues* variable.

Therefore, the model given by expression (3) disaggregates the non-financial deficit into six different components (CE_{it}, TX_{it}, CT_{it}, KE_{it}, KT_{it} and DR_{it}). The breaking down of the two non-financial deficit components allows us to investigate in detail how both the current and capital deficits adjust to an urban sprawl shock. In other words, we are able to see whether an increase (decrease) in the current deficit resulting from a sprawl shock is attributable to an increase (decrease) in current spending or a decrease (increase) in tax revenues or current transfers. Likewise, an increase (decrease) in the capital deficit might respond to an increase (decrease) in capital spending or alternatively to a decrease (increase) in capital transfers or the revenues associated with building.

4.1. Econometric procedure

Omitting f_i from the above regressions results in inconsistent estimates, since it correlates with the right-hand side variables. In this context, a common way to proceed is to get rid of the fixed effect by taking the first differences in the above model. Since u_{it} is white noise, this transformation introduces a first-order moving average process in the new residual term that creates an endogeneity problem in the equation. Thus, an instrumental variable approach has to be applied so as to ensure consistent estimates[21]. The orthogonality conditions satisfied by u_{it} can be used to identify the parameters of the model, given that Δu_{it} is uncorrelated with $X_{i,t-1}$ for s ≥ 2. Hence, the values of lagged variables can be used to define the matrix of possible instruments for the equations in first differences, say Z_{it}, so that $E[Z_{it}\Delta u_{it}] = 0$ and $E[X_{it}\Delta u_{it}] \neq 0$.

Provided that this is an overidentified case, efficiency requires that we use all available instruments by means of the Generalised Method of Moments (GMM) rather than a simple Instrumental Variables (IV) or Two Stage Least Squares (2SLS) approach[22]. In the case of fixed-effect dynamic panel data with a large cross-section observed over a short time period, Holtz-Eakin *et al.* (1988) and Arellano and Bond (1991) developed an estimator that uses all available lagged values of the variables in levels at each time

[21] In micro panel data models, i.e. large N and short T, where lagged dependent variables are included as regressors, the within groups estimator gives inconsistent estimates (Nickell, 1981). Besides, applying pooled OLS, which omits the unobserved heterogeneity, would be inconsistent as well.

[22] The IV estimator, proposed by Anderson and Hsiao (1982), uses values of the variables in levels or in differences lagged two periods as instruments. This procedure leads to consistent but inefficient estimates, since not all moment conditions are used and the serial correlation structure in the residuals is not taken into account.

period as instruments in the first-differenced equation. But, as noted in Arellano and Bover (1995) and Blundell and Bond (1998), the lagged values of the dependent variable may be weak instruments for the first differences when the series is particularly persistent, i.e. when the variables are close to a random walk. In this case, it is better to implement the system-GMM estimator in order to avoid possible biases. This estimator combines the moment conditions for the equations in first differences with additional moment conditions for the equations in levels. In particular, under the additional assumption that past changes of the instrumented variables are orthogonal to the current error term in levels, it is possible to use instruments in levels for the first-differenced equations and first-differenced instruments for the equations in levels (Arellano, 2003; Roodman, 2007, 2008).

Finally, the model is estimated equation by equation. As Baltagi (1995) stated, even though the innovations may be contemporaneously correlated, this procedure is asymptotically efficient and joint estimation does not improve efficiency since the set of regressors is the same in each equation.

4.2. Generalized Impulse Response Functions

Estimated coefficients from the reduced form of the model above can be used to implement dynamic simulations by means of the generalised impulse response functions (GIRFs hereinafter), as described in Pesaran and Shin (1997). GIRFs measure the adjustment pattern of each endogenous variable in a dynamic system in reaction to a shock, which is either to itself or to any other endogenous variable. An initial advantage of these impulse response functions is that they take into account the historical observed distribution of the residuals, i.e. they do not analyse the effect of a shock on a variable assuming that the other variables remain constant, but rather consider the correlation between the endogenous variables of the system. Moreover, they overcome the main shortcoming of traditional 'orthogonalized' impulse response functions (Hamilton, 1994), as they are invariant to the ordering of the endogenous variables in the vector autoregressive model.

Hence, denoting the known history of the economy up to time t-1 by Ω_{t-1} and letting δ_j be the shock on the jth equation, the GIRF of X_t at horizon n is defined by

$$GIRF_x\left(n, \delta_j, \Omega_{t-1}\right) = E\left(x_{t+n} \mid u_{jt} = \delta_j, \Omega_{t-1}\right) - E\left(x_{t+n} \mid \Omega_{t-1}\right) \quad (5)$$

Note that this expression establishes that the GIRF for the endogenous variables vector x_t, n periods ahead, is the difference in the expected value of x_{t+n} when taking δ_j shock into account. As shown in Pesaran and Shin (1997), under the assumption of normally distributed errors, the scaled GIRF of the effect of one standard error shock to the *jth* equation at time t on x_{t+n} is given by

$$\psi_j^g(n) = \sigma_{jj}^{-1/2} A_n \Sigma e_j \quad n = 0, 1, 2, \ldots \qquad (6)$$

where A_n denotes the MA coefficient matrix at $t+n$, e_k is m x 1 the selection vector with unity as its kth element and zero elsewhere.

5. Data

5.1. The sample

The previous specification (expression 3) was estimated using a wide dataset of Spanish municipalities covering the period 1994-2005[23]. The first year (1994) was not selected randomly, but rather determined by data constraints, given that the data required to construct the urban sprawl variable was not available prior to this year. Nonetheless, the period of study is particularly relevant to the aim of this paper, since in the mid-90s the Spanish housing market started to recover, leading to a period of intense urban expansion that has driven the Spanish economy until recent years.

Note that the analysis of the relationship between urban sprawl and budget variables must be conducted at the local level. This is because policy decisions concerning urban planning are taken principally by municipal governments, while sprawl affects the revenues and expenditures that fall primarily under the control of local authorities. Moreover, as Holtz-Eakin *et al.* (1989) and Dahlberg and Johansson (1998) point out, the availability of budget data at the local level represents an improvement with respect to earlier studies where national data had to be used and avoids our having to deal with stabilisation and aggregation problems. In the first instance, cyclical adjustments had to be made to take into account the stabilization activity in which the central government was involved, while in the second, the

[23] Note that, since the panel has only 12 years of data, conclusions cannot be drawn regarding long-run budget dynamics but it is possible to analyse the short-term effects of sprawl shocks.

analysis of local government behaviour via national data obviously added an aggregation problem to the estimation.

Next we briefly describe the variables included in the model. Descriptive statistics and definitions are provided in Table 2.

5.2. Budget variables

Spanish local budgets are classified in terms of revenues and expenditures sections (see Table 1). Here, the budget variables have been constructed similarly in accordance with the nature of revenues and expenditures, using the data provided by the Spanish Ministry of Economy and Finance. Hence, *Current Expenditures* (CE_{it}) are defined as the sum of expenditures on public wages, the purchase of goods and services, debt service and current transfers, and *Capital Expenditures* (KE_{it}) as the sum of real investments and capital transfers. On the revenues side, we consider *Current Transfers* (CT_{it}), *Capital Transfers* (KT_{it}), *Tax Revenues* (TR_{it}) - including direct and indirect taxes as well as user charges, and *Development Revenues* (DR_{it}), defined as the sum of revenues from the sales of public land, asset revenues and all taxes associated with building (planning permissions, construction taxes and taxes on land value improvements). Note that this last variable includes revenues that might be considered as being more closely linked to the real estate cycle (and as such they are highly volatile), regardless of the current revenues status of some of them. All budget variables have been deflated using the regional Consumer Price Index and are expressed in per capita terms[24].

The use of more accurately defined budget variables is essential here, since the standard aggregation of budget data implemented in studies elsewhere might well result in misleading interpretations of our results, especially on the revenues side. To date, current and capital revenues, which respectively include own revenues and current transfers, and public land sales and capital transfers, have been considered. Thus, a positive impact of urban sprawl on current revenues can be interpreted as follows: this spatially expansive urban development pattern increases the ability of municipal authorities to generate revenues, but at the same time it requires higher levels of government to cover their additional costs by increasing transfers to municipalities.

[24] Both the Consumer Price Index and population data have been obtained from the Spanish National Statistics Institute. The latter corresponds to the Population Census undertaken at the beginning of each year.

Similarly, higher levels of capital revenues in cities with greater urban sprawl can be explained as the additional revenues generated by urban expansion, as well as being the result of higher capital transfers from upper tiers of government to growing municipalities. Therefore, these definitions needed be modified to enhance their precision.

Table 2. Descriptive statistics of the variables

Variable	*Mean*	*Std. Dev.*	*Definition*
$\boldsymbol{NFD_{it}}$	-8.369	154.365	$CD_{it} - KD_{it}$
$\boldsymbol{CD_{it}}$	-0.109	110.878	$CE_{it} - TX_{it} - CT_{it}$
CE_{it}	444.948	209.478	Sections I, II, III, IV of Expenditure Budget
TX_{it}	243.219	163.394	Sections I, II and III of Revenue Budget (minus UR_{it})
CT_{it}	201.797	104.572	Section IV of Revenue Budget
$\boldsymbol{KD_{it}}$	-8.259	168.503	$KE_{it} - KT_{it} - UR_{it}$
KE_{it}	269.862	334.336	Sections VI and VII of Expenditure Budget
KT_{it}	164.293	292.395	Section VII of Revenue Budget
DR_{it}	113.842	155.692	Sub-sections 1.1.4, 2.8.2, 3.6, 3.9, and Sections V and VI of Revenue Budget
$\boldsymbol{Sprawl_{it}}$	224.115	140.738	Built-up area per capita

Notes: (a) The definition of the fiscal variables is based on the economic classification of the Spanish budget by sections (see Table 1). (b) All budget variables are deflated using the regional Consumer Price Index, expressed in € 2005 and scaled in terms of population size. (c) Sprawl variable is measured in per capita square metres.
Sources: Spanish Ministry of Economy and Finance, Spanish National Statistics Institute and Spanish Property Assessment Office.

5.3. Urban Sprawl variable

Obtaining a reliable specification of urban sprawl is complicated by both the lack of consensus as to its definition and obvious data constraints. Thus, most empirical studies use variants of population density to measure sprawl (see Ladd, 1992). Yet, this single measure, while easy to compute, might not be sufficiently informative to describe the full spatial dimension of urban sprawl. For this reason, some researchers have sought to introduce additional measures so as to characterize more fully this particular pattern of urban development (see, for instance, Carruthers and Ulfarsson, 2003, 2008; Burchfield *et al.*, 2006).

In line with the literature, urban sprawl is considered here as a growth pattern that is characterized by the excessive spatial expansion of urban land. Indeed, sprawl reflects the over-consumption of land per person rather than simple urban expansion or population growth and, hence, it is proxied here using a density variable (defined as $sprawl_{it}$) that represents per capita built-up area. Note that a consideration of administrative boundaries as the definition of consumed land area is not particularly useful as the municipal limits may include a large amount of vacant land or even non-developable land. The only way to obtain a meaningful measure of density requires using the built-up area devoted to urban activities[25]. Note also that, as explained in Carruthers and Ulfarsson (2008), total municipal land area is held constant, so the percentage of local land area that is developed measures the spatial extent of development or, in other words, the horizontal dimension of sprawl.

6. Estimation results

In this section we present the estimation results for the specification given by expression (3).

6.1. Model specification

Before estimating the model, it is important to verify its proper specification in terms of optimal lag length. To do so, and adopting a general-to-specific approach, we selected a sufficient lag length to ensure there was no serial correlation in the error terms of the first-differenced equations[26]. In line with previous studies (see Holtz-Eakin *et al.*, 1989, Dahlberg and Johansson, 1998, 2000) we initiated the analysis with a

---

[25] In Spain, urbanized land is defined as the total amount of land that is legally recognized as having been developed or which is available for development in each municipality. As such it includes both the built-up and the non built-up areas available for construction purposes. The use of data on built-up area represents an improvement with respect to previous studies where total urbanized land is used instead, and has been obtained from the Spanish Property Assessment Office. Unfortunately, there is no data available for other measures (including percentage of residential houses, percentage of scattered population or number of population centres per municipality) for the whole period considered. Thus, per capita built-up area remains the only data source currently available for comparing land use patterns across the country as a whole.

[26] The tests for serial correlation are provided by the m1 and m2 statistics developed by Arellano and Bond (1991), which are asymptotically distributed as N(0,1). The residuals in levels must be uncorrelated, which implies that those in the first-differenced equation can exhibit serial correlation of order one but not of order two. In other words, an AR(1) process is expected in the first-differenced residuals since $\Delta u_{it}=u_{it}-u_{i,t-1}$ and $\Delta u_{i,t-1}=u_{i,t-1}-u_{i,t-2}$ share a common term, $u_{i,t-1}$. By contrast, an AR(2) process indicates autocorrelation in the first-differenced residuals, since $u_{i,t-1}$ from $\Delta u_{it}=u_{it}-u_{i,t-1}$ and $u_{i,t-2}$ from $\Delta u_{i,t-2}=u_{i,t-2}-u_{i,t-3}$ are related. In practice, m1 is expected to be significant but not m2.

three-year dynamic process and then tested for a possible reduction in the number of lags in all the equations simultaneously.

As the results in Table 3 show, we found first-, though not second-, order correlation in the residuals from the first-differenced equations, indicating that there is no serial correlation in the residuals in levels[27].

Once the model has been correctly specified, the next step involves testing the possibility of shortening the lag length, by excluding one lag at a time from all regressors. As noted in Dahlberg and Johansson (2000), this can be achieved by initiating a sequential procedure by means of the difference-Hansen statistic (see also Arellano and Bond, 1991). This statistic is computed as the difference between the values of the Hansen test in both the restricted and the unrestricted models[28]. Results are presented in Table 4.

Table 3. Autocorrelation Tests for the initial model specification. p=3, N=1,120, T=12 (1994-2005)

	m1	m2
$Sprawl_{it}$	-2.88 [0.004]	0.31 [0.755]
CE_{it}	-1.58 [0.115]	0.19 [0.852]
TX_{it}	-0.93 [0.354]	-1.69 [0.091]
CT_{it}	-1.39 [0.163]	-0.57 [0.570]
KE_{it}	-3.68 [0.000]	1.63 [0.103]
KT_{it}	-4.82 [0.000]	-0.35 [0.729]
DR_{it}	-1.23 [0.219]	-1.66 [0.100]

Note: Results obtained after one-step system-GMM estimation using asymptotic values. P-values in parentheses. m1 and m2 are the Arellano-Bond tests for AR(1) and AR(2) processes in the first-differenced residuals, respectively.

[27] We expect an AR(1) process in the first-differenced residuals since $\Delta u_{it}=u_{it}-u_{i,t-1}$ and $\Delta u_{i,t-1}=u_{i,t-1}-u_{i,t-2}$ share a common term, $u_{i,t-1}$.

[28] The Hansen test is an overidentifying restrictions test provided after system-GMM estimation. Under the null of valid instruments, the test is asymptotically χ^2-distributed with k-n degrees of freedom, where k is the number of instruments and n is the number of estimated parameters (see Arellano and Bond, 1991; Arellano, 2003). Thus, the difference-Hansen statistic is asymptotically χ^2-distributed with m_R-m_U degrees of freedom, where m_R and m_U are the degrees of freedom of the restricted and the unrestricted model, respectively. Note that the restricted model is the one with the longer lag length, since using more instruments is equivalent to imposing more assumptions (in terms of moment conditions) while in the unrestricted model only a subset of instruments is used.

The p-value of the difference-Hansen statistic indicates that the model can be shortened to two lags but not any further[29]. Hence, the equations for the model considered here require a specification with only two lags in order to capture the whole dynamics of the process.

Table 4. Reduction of lag length: p=3, N=1,120, T=12 (1994-2005)

Equation	Lag reduction	Difference-Hansen statistic
$Sprawl_{it}$	3 → 2	2.98 [0.3947]
	2 → 1	2.17 [0.5378]
CE_{it}	3 → 2	3.76 [0.5844]
	2 → 1	15.35 [0.0177]
TX_{it}	3 → 2	12.96 [0.075]
	2 → 1	20.08 [0.0012]
CT_{it}	3 → 2	1.22 [0.7482]
	2 → 1	8.77 [0.0325]
KE_{it}	3 → 2	1.96 [0.1615]
	2 → 1	24.3 [0.0020]
KT_{it}	3 → 2	9.93 [0.6221]
	2 → 1	19.03 [0.0399]
UR_{it}	3 → 2	10.75 [0.1499]
	2 → 1	30.76 [0.0001]

Note: p-values in parentheses.

6.2. Response of budget variables to a sprawl shock

Note that the reduced form depicted in equation (3) is a pure forecast model, as it is a reflection of the true but unknown structural model. This implies refraining from the analysis of individual coefficients after system-GMM estimation since neither their sign nor their magnitude has any causal interpretation in a vector autoregressive context (i.e. the lagged effects of a particular variable tell us nothing about their contemporaneous correlation)[30].

[29] The Sprawl equation could be reduced to one lag, but this would imply serial correlation. For this reason we do not reduce the model specification to one lag.

[30] The estimation was performed using one step system-GMM estimation, given that the two-step estimated standard error tends to be downward biased and, hence, unreliable (see Arellano and Bond, 1991; Bond, 2002; Roodman, 2008). Note also that a correction to the standard errors was applied. The set of equations included in the model passed both the autocorrelation tests and the test for the validity of instruments. Estimation results are shown in the Appendix.

However, the estimation of a vector autoregressive model does provide us with certain insights into local government behaviour and the adjustment pattern of all municipal budget components to a shock in the sprawl equation by means of the computed GIRFs[31]. These are summarized in terms of average responses at present values[32] and are shown in Table 5. Note that each row describes the impact of one standard error shock on the sprawl equation for each local budget component (in 2005 € per capita). Several interesting findings emerge from the analysis of these results.

First, urban sprawl generates both a current and a capital surplus in the short-run, which tend to disappear over time, although only the former was found to be statistically significant. More specifically, one standard deviation of sprawl (which represents 141 per capita square metres and about a 60% increase in Spanish average sprawl levels[33]) generates a current surplus and a capital surplus of 5.26 and 8.02 € per capita, respectively. Second, sprawl leads to a considerable increase in current expenditures. In fact, when a municipality undergoes urban sprawl, local politicians extend public goods and services to the new developments located at the urban fringe, leading to an increase in local current expenditure. However, this increase in current expenditures is offset to a slightly greater extent by increases in current revenues (other than those associated with building), which in this instance are mainly operating transfers. Specifically, one standard deviation shock to sprawl leads to an increase in current expenditures of 5.89 €, an increase in tax revenues of 5.22 € and an increase in current transfers of 5.93 €, all in per capita terms. In other words, a 60% increase in sprawl increases current expenditures, tax revenues and current grants, on average, by 1.32%, 2.15% and 2.94%, respectively. Third, the impact of sprawl on capital spending was particularly high, with a 60% increase in sprawl resulting in a 6.7% increase in capital expenditures. This result suggests that the sprawled growth of cities requires heavy investment in infrastructure to maintain a given level of provision of public goods and services for all residents in a jurisdiction. Note that these findings are in line with those obtained in Hortas-Rico and Solé-Ollé (2010) who provide evidence of the additional costs generated by the spatially expansive growth of Spanish municipalities. More

[31] According to the empirical literature, the estimation of a micro panel vector autoregressive model of this type requires computing the GIRFs for a short reaction period (7 years in our case). For a robustness check, longer time horizons were applied yielding similar results. The bootstrapped standard errors of the GIRFs were computed by conducting 500 replications with replacement. Then, the 5^{th} and 95^{th} percentiles of this distribution were used as confidence intervals for the impulse responses.

[32] The discount tax rate was fixed at 3%.

[33] The mean and standard deviation of all variables are shown in Table 2.

specifically, their findings suggest that, among all the public services analysed, the greatest costs are those incurred from extending roads and basic infrastructure to new housing developments[34].

Table 5. Present value of GIRFs

Response of	*Innovation to sprawl (absolute values)*
CD	-5.26 [1,42]***
CE	5.89 [0.79]***
TX	5.22 [0.57]***
CT	5.93 [1.01]***
KD	-8.02 [7,85]
KE	18.09 [6.41]***
KT	15.68 [3.97]***
UR	10.44 [1.47]***
NFD^{+}	-13.27 [7,96]*
Sprawl	26.47 [3.07]***

Notes: (i) Bootstrapped standard errors shown in brackets: 1000 replications with replacement; (ii) ***, ** and * denote statistically significant coefficients at the 99%, 95% and 90% levels, respectively; (iii) CD, KD and NFD have been computed manually according to expression (2).

Yet, capital grants from upper tiers of government and development revenues increase in order to meet the new demands for infrastructure (by 15.68 and 10.44 € per capita, respectively, which represent about a 10% increase in average values for both budget components) resulting in a capital surplus of 8.02 € per capita. Thus, these results show that development revenues play an important role in covering the extra capital expenditures generated by new infrastructure needs. In other words, this urban development pattern increases the ability of municipal authorities to generate revenues (through construction taxes, planning permits and taxes on land value improvements, among others). However, these revenues, which can be immediately generated, do not cover all additional facilities and infrastructure needs so that eventually grant financing is also required for the adjustment.

[34] A 1% increase in sprawl raises *Basic Infrastructures and Transportation* costs by 0.28%, *Community facilities* costs by 0.11%, *Local police* costs by 0.10%, *Housing and community development* costs by 0.08%, *Culture and sports* costs by 0.17% and *General administration* costs by 0.12%. A simulation exercise conducted by the authors showed that the average increase in sprawl during the period analyzed was about 40%, which resulted in a 2% increase approximately in Spain's local current costs and a 7% increase in the country's infrastructure costs. When considering the smaller sample of 1,033 municipalities used in the present paper, rather than the complete set of 7,300 local governments, this impact stood at 1.6% and 4.7%, respectively.

Overall, it can be concluded that development revenues, in addition to both current and capital grants from upper tiers of government, play an important role in the adjustment process initiated by municipalities to urban sprawl shocks. Thus, local governments undergoing urban expansion rely heavily on grant financing and immediately relevant revenues from building activity to cover the sizeable investments required by new housing developments located at the urban fringe.

6.4. Fiscal adjustment: city size and the initial level of sprawl.

The analysis up to this point has assumed that all Spanish municipalities follow a common fiscal adjustment process in response to an urban sprawl shock. However, cities will behave differently in line with specific municipal characteristics, including population size and the initial level of sprawl[35]. Thus, the typically weaker financial situation described for smaller municipalities might encourage them to rely more heavily on sprawl as a funding tool, while it is probable that municipalities which experienced major land-use changes at the beginning of the 90s will continue to sprawl more readily than their more compact counterparts.

Hence, we decided to perform further estimations on subsamples of the municipalities. First, we estimated the model separately for large and small cities. In order to ensure a reasonable number in each group, the sample was split into two population categories, below and above 5,000 inhabitants, containing 329 and 704 observations, respectively[36]. In the case of the impact of a sprawl shock on the current deficit and its components, the results were largely similar to those presented above. By contrast, the impact of sprawl on the capital deficit components was considerably higher in small cities. As reported in Table 6, the investment needs of small municipalities resulting from urban expansion more than double those encountered in big cities. Moreover, small cities are much more reliant on development revenues and transfers from higher tiers of government to finance the investment needs generated by sprawl.

---

[35] The variables were chosen so that no correlation existed between them.

[36] Note that this division is in keeping with the allocation of responsibilities to the municipalities provided for under Spanish law. Thus, in small cities only the provision of basic services is compulsory, while in the larger ones a number of other responsibilities are included. See *Section 3* for further details.

Table 6. Present value of GIRFs

(i) Subsamples according to city size

Response of	*Municipalities with population <5,000 inhabitants*	*Municipalities with population >5,000 inhabitants*
	Innovation to sprawl	
CD⁺	-5.51 [1.40]***	-5.07 [1.22]***
CE	7.09 [0.89]***	5.30 [0.70]***
TX	4.92 [0.34]***	4.79 [0.59]***
CT	7.67 [1.02]***	5.59 [0.81]***
KD	-8.60 [10.32]	-5.28 [1.58]***
KE	17.87 [9.18]*	6.69 [0.90]***
KT	14.03 [3.81]***	6.28 [0.77]***
UR	12.45 [1.68]***	5.68 [1.02]***
NFD⁺	-14.11 [10.41]	-10.35 [1.98]***

(ii) Subsamples according to initial level of sprawl

Response of	*Municipalities with initial sprawl <200 pc square metres*	*Municipalities with initial sprawl >200 pc square metres*
	Innovation to sprawl	
CD⁺	-3.40 [2.09]*	-6.81 [6.89]
CE	5.28 [1.25]***	8.55 [3.64]*
TX	2.92 [0.54]***	6.31 [0.86]**
CT	5.76 [1.52]***	9.05 [5.56]
KD	-9.65 [7.37]	-11.02 [128.85]
KE	14.41 [3.80]***	23.99 [22.61]
KT	16.40 [6.01]***	19.78 [132.72]
UR	7.65 [1.75]***	15.23 [7.28]*
NFD⁺	-13.05 [7.68]*	-17.82 [128.92]

Notes: (i) Bootstrapped standard errors shown in brackets: 1000 replications with replacement; (ii) ***, ** and * denote statistically significant coefficients at the 99, 95 and 91% levels; (iii) CD, KD and NFD have been computed manually according to expression (2).

Finally, we estimated the model for two groups of municipalities based on their initial level of sprawl. We determined a cut-off point around the average level of sprawl in the sample, while ensuring (as above) a reasonable number of observations in both new sub-samples. Thus, we ended up with 569 and 464 municipalities with initial sprawl levels below and above 200 square metres per capita of built-up area, respectively. The adjustment recorded in local budgets was quantitatively higher (although in most instances not statistically significant) in those cities where urban sprawl was evident from the beginning of the period. More specifically, in cities that had already undergone urban sprawl and which continued to expand during the 90s, the impact on urban revenues doubled that recorded in their more compact counterparts.

Generally speaking, however, these results confirmed the findings for the entire sample presented in the previous section.

7. Conclusions

This study has sought to provide insights into the relationship between urban sprawl and municipal budgets by analysing how local government budgets adjust to a change in the urban development pattern. Thus, the study has drawn on a broad panel dataset from 4,000 Spanish municipalities for the period 1994-2005 to estimate a panel vector autoregressive model. The modelling approach adopted here has enabled us to investigate how each individual budget component adjusts to an urban sprawl shock by means of Generalised Impulse Response Functions.

The model specified includes capital and current deficit as well as an inverse measure of population density to proxy urban sprawl. The two budget components have been disaggregated into six different variables (current expenditures, tax revenues, operating grants, capital expenditures, capital transfers and development revenues) so as to examine how the individual components of local budgets adjust to changes in local urban development patterns.

The GIRF results show that the sprawl of cities produces both a current and a capital surplus leading to an overall non-financial surplus for local governments (although only the former was found to be statistically significant). This was particularly marked in the case of small cities and municipalities that had already undergone considerable urban expansion in the mid-90s.

The results record an increase in current expenditures, suggesting that local politicians will provide additional public goods and services for new housing developments. Moreover, urban sprawl is associated with large investment requirements as roads and basic infrastructures are extended for the new residents located at the urban fringe. Most of the adjustments to a sprawl shock are borne by upper tiers of government via grant financing (principally capital transfers) together with the not insignificant role played by the revenues associated with the real estate cycle itself (tax on land use improvements, building permits, construction taxes, public land sales, etc.).

However, the over-reliance of municipalities on grants to make adjustments to their budgets highlights a potential moral-hazard problem. Additional infrastructure requirements associated by spatially expansive growth are funded in the main by upper tiers of government, encouraging municipalities to promote urban expansion without necessarily considering the full fiscal consequences of such policies. Here, this problem could be due to the design of Spain's grant system, since some capital transfers are dependent on the municipalities' infrastructure deficit, which in turn is usually induced by urban growth.

8. References

Aguinaga, M. (2002): El patrimonio municipal del suelo como fuente de ingresos para los ayuntamientos, *Papeles de Economía Española* 92, 218-231.

Anderson, T.; Hsiao, C. (1981): Estimation of dynamic models with error components, *Journal of the American Statistical Association* 76, 598-606

Arellano, M. (2003): *Panel Data Econometrics,* Oxford University Press.

Arellano, M.; Bond, S. (1991): Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations, *Review of Economic Studies* 58, 277-297.

Arellano, M.; Bover, O. (1995): Another look at the instrumental variables estimation of error-components models, *Journal of Econometrics* 68, 29-51.

Baltagi, B. (1995): *Econometric Analysis of Panel Data*. Wiley, New York.

Bilbao et al (2006): Intervenciones públicas, haciendas territoriales y precios de la vivienda, *Papeles de Economía Española* 109, pp

Bird, R.; Slack, E. (1991): Financing urban growth through development charges, *Canadian Tax Journal*, 39(5), 1288-1304.

Blundell, R.; Bond, S. (1998): Initial conditions and moment restrictions in dynamic panel data models, *Journal of Econometrics* 87, 11-143.

Bond, S. (2002): Dynamic panel data models: A guide to micro data methods and practice, Working paper 09/02. Institute for Fiscal Studies. London.

Brueckner, J.K. (2000): Urban Sprawl: Diagnosis and Remedies, *International Regional Science Review* 23, 160-171.

Brueckner, J.K. (2001): Urban Sprawl: Lessons from Urban Economics, in: Gale, W.G., Pack, J.R. (Ed.): *Brookings-Wharton Papers on Urban Affairs*, pp. 65-89. Washington, DC: Brookings Institution.

Brueckner, J. K.; Fansler, D. (1983): The Economics of Urban Sprawl: Theory and Evidence on the Spatial Sizes of Cities, *Review of Economics and Statistics* 65, 479–482.

Brueckner, J.K. and Kim, H. (2003): "Urban Sprawl and the Property Tax", *International Tax and Public Finance* 10, 5-23.

Buettner, T. (2007): Equalization Transfers and Dynamic Fiscal Adjustment: Results for German Municipalities and a US-German Comparison, IFIR Working Paper No.2007-07.

Buettner, T.; Wildasin, D. E. (2006): The dynamics of municipal fiscal adjustment. *Journal of Public Economics*, 90, 1115-1132.

Bunnell, G. (1998): Analyzing the fiscal impacts of development: lessons for building successful communities, *Community Development* 29(1), 38-57.

Burchell, R. and D. Listokin (1978): *The Fiscal Impact Handbook: Projecting the Local Costs and Revenues Related to Growth*. New Brunswick, NJ, Center for Urban Policy Research.

Burchell, R. et al (1998): The Costs of Sprawl. Revisited, *Transportation Cooperative Research Program Report 39*. Washington, DC: National Academy Press.

Burchell, R., Lowenstein, G., Dolphin, W. R. and Galley, C. C. (Eds) (2002) *Costs of Sprawl: 2000*. *Transportation Cooperative Research Program Report No. 74.* Washington, DC: National Academies Press.

Burchfield, M., Overman, H. and Turner, M. (2006): Causes of Sprawl: A Portrait from the Space, *The Quarterly Journal of Economics*, 121(2), 587-633.

Carruthers, J.I. (2002): The impacts of state growth management programmes: a comparative analysis, *Urban Studies*, volume 39 (11), 1956-1982.

Carruthers, J.I. and Ulfarsson, G.F. (2002): Fragmentation and Sprawl: Evidence from interregional analysis, *Growth and Change* 33, 312-340.

Carruthers, J.I. and Ulfarsson, G.F. (2003): Urban sprawl and the cost of public services, *Environment and Planning B: Planning and Design* 30, 503-522.

Carruthers, J.I. and Ulfarsson, G.F. (2008): Does Smart Growth Matter to Public Finance? *Urban Studies* 45(9), 1791-1823.

Dahlberg, M.; Johansson, E. (1998): The revenues-expenditures nexus: panel data evidence from Swedish municipalities, *Applied Economics* 30, 1379-1386.

Dahlberg, M.; Johansson, E. (2000): An examination of the dynamic behaviour of local governments using GMM bootstrapping methods, *Journal of Applied Econometrics* 15, 401-416.

Devarajan, S.; Khemani, S.; Shah, S. (2009): Political economy and servicedelivery, *Handbook of Fiscal Federalism* vol. II, Edward Elgar, forthcoming.

Downs, A. (1999): Some realities about Sprawl and Urban Decline, *Housing Policy Debate* 10 (4), 955-974.

Ewing, R. (1997): Is Los Angeles-style sprawl desirable?, *Journal of American Planning Association* 63, 107-126.

European Environmental Agency (2006): *Urban Sprawl in Europe: The ignored challenge*, EEA Report No.10/2006.

European Parliament (2009): *Auken Report*, Session Document A6-0082/2009.

Fernández, G. (2008): Urbanismo y financiación local, *Papeles de Economía Española* 115, 212-225.

Glaeser, E.L. and Kahn, M.E. (2004): Sprawl and Urban Growth, in Henderson, J.V. and Thisse, J.F. (Eds): *Handbook of Urban and Regional Economics*, volume IV , pp.2498-2527. Elsevier, Amsterdam.

Greene, W. (2006) *Econometric Analysis*, 6th ed. Upper Addle River, NJ: Prentice-Hall.

Greenpeace España (2009): Destrucción a toda costa 2009. Situación del litoral español y sus espacios protegidos.

Hamilton, J.D. (1994): *Time Series Analysis*. Princeton University Press, Princeton.

Heikkila, E.; Craig, S. (1991): Nested fiscal impact measures using the new theory of local public goods, *Journal of Regional Science* 31 (1), 65-81.

Hortas-Rico, M.; Solé-Ollé, A (2010): Does urban sprawl increase the costs of providing local public services? Evidence from Spanish municipalities. *Urban Studies* 47 (7), 1513-1540.

Hotlz-Eakin, D.; Newey, W.; Rosen, H.S. (1988): Estimating vector autoregressions with panel data, *Econometrica* 56(6), 1371-1395.

Hotlz-Eakin, D.; Newey, W.; Rosen, H.S. (1989): The revenues-expenditures nexus: evidence from local government data, *International Economic Review* 30(2), 415-429.

Kelsey, T.W. (1996): The fiscal impacts of alternative land uses: what do cost of community services studies really tell us?, *Journal of the Community Development* 27(1), 78-89.

Kotchen, M.; Schutle, S. (2009): A meta-analysis of cost of community service studies, *International Regional Science Review* 32(3), 376-399.

Ladd, H.F. (1992): Population Growth, Density and the Costs of Providing Public Services, *Urban Studies* 29 (2), 273-295.

Ladd, H.F. (1994): Fiscal impacts of local population growth: A conceptual and empirical analysis, *Regional Science and Urban Economics* 24, 661-686.

Lütkepohl, H. (2005): *New Introduction to Multiple Time Series Analysis*, Berlin: Springer-Verlag.

Maldonado, J.; Suárez-Pandiello, J. (2008): Hacienda local y urbanismo. ¿Es tan grave como lo pintan?, *Clm.Economía* 11, 245-264.

McGrath, D. (2005): More evidence on the spatial scale of cities, *Journal of Urban Economics* 58, 1-10.

Mieszkowski, P. and Mills, E.S. (1993): The causes of Metropolitan Suburbanization, *Journal of Economic Perspectives* 7 (3), 135-147.

Moisio, A. (2000): Spend and tax or tax and spend? Panel data evidence from Finnish municipalities during 1985-1999, VATT Discussion papers. Government Institute for Economic Research. Helsinki.

Moisio, A.; Kangasharju, A. (1997): The Revenues-Expenditures nexus: Evidence from Finnish Local Governments panel data. Working paper 169/1997. University of Jyvaskyla.

Nechyba, T. and Walsh, R. (2004): "Urban Sprawl", *Journal of Economic Perspectives* 18 (4), 177-200.

Nickell, S. (1981): Biases in dynamic models with fixed effects, *Econometrica* 49(9), 1417-1426.

Persson, T.; Tabellini, G. (1996): Federal fiscal constitutions: risk-sharing and moral hazard, *Econometrica*, 64, 623-646.

Pesaran, H.; Shin, Y. (1997): Generalized impulse response analysis in linear multivariate models, *Economics Letters* 58, 17-29.

Pou, V. (2007): El impacto del Mercado inmobiliario en las finanzas públicas, BBVA.

Roodman, D. (2007): How to do xtabond2: An introduction to "Difference" and "System" GMM in Stata, Working Paper 125. Centre for Global Development.

Roodman, D. (2008): A note on the theme of too many instruments, *Centre for Global Development Working Paper* 125.

Slack, E. (2002): Municipal finance and the pattern of urban growth, *Commentary*, Toronto: C.D. Howe Institute, 160.

Solé-Ollé, A.; Sorribas, P. (2009): The dynamic adjustment of local government budgets: does Spain behave differently? Working Paper 2009/7, Barcelona Institute of Economics.

Sierra Club (1998) *Sprawl: the dark side of the American dream*. Sprawl Report, Sierra Club.

Appendix

Table A1. Detailed estimation results, p=2, n=1,033, T=12

	CE_{it}	TX_{it}	CT_{it}	KE_{it}	KT_{it}	UR_{it}	$SPRAWL_{it}$
CE_{it-1}	0.894** [0.356]	0.095** [0.045]	-0.005 [0.072]	0.076 [0.176]	-0.061 [0.105]	0.209* [0.124]	-0.004 [0.003]
CE_{it-2}	0.051* [0.215]	0.053*** [0.012]	0.032 [0.029]	-0.095 [0.122]	-0.088 [0.070]	0.087** [0.043]	0.003 [0.003]
TX_{it-1}	-0.014 [0.123]	0.344 [0.217]	-0.012 [0.038]	0.149 [0.192]	0.161 [0.108]	-0.061 [0.057]	-0.013** [0.005]
TX_{it-2}	0.047 [0.039]	0.463** [0.161]	-0.014 [0.014]	-0.138 [0.129]	-0.056 [0.082]	-0.092 [0.080]	0.003 [0.006]
CT_{it-1}	0.041 [0.164]	-0.074** [0.027]	0.675** [0.225]	-0.123 [0.247]	0.113 [0.100]	-0.179** [0.084]	-0.003 [0.003]
CT_{it-2}	-0.019 [0.020]	-0.047** [0.017]	0.223 [0.151]	0.285*** [0.108]	0.211** [0.074]	-0.106** [0.044]	0.001 [0.003]
KE_{it-1}	-0.009 [0.034]	0.029* [0.012]	-0.013 [0.023]	0.678 [0.479]	-0.353* [0.200]	0.113 [0.082]	0.001 [0.002]
KE_{it-2}	0.019 [0.020]	0.026** [0.010]	0.004 [0.009]	0.121** [0.051]	0.078* [0.042]	0.019 [0.019]	0.001 [0.001]
KT_{it-1}	-0.0004 [0.025]	-0.030 [0.013]	0.024 [0.022]	-0.185 [0.453]	0.862*** [0.263]	-0.074 [0.074]	-0.001 [0.002]
KT_{it-2}	-0.012 [0.019]	-0.031 [0.010]	0.004 [0.011]	0.209*** [0.052]	0.252*** [0.050]	-0.023 [0.021]	-0.001 [0.002]
UR_{it-1}	-0.004 [0.061]	-0.021*** [0.008]	0.003 [0.023]	-0.039 [0.242]	0.186* [0.110]	0.164 [0.242]	-0.001 [0.002]
UR_{it-2}	0.008 [0.026]	-0.013 [0.010]	-0.015 [0.015]	0.151* [0.086]	0.082 [0.061]	0.347*** [0.096]	-0.001 [0.002]
$Sprawl_{it-1}$	0.053 [0.143]	0.141* [0.078]	-0.055 [0.052]	0.473 [0.374]	0.553 [0.345]	0.103 [0.163]	1.457*** [0.179]
$Sprawl_{it-2}$	-0.060 [0.151]	-0.126* [0.075]	0.038 [0.054]	-0.371 [0.378]	-0.479 [0.354]	-0.038 [0.162]	-0.450** [0.182]
m1	-2.23**	-2.07**	-2.67***	-3.95***	-5.82***	-1.95*	-4.58***
m2	0.30	-1.38	0.10	0.49	-0.16	-1.41	1.65
Hansen test	17.14	14.25*	16.38	32.38	50.63*	28.65	14.61

Notes: (i) Estimation results after system-gmm estimation, including individual and time effects in all equations. (ii) Heteroskedasticity standard errors in brackets. (iii) ***, ** and * denote statistically significant coefficients at the 99, 95 and 91% levels. (iv) m1 and m2 are the Arellano's AR(1) and AR(2) tests for autocorrelation while the Hansen test checks for the validity of the instruments used in the estimation procedure (see *Section 5.1.* for further details). (v) All equations pass both the autocorrelation tests and the test for overidentifying restrictions with the exception of the TX and KT equations, where the null of valid instruments is rejected at 10%. However, these results should be interpreted with caution since, as noted in Dahlberg and Johansson (2000), estimation techniques that are generally adopted tend to reject too often a true null of validity of instruments (type I error).

.

2009

2009/1. Rork, J.C.; Wagner, G.A.: "Reciprocity and competition: is there a connection?"
2009/2. Mork, E.; Sjögren, A.; Svaleryd, H.: "Cheaper child care, more children"
2009/3. Rodden, J.: "Federalism and inter-regional redistribution"
2009/4. Ruggeri, G.C.: "Regional fiscal flows: measurement tools"
2009/5. Wrede, M.: "Agglomeration, tax competition, and fiscal equalization"
2009/6. Jametti, M.; von Ungern-Sternberg, T.: "Risk selection in natural disaster insurance"
2009/7. Solé-Ollé, A; Sorribas-Navarro, P.: "The dynamic adjustment of local government budgets: does Spain behave differently?"
2009/8. Sanromá, E.; Ramos, R.; Simón, H.: "Immigration wages in the Spanish Labour Market: Does the origin of human capital matter?"
2009/9. Mohnen, P.; Lokshin, B.: "What does it take for and R&D incentive policy to be effective?"
2009/10. Solé-Ollé, A.; Salinas, P..: "Evaluating the effects of decentralization on educational outcomes in Spain?"
2009/11. Libman, A.; Feld, L.P.: "Strategic Tax Collection and Fiscal Decentralization: The case of Russia"
2009/12. Falck, O.; Fritsch, M.; Heblich, S.: "Bohemians, human capital, and regional economic growth"
2009/13. Barrio-Castro, T.; García-Quevedo, J.: "The determinants of university patenting: do incentives matter?"
2009/14. Schmidheiny, K.; Brülhart, M.: "On the equivalence of location choice models: conditional logit, nested logit and poisson"
2009/15. Itaya, J., Okamuraz, M., Yamaguchix, C.: "Partial tax coordination in a repeated game setting"
2009/16. Ens, P.: "Tax competition and equalization: the impact of voluntary cooperation on the efficiency goal"
2009/17. Geys, B., Revelli, F.: "Decentralization, competition and the local tax mix: evidence from Flanders"
2009/18. Konrad, K., Kovenock, D.: "Competition for fdi with vintage investment and agglomeration advantages"
2009/19. Loretz, S., Moorey, P.: "Corporate tax competition between firms"
2009/20. Akai, N., Sato, M.: "Soft budgets and local borrowing regulation in a dynamic decentralized leadership model with saving and free mobility"
2009/21. Buzzacchi, L., Turati, G.: "Collective risks in local administrations: can a private insurer be better than a public mutual fund?"
2009/22. Jarkko, H.: "Voluntary pension savings: the effects of the finnish tax reform on savers' behaviour"
2009/23. Fehr, H.; Kindermann, F.: "Pension funding and individual accounts in economies with life-cyclers and myopes"
2009/24. Esteller-Moré, A.; Rizzo, L.: "(Uncontrolled) Aggregate shocks or vertical tax interdependence? Evidence from gasoline and cigarettes"
2009/25. Goodspeed, T.; Haughwout, A.: "On the optimal design of disaster insurance in a federation"
2009/26. Porto, E.; Revelli, F.: "Central command, local hazard and the race to the top"
2009/27. Piolatto, A.: "Plurality versus proportional electoral rule: study of voters' representativeness"
2009/28. Roeder, K.: "Optimal taxes and pensions in a society with myopic agents"
2009/29, Porcelli, F.: "Effects of fiscal decentralisation and electoral accountability on government efficiency evidence from the Italian health care sector"
2009/30, Troumpounis, O.: "Suggesting an alternative electoral proportional system. Blank votes count"
2009/31, Mejer, M., Pottelsberghe de la Potterie, B.: "Economic incongruities in the European patent system"
2009/32, Solé-Ollé, A.: "Inter-regional redistribution through infrastructure investment: tactical or programmatic?"
2009/33, Joanis, M.: "Sharing the blame? Local electoral accountability and centralized school finance in California"
2009/34, Parcero, O.J.: "Optimal country's policy towards multinationals when local regions can choose between firm-specific and non-firm-specific policies"
2009/35, Cordero, J,M.; Pedraja, F.; Salinas, J.: "Efficiency measurement in the Spanish cadastral units through DEA"
2009/36, Fiva, J.; Natvik, G.J.: "Do re-election probabilities influence public investment?"
2009/37, Haupt, A.; Krieger, T.: "The role of mobility in tax and subsidy competition"
2009/38, Viladecans-Marsal, E; Arauzo-Carod, J.M.: "Can a knowledge-based cluster be created? The case of the Barcelona 22@district"

2010

2010/1, De Borger, B., Pauwels, W.: "A Nash bargaining solution to models of tax and investment competition: tolls and investment in serial transport corridors"
2010/2, Chirinko, R.; Wilson, D.: "Can Lower Tax Rates Be Bought? Business Rent-Seeking And Tax Competition Among U.S. States"
2010/3, Esteller-Moré, A.; Rizzo, L.: "Politics or mobility? Evidence from us excise taxation"
2010/4, Roehrs, S.; Stadelmann, D.: "Mobility and local income redistribution"

2010/5, Fernández Llera, R.; García Valiñas, M.A.: "Efficiency and elusion: both sides of public enterprises in Spain"
2010/6, González Alegre, J.: "Fiscal decentralization and intergovernmental grants: the European regional policy and Spanish autonomous regions"
2010/7, Jametti, M.; Joanis, M.: "Determinants of fiscal decentralization: political economy aspects"
2010/8, Esteller-Moré, A.; Galmarini, U.; Rizzo, L.: "Should tax bases overlap in a federation with lobbying?"
2010/9, Cubel, M.: "Fiscal equalization and political conflict"
2010/10, Di Paolo, A.; Raymond, J.L.; Calero, J.: "Exploring educational mobility in Europe"
2010/11, Aidt, T.S.; Dutta, J.: "Fiscal federalism and electoral accountability"
2010/12, Arqué Castells, P.: "Venture capital and innovation at the firm level"
2010/13, García-Quevedo, J.; Mas-Verdú, F.; Polo-Otero, J.: "Which firms want PhDS? The effect of the university-industry relationship on the PhD labour market"
2010/14, Calabrese, S.; Epple, D.: "On the political economy of tax limits"
2010/15, Jofre-Monseny, J.: "Is agglomeration taxable?"
2010/16, Dragu, T.; Rodden, J.: "Representation and regional redistribution in federations"
2010/17, Borck, R; Wimbersky, M.: "Political economics of higher education finance"
2010/18, Dohse, D; Walter, S.G.: "The role of entrepreneurship education and regional context in forming entrepreneurial intentions"
2010/19, Åslund, O.; Edin, P-A.; Fredriksson, P.; Grönqvist, H.: "Peers, neighborhoods and immigrant student achievement - Evidence from a placement policy"
2010/20, Pelegrín, A.; Bolance, C.: "International industry migration and firm characteristics: some evidence from the analysis of firm data"
2010/21, Koh, H.; Riedel, N.: "Do governments tax agglomeration rents?"
2010/22, Curto-Grau, M.; Herranz-Loncán, A.; Solé-Ollé, A.: "The political economy of infraestructure construction: The Spanish "Parliamentary Roads" (1880-1914)"
2010/23, Bosch, N.; Espasa, M.; Mora, T.: "Citizens' control and the efficiency of local public services"
2010/24, Ahamdanech-Zarco, I.; García-Pérez, C.; Simón, H.: "Wage inequality in Spain: A regional perspective"
2010/25, Folke, O.: "Shades of brown and green: Party effects in proportional election systems"
2010/26, Falck, O.; Heblich, H.; Lameli, A.; Südekum, J.: "Dialects, cultural identity and economic exchange"
2010/27, Baum-Snow, N.; Pavan, R.: "Understanding the city size wage gap"
2010/28, Molloy, R.; Shan, H.: "The effect of gasoline prices on household location"
2010/29, Koethenbuerger, M.: "How do local governments decide on public policy in fiscal federalism? Tax vs. expenditure optimization"
2010/30, Abel, J.; Dey, I.; Gabe, T.: "Productivity and the density of human capital"
2010/31, Gerritse, M.: "Policy competition and agglomeration: a local government view"
2010/32, Hilber, C.; Lyytikäinen, T.; Vermeulen, W.: "Capitalization of central government grants into local house prices: panel data evidence from England"
2010/33, Hilber, C.; Robert-Nicoud, F.: "On the origins of land use regulations: theory and evidence from us metro areas"
2010/34, Picard, P.; Tabuchi, T.: "City with forward and backward linkages"
2010/35, Bodenhorn, H.; Cuberes, D.: "Financial development and city growth: evidence from Northeastern American cities, 1790-1870"
2010/36, Vulovic, V.: "The effect of sub-national borrowing control on fiscal sustainability: how to regulate?"
2010/37, Flamand, S.: "Interregional transfers, group loyalty and the decentralization of redistribution"
2010/38, Ahlfeldt, G.; Feddersen, A.: "From periphery to core: economic adjustments to high speed rail"
2010/39, González-Val, R.; Pueyo, F.: "First nature vs. second nature causes: industry location and growth in the presence of an open-access renewable resource"
2010/40, Billings, S.; Johnson, E.: "A nonparametric test for industrial specialization"
2010/41, Lee, S.; Li, Q.: "Uneven landscapes and the city size distribution"
2010/42, Ploeckl. F.: "Borders, market access and urban growth; the case of Saxon towns and the Zollverein"

UNIVERSITAT DE BARCELONA

ieb@ub.edu
www.ieb.ub.edu

Fiscal Federalism

Document de treball de l'IEB