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FISCAL AND GROWTH SPILLOVERS IN LARGE URBAN AREAS [a,b]

Albert Solé Ollé, Elisabet Viladecans Marsal[c]

ABSTRACT: This paper looks for empirical evidence on spillovers occurring between central cities and their suburbs, both on the fiscal side and on the growth of population and output. To test these hypotheses we specify a dynamic model with population and output both in the central city and in the suburbs as endogenous variables and with fiscal variables in the central city and in the suburbs as covariates. The model is estimated with a panel of data of twenty-eight metropolitan areas in Spain for the period 1992-2001.The main findings are that the capital stock in the central city promotes growth both in the city and in the suburbs. Also, higher growth in the central city translates into higher long run growth in the suburbs. These results are indicative of the potential welfare gains of both, concentrating financial resources in the central city, and of the implementation of existing proposals of metropolitan consolidation.

Keywords: cities, spillovers, local government
JEL codes: H73, R38

RESUMEN: Este trabajo proporciona evidencia empírica acerca de los efectos desbordamiento (*spillovers*) que tienen lugar entre la ciudad central y su entorno, tanto en el ámbito fiscal como en el ámbito del crecimiento de la población y la producción. Para contrastar estas hipótesis se especifica un modelo dinámico con la población y la producción en la ciudad central y los municipios del entorno como variables endógenas y con las variables fiscales de la ciudad central y los municipios del entorno como variables de control. El modelo se estima con un panel de datos para veintiocho áreas metropolitanas españolas y para el período 1992-2001. Los principales resultados indican que el stock de capital de la ciudad central promueve el crecimiento tanto en la ciudad como en los suburbios. Además, un crecimiento superior en la ciudad central se trasforma en el largo plazo en un mayor crecimiento en los suburbios. Estos resultados son indicativos de las ganancias potenciales de bienestar derivadas bien de la concentración de recursos financieros en la ciudad central, bien de la aplicación de las diversas propuestas existentes de consolidación metropolitana.

Palabras clave: ciudades, spillovers, gobierno local
Clasificación JEL: H73, R38

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1. Introduction

In several countries big cities receive preferential attention by higher layers of government, often meaning the establishment of more generous financial arrangements. This is the case, for example, of Germany and Spain, where the spending needs used in the calculation of intergovernmental transfers are assumed to grow with population size[1]. In other countries, like the US, the worries are related to the financial difficulties experienced by central cities. In this context, many authors have proposed to increase financial help to big cities or even the fiscal consolidation of the central city and its suburbs (see, e.g., Inman and Haugwhout, 2002). Therefore, and for different reasons, there is a lively debate at both sides of the Atlantic regarding the need to give special financial assistance to big cities.

Three separate but related arguments can be invoked to justify such a deal. First, provision costs, crime and social disruption, and other congestion-related problems are higher in cities (Oates, 1988)[2]. Second, the central city bears a substantial amount of the cost of the activities developed across the conurbation (e.g., care of the poor and services to commuters) but only enjoys a fraction of the benefits (e.g., tax bases). This situation may lead to the so-called "fiscal exploitation" of the central cities (Greene *et al.*, 1977). And third, the city's environment must not be allowed to deteriorate because those problems will spill over the entire conurbation. That is, lower growth in the city may ultimately mean lower growth elsewhere.

In this paper we concentrate in the second and third arguments and try to provide empirical evidence on spillovers occurring among central cities and its suburbs, both on the fiscal side and in the growth of population and output. There are only a few empirical papers dealing with these issues in the literature. There are many papers in the literature analysing the efficiency consequences of benefit spillovers (see, e.g., Brainard and Dolbear, 1967, Pauly, 1970, and Boskin, 1973). However, there are only a few

[1] For example, in Germany a resident of a municipality with less than 5,000 inhabitants is weighted one; this weight rises to 1.1, 1.15, 1.2, 1.25 and 1.3 for municipalities with populations between 5 and 20 thousand inhabitants, between 20 and 100, between 100 and 500, and higher than 500, respectively. In addition to this, the weight is further increased in the last two segments depending on population density (see, Spahn, 1997, for a detailed explanation). In Spain , the pattern is similar but the weights rise up to 2.8 for cities with more than 500,000 inhabitants (see Solé-Ollé and Bosch, 2002).

[2] However, there does not exist a clear academic position on that issue. Some empirical papers find that provision costs are higher in big cities (Ladd and Yinger, 1989), but others (Glaeser, 1997, and Fenge and Meier, 2001) argue about the need to compensate those high costs from an efficiency point of view.

papers trying to quantify directly its magnitude[3]. The book by Greene *et al.* (1977) quantified both benefit and tax exporting in Washington D.C. by using direct imputation methods. The paper by Haughwout (1999) is similar both in purpose and methods to ours. This author finds that central city's infrastructure raises housing prices in the suburbs. This result is interpreted as evidence of benefit spillovers: households will bid more for houses in suburbs of metropolitan areas with good central city's services only if they are able to benefit form these services without having to live in the centre.

There is also a recent strand of literature that asks whether the economic health of the suburbs depend on the growth of the central city. The articles that have empirically addressed this question (Ihlandfelt, 1995, Brooks and Summers, 1997, Voith, 1992, 1993, 1998) conclude that the growth of a typical U.S. metropolitan area is higher the higher is the growth of the central city. More recently, Voith (1998) obtains that the positive effect of the central city on its surrounding area increases with the size of the central city. Work by Solé and Viladecans (2002) with data of 28 Spanish metropolitan areas during the period 1967-2001 confirm this hypothesis with European data: growth in the suburbs is higher the better is the performance of the central city. Inman and Haughwout (2002) find evidence that central cities' good fiscal policies are at the heart of this growth spillover in U.S. metropolis.

This paper will test two different hypothesis: a) central city's services provide direct benefits to firms and households in the suburbs, and b) central city's services provide indirect benefits to suburbanites by fostering the growth in the suburbs. The second hypothesis will be tested by looking at the effects of central city's population (or output) on suburb's population (or output). growth. The first hypothesis will be tested by looking at the effect of central city's policies on suburb's population (and output) growth after controlling for the levels of population (and output) in the central city. These hypothesis will be tested for the sample of 28 Spanish metropolitan areas used in Solé and Viladecans (2002). Unfortunately, it has not been possible to assemble a data base on housing prices covering all the Spanish geography and, therefore, we are not

[3] More recently, some papers have developed indirect tests of benefit spillovers by looking for interactions among the expenditure levels of neighbouring communities. See, for example, Murdoch *et al.* (1993) for a study of local recreation expenditures in the metropolitan area of L.A., and Case *et al.* (1993) for an analysis of the U.S. states spending. This approach is problematic, because these interactions may be also generated by other theories, as Brueckner (2001) has recently pointed out.

able to use hedonic equation methods, as in Haugwhout (1999). Our procedure resembles more to the one used in Voith (1998) since we analyse the effects of fiscal variables and growth spillovers on output and population growth. Since fiscal data for all localities in the sample is available only from 1992, the analysis will cover only the period 1992-2001.

The analysis presents some new features over other exercises. First, we try to disentangle the two different kinds of spillovers of central cities' policies, direct and indirect. Second, in order to obtain some reference points with which to compare our estimates of the central city-to-suburbs spillovers, we allow also for spillovers among suburban localities and from the suburb to central city. Third, instead of analysing growth in a cross-section of cities as in other papers (e.g, Rappaport, 1999b) we use a panel of data. This allows us to control for heterogeneity through the inclusion of individual effects, to analyse causality without having to rely on instruments of dubious reliability, and to be more careful with the dynamics of the system by using a Vector Error Correction Model. Fourth, this is one of the few papers focusing on this issue with European data and from an European perspective.

The paper is organised in the following way. The second section summarises the main theoretical contributions predicting fiscal and growth spillovers. The third section presents the econometric model and the database. The fourth section discusses the results obtained from the estimation of the model. Finally, the last section concludes with some comments about the implications of the results for the design of economic policy.

2. Theoretical background

2.1 *Fiscal spillovers*

Improved public services in the central city may have two different kinds of effects on the level of population and economic activity in the suburbs. On the one hand, the benefits of these policies may spill over the boundaries of the central city. In this case, the suburbs may become a better place to live and/or locate business activity, since the benefits provided by central city's services to people and firms can be enjoyed without having to pay for them (Greene *et al.*, 1977).Therefore, this first effect suggest that improved central city's services result in enhanced population and economic activity growth in the suburbs. We will name this the *spillover effect* of public services. On the other hand, if there are no spillovers from central city's services, then the only way to enjoy its benefits will be to live or locate in the centre. In this case, an improvement in central city's services (keeping taxes constant) will drive out activity from the suburbs to the central city. We will name this the *competition effect* of public services.

a) *Spillover effect*

The starting point to analyse fiscal spillovers among local jurisdictions is the compensating variations model developed by Rosen (1979) and Roback (1982), and applied by Gyourko and Tracy (1989, 1991) and Haugwhout *et al.* (2000) to the analysis of fiscal policies. In this model, people and firms are perfectly mobile and choose to locate in the jurisdictions where utility and profits, respectively, are the highest. Attractive locations are relatively scarce and wages and rents must adjust until there are no people and firms wanting to change their location.

Consider, for example, an economy composed by K metropolitan areas, each one containing J_k localities. Let's assume for the moment that there is no commuting but that both firms and people are perfectly mobile, both across metropolitan areas and across localities within a metropolitan area. Individuals have utility functions defined over a composite good y, land n, and public services, q. These services may be provided in the jurisdiction of residence, q_{jk}, or may spill over from other localities in the metropolitan area (the central city or other suburban localities), q_k. Individuals supply the same amount of labour, earning wages w, and pay a rent r for the consumption of land. Firms produce the composite output good using labour p and public services, s. As with the case of households, public services may be provided by the locality, s_{jk}, or spill over form other localities in the metropolitan area, s_k. The spatial equilibrium conditions equating utility levels across localities, and requiring firms not to make excess profits solely because of their location can be expressed as:

$$V(w_{jk},\ r_{jk},\ q_{jk},\ q_k) = \overline{V} \qquad (1a)$$

$$\Pi(w_{jk},\ r_{jk},\ s_{jk},\ s_k) = \overline{\Pi} \tag{1b}$$

where V(•) is the indirect utility function, Π(•) is the profits function and $\overline{V}$ and $\overline{\Pi}$ are constants. The resource constraint of a locality is:

$$n_{jk} \cdot p_{jk} = N_{jk} \tag{2}$$

Where p_{jk} is population (that is equal to the labour force because there is no commuting), and where n_{jk} is the demand of land per resident, and N_{jk} is the fixed amount of land of the locality. Expressions (1a) and (1b) allows the derivation of equilibrium rent and wage expressions:

$$r^*_{jk} = r(\underset{+}{q_{jk}},\ \underset{+}{q_k},\ \underset{+}{s_{jk}},\ \underset{+}{s_k},\ \underset{-}{V},\ \underset{-}{\Pi}) \tag{3a}$$

$$w_{jk} = w(\underset{+}{s_{jk}},\ \underset{+}{s_k},\ \underset{+}{V},\ \underset{+}{\Pi}) \tag{3b}$$

And by inserting (3a) and (3b) in the individuals' and firms' demands and considering (2), expressions relating public services to population and output levels can be obtained:

$$p^*_{jk} = p(\underset{+}{q_{jk}},\ \underset{+}{q_k},\ \underset{+}{s_{jk}},\ \underset{+}{s_k},\ \underset{+}{N_{jk}},\ \underset{-}{\overline{V}},\ \underset{-}{\overline{\Pi}}) \tag{4a}$$

$$y^*_{jk} = y(\underset{+}{q_{jk}},\ \underset{+}{q_k},\ \underset{+}{s_{jk}},\ \underset{+}{s_k},\ \underset{+}{N_{jk}},\ \underset{-}{\overline{V}},\ \underset{-}{\overline{\Pi}}) \tag{4b}$$

That is, both population an output will be higher the higher are public services directly valued to household and firms and provided both locally or regionally, and the higher is the amount of land available to be developed. In this model there are no differential effects of public services on population and output, since individuals reside and work in the same locality[4].

Things are a little different when one allows for commuting. This extension has much sense in our case; after all, an important source of benefit spillovers in urban areas

[4] An important caveat to these partial derivatives is that several rely on the exclusion of land from the production function, $y(\cdot)$. When land is included in the production function as in Roback (1982), Gyourko and Tracy (1989 and 1991) and Haugwouth (2002) the derivative of the wage with respect to q is not zero but negative: in order to attain the reservation level of profits, firms pay a lower wage as a compensation for the higher rent. More important, the positive derivative of population (and output) with respect to s is not warranted (see Haugwouth, 2002, and Rappaport, 1999a and 1999b).

comes through com-muting (Greene *et al.*, 1977). Commuting can be introduced in the model by considering that each metropolitan area is a homogeneous labour market, as in Voith (1991). As a result of this assumption, the new equilibrium wage will be the same for all localities belonging to the same metropolitan area and will depend only on public services provided regionally (i.e., s_k but not $s_{j,k}$). And most important, now the effects of fiscal variables on population and output are no longer the same: the effect of $s_{j,k}$ on population in (4a) and of $q_{j,k}$ on output in (4b) are uncer-tain. Intuitively, this is occurs because now people need not be located in the same place than firms and the same is true for firms. For example, if firms' demand for a locality raises (as a result of increasing $s_{j,k}$) and this pushes up rents, people may decide to live in nearby jurisdic-tions without changing jobs. This negative effect counteracts the original positive effect and so-mething similar happens with $q_{j,k}$ in the output equation. This suggest that, if commuting is a relevant feature of metropolitan economies, then it has much sense to analyse separately the effect of fiscal policies on population and economic activity, because some of these policies provide more direct benefits to households than to firms, and viceversa.

b) *Competition effect*

In the different models sketched above, all locations were perfect substitutes of each other, irrespective of the geographical distance between them. This assumption effectively impedes the competition effect between the central city and the suburbs. But this result could be generated by assuming that there are mobility costs across regions but not across localities within a metropolitan area. If this is the case, the levels of utility and profits achievable by individuals and firms will vary by metropolitan area, depending on the level of metropolitan amenities available: $\overline{V}_k(q_k)$ and $\overline{\Pi}_k(s_k)$, with positive partial derivatives. With this assumption, it is clear that, even if the effect of fiscal policies was positive in the original model, the sign is now unclear. For example, the effect of s_k on y^*_{jk} is now:

$$\underset{?}{\frac{\partial y^*_{jk}}{\partial s_k}} = \underset{+}{\frac{\partial y}{\partial s_k}} + \underset{-}{\frac{\partial y}{\partial \overline{\overline{\Pi}}}}\underset{+}{\frac{\partial \overline{\Pi}}{\partial s_k}} \tag{5}$$

There are two effects at work: the first term is the positive *spillover effect* and the second term is the negative *competition effect*. It is important, therefore, to have in mind that better public services in the central city may benefit its suburbs (if the *spillover effect* dominates) but may also harm them (if the *competition effect* is more relevant). The relative influence of both effects may differ across fiscal instruments, since in some of them there are not obvious direct spillovers, and some of them are more effective than other in attracting population and/or firms.

2.2 *Growth spillovers*

But not all economic interactions among the central city and the suburbs arise as a result of direct spillovers. The growth of the central city (whatever its source) may facilitate the growth of the suburban localities. Again, the compensating variations model (Rosen, 1979 and Roback, 1982) will help us to understand this linkage. In the simplest version of this type of models, the different locations are perfect substitutes and population or economic activity looses in some areas imply automatically gains in other areas. This suggests a possible negative causality from central city growth and the growth of its surrounding area. However, this effect will only take place in the short run, while the system converges to a new equilibrium. In the context of these models, the long run levels of population and output in a suburban locality (see, e.g., equations 4a and 4b) only depend on location fundamentals (e.g., land area, public services and other amenities). There is no place, therefore, for a long-run causal relationship between population (output) in the central city and population (output) in the suburbs.

These linkages can only arise in models including external effects between the central city and the suburbs. These external effects may arise as a combination of the agglomeration economies of central cities and the proximity of suburbs to the city (Haugwhout and Inman, 2002)[5]. That is, if central cities have an economic advantage that can not be replicated elsewhere, then the price of city produced goods and services will be lower and/or its quality will be higher. But as consumption of city's goods and services is high in the suburbs (because of its proximity), they will also enjoy these benefits.

Both firms and households may benefit from city's agglomeration economies. In the

[5] See Blomquist *et al.* (1988) and Gyourko and Tracy (1989) for earlier papers that include agglomeration economies in compensating variation models.

case of firms, city agglomeration economies imply a level of productivity that rises with firm density. High firm density within the same industry may lower shipping costs for inputs, reduces salaries through the broadening of labour markets, and promotes supplier innovation and specialisation (these are the so-called Marshallian economies). Innovation also tends to be higher in cities, as ideas are transferred in a quicker and more efficient way at high densities (Rauch, 1993; Glaeser and Khan, 2001). City size also allows for highly diversified economies, an environment that is associated with high levels of innovation (Audretsch, 1998, Duranton and Puga, 2001a). Therefore, cities seem to have still a clear advantage in knowledge-intensive industries (e.g., science and technology, finance and business services, health care) or in knowledge intensive business functions, as the headquarters of big companies (Duranton and Puga, 2001b). In the case of households, there are location factors that are particular to the central city but that provide benefits to rest of the metropolitan area (Voith, 1991). For example, central cities have some characteristics (e.g., commercial diversity, cultural, artistic activities and leisure) that can attract high income residents (Glaeser *et al.*, 2001) and highly qualified workers that, still living in the metropolitan area, will be able to enjoy these factors.

A decrease in the population and economic activity in the central city will reduce the agglome-ration economies faced by firms and households, increasing the price of goods and services and /or reducing its quality and availability. The crisis will be ultimately felt by suburban firms and residents. To sum up, the different arguments analysed in this section suggest that the level of population (output) in the central city will have long run effects on the level of population (output) in suburban localities. In order to account for these hypothesis, the long-run relation-ships may be reformulated as:

$$p^*_{jk} = p(\underset{+}{p_k},\ \underset{+}{q_{jk}},\ \underset{+}{q_k},\ \underset{?}{s_{jk}},\ \underset{?}{s_k},\ \underset{+}{N_{jk}},\ \underset{-}{\overline{V}},\ \underset{-}{\overline{\Pi}}) \qquad (6a)$$

$$y^*_{jk} = y(\underset{+}{y_k},\ \underset{?}{q_{jk}},\ \underset{?}{q_k},\ \underset{+}{s_{jk}},\ \underset{+}{s_k},\ \underset{+}{N_{jk}},\ \underset{-}{\overline{V}},\ \underset{-}{\overline{\Pi}}) \qquad (6b)$$

Note that now central city’s fiscal policies can influence the population and output levels in the suburbs by two different channels. First, directly through the effect of *fiscal spillovers*, as we explained in the previous section. Second, indirectly through the effect of *growth spillovers*; that is, if fiscal policies have some effect on central cities’ population and output, this effect will translate to suburb’s population and output. For example, the effect of s_k on y^*_{jk} is now:

$$\frac{\partial y^*_{jk}}{\partial s_k} = \left.\frac{\partial y^*_{jk}}{\partial s_k}\right|_{y_k=\bar{y}_k} + \frac{\partial y^*_{jk}}{\partial y_k}\frac{\partial y_k}{\partial s_k} \tag{7}$$

The first term measures *fiscal spillovers*: the effect of s_k on y^*_{jk} holding of y_k constant. The second measures the effect of fiscal variables through the operation of *growth spillovers*: the effect of s_k on y^*_{jk} through a change in y_k. By controlling for y_k in the empirical analysis we will be able two disentangle the effects of the two different channels.

3. Empirical model

3.1 *Long-run relationships*

The theoretical considerations of the previous section helped us to identify the two key hypothesis of the paper: a) improved central city's public services foster output and population growth in the suburbs, and b) enhanced central city's population and output growth also foster the growth of localities in the suburbs. But the central city-to-suburb interactions will be better analysed by having some reference point; that is, by comparing its magnitude with suburb-to-central city and suburb-to-suburb interactions. Therefore, we will also test two additional complementary hypothesis: c) growth in a suburb may be also enhanced by the level public services and growth in other suburbs, and d) growth in the central city may be positively affected by public services and growth in the suburbs. These hypothesis can be summarised in the following four long-run relationships:

$$p^*_{jk,t} = \alpha_0 + \alpha_{11}.\mathbf{z}_{jk,t} + \alpha_{12}.\bar{\mathbf{z}}_{jk,t} + \alpha_{13}.\bar{\mathbf{Z}}_{jk,t} + \alpha_{21}.\bar{p}_{jk,t} + \alpha_{22}.\bar{P}_{jk,t} + \alpha_3.n_{jk,t} + f^p_{jk} \tag{8a}$$

$$y^*_{jk,t} = \beta_0 + \beta_{11}.\mathbf{z}_{jk,t} + \beta_{12}.\bar{\mathbf{z}}_{jk,t} + \beta_{13}.\bar{\mathbf{Z}}_{jk,t} + \beta_{21}.\bar{y}_{jk,t} + \beta_{22}.\bar{Y}_{jk,t} + \beta_3.n_{jk,t} + f^y_{jk} \tag{8b}$$

$$P^*_{k,t} = \delta_0 + \delta_{11}.\mathbf{Z}_{k,t} + \delta_{12}.\bar{\mathbf{z}}_{k,t} + \delta_2.\bar{p}_{k,t} + \delta_3.N_{k,t} + f^P_k \tag{8c}$$

$$Y^*_{k,t} = \gamma_0 + \gamma_{11}.\mathbf{Z}_{k,t} + \gamma_{12}.\bar{\mathbf{z}}_{k,t} + \gamma_2.\bar{y}_{k,t} + \gamma_3.N_{k,t} + f^Y_k \tag{8d}$$

The endogenous variables are population and output in the *j*th suburban locality of the *k*th metropolitan area ($p_{jk,t}$ and $y_{jk,t}$) and population and output in the *k*th central city ($P_{k,t}$ and $Y_{k,t}$). All the variables included are in logs; therefore, the coefficients can be interpreted as elasticities. Lower case letters are variables computed with data coming from suburban localities and capital letters are variables computed with data coming from central cities. The **z** denotes a vector of fiscal variables, including various kinds of public expenditure, the capital stock and tax rates.

Barred variables are spillover variables, computed with data from other localities of the same metropolitan area. For example, $\bar{\mathbf{z}}_{jk,t}$ are fiscal variables of suburban localities that belong to the same metropolitan area of the *j*th locality, and $\bar{\mathbf{Z}}_{jk,t}$ are fiscal variables of the central city of the metropolitan are of the *j*th locality. Note that these variables appear in equation (8a) and (8b) indexed by *jk* and not only by *k*; this is because we allow these variables to differ not only between metropolitan areas but also between localities belonging to the same metropolitan area. To allow for intra-regional variation we constructed these variables using accessibility or gravity expressions, as in Boarnet (1994). Using population as an example:

$$\bar{p}_{jk,t} = \sum_{i \neq j} \frac{p_{ik,t}}{d_{ji}^{\alpha}} \quad \text{and} \quad \bar{P}_{jk,t} = \frac{P_{k,t}}{d_{jk}^{\alpha}} \qquad (9)$$

Where $p_{ik,t}$ is the population of suburban locality $i(\neq j)$, $P_{k,t}$ is the population of the *k*th central city ($j \in k$), d_{ji} is the distance between the localities *j* and *i*, d_{jk} is the distance between the locality *j* and the central city *k*, and α defines the shape of the distance-decay function. The results we report below are based on a value of α equal to one. This value was found to be the one that maximised the explanatory capacity of the system of equations[6]. Barred variables in equations (8c) and (8d) are computed similarly. In this case the variables account for the accessibility of the central city to the fiscal variables, population and output of the suburbs. By using gravity measures we allow the central city to be more influenced by nearby suburbs than by more distant ones. The expression is:

[6] We estimated the system with values of α equal to 0.5, 1, 1.5 and 2. Although the Log-likelihood function was maximised with a value of 1, the results displayed little sensitivity to the choice of α.

$$\overline{p}_{k,t} = \sum_{j \in k} \frac{p_{jk,t}}{d_{jk}^{\alpha}} \qquad (10)$$

Finally, note that the long-run relationships also include as control variables the supply of land in the locality ($n_{,t}$ for the suburb and $N_{k,t}$ for the central city)[7] and a set of individual effects, different for each equation (f_j^p, f_j^y, f_j^P and f_j^Y). These individual effects will pick up other factors influencing utility or productivity that remain constant during the period analysed as, for example, climate, or proximity to big infrastructures as, for example, ports and airports.

3.2 *Vector Error Correction Model*

The empirical task of finding evidence on the causal relationships described by expressions (8a) to (8d) is subject to considerable econometric problems. The first of them is simultaneity, since not only fiscal variables may have effects on population and output growth, but also population and output may be important determinants of local spending and taxation (Solé-Ollé, 2001). Moreover, if spillovers are indeed relevant, local spending may react to increases both in spending made by other localities within the metropolitan area and to metropolitan population and output growth. The simultaneity problem also appears when analysing growth spillovers, since these interactions can take place in the two directions: from the central city to the suburbs, and from the suburbs to the city. The procedure used by some authors to account for the endogeneity of central city's output and population consists of employing instrumental variables methods (Voith, 1998). The problem associated with this method is that it is extremely difficult to find variables that are correlated with the growth in one of the two areas (central city and suburbs) but not with the growth in the other one[8]. The second problem is caused by shocks that may affect at the same time both economies. For example, the structural decline in an industrial sector can affect at the same time the city and the suburbs, and result in a positive correlation between the growth rates.

[7] It should be noted that the supply of land in the locality is not constant over time; we are able to measure the land available each year for development, that may change from year to year because a portion of land available is occupied each year and because new zoning regulations are enacted.

[8] Note that the theoretical model suggests that central city's amenity variables are direct determinants of suburban output and population and, therefore can not be excluded from the equation.

The third problem is that population and output in a locality will hardly be in equilibrium in a given year. Many authors that have previously analysed growth in metropolitan areas have suggested that these variables are likely to adjust to equilibrium with substantial lags (Mills and Price, 1984; Carlino and Mills, 1987; Boarnet, 1994). However, these papers use to analyse growth with a cross-section of cities during a long period (ten or twenty years). This means that the dynamics of the model are quite simple, and consist only of conditioning by the initial value of output or population. Although panel data seem more appropriate to analyse local growth dynamics, papers using this approach are really scarce (see Bollinger and Ihlandfelt, 2000 for an exception). With panel data, the relationship between the levels of population, output and fiscal variables both in the central city and in the suburbs could be modelled by means of a vector autoregressive model (VAR). Different methods have been proposed to estimate dynamic panel data models with fixed effects (Holtz-Eakin *et al*, 1988, and Arellano and Bond, 1990). However, if some of the variables analysed are not stationary, none of these are appropriate. Indeed, if some of the variables have a long-run relationship (i.e., they are cointegrated) it will be more appropriate to add this long-run relationship (Error Correction Mechanism) to the equation (Hamilton, 1994).

Following this approach we will deal with the dynamics of the system by estimating a Vector Error Correction Model (VECM) with panel data. This methodology has the advantage of allowing us to disentangle the interactions between the central city and the metropolitan area that occur in the short run from those that take place in the long run. But this approach has other advantages: with this approach we will solve also the other two mentioned problems (endogeneity and common shocks) while avoiding the need to use instrumental variables.

The four-equation Vector Error Correction Model (VECM), with population and output both in the central city and in the suburbs as the endogenous variables, may be expressed as:

$$\Delta p_{jk,t} = \lambda_p.(p^*_{jk,t-1} - p_{jk,t-1}) \ + \ \sum_l \phi_l^p.\Delta\mathbf{x}_{jk,t-l} + \sum_k (\mu_k + \mu_s.(1+d_{jk})).t_t \ + \varepsilon^p_{jk,t} \qquad (11a)$$

$$\Delta y_{jk,t} = \lambda_y.(y^*_{jk,t-1} - y_{jk,t-1}) \ + \ \sum_l \phi_l^y.\Delta\mathbf{x}_{jk,t-l} + \ \sum_k (\eta_k + \eta_s.(1+d_{jk})).t_t \ + \varepsilon^y_{jk,t} \qquad (11b)$$

$$\Delta P_{jk,t} = \lambda_P.(P^*_{jk,t-1} - P_{jk,t-1}) \ + \ \sum_l \phi_l^P.\Delta\mathbf{x}_{jk,t-l} + \sum_k (\mu_k + \mu_c).t_t \ + \varepsilon^P_{jk,t} \qquad (11c)$$

$$\Delta Y_{jk,t} = \lambda_Y.(Y^*_{jk,t-1} - Y_{jk,t-1}) + \sum_l \phi_l^Y.\Delta\mathbf{x}_{jk,t-l} + \sum_k (\eta_k + \eta_c).t_t + \varepsilon^Y_{jk,t} \qquad (11d)$$

The growth of a variable is related first to the Error Correction Term, that states that a portion λ of the disequilibrium will be corrected each year. The equation includes lagged variables in first differences, where **x** denotes a vector that includes all variables and l is the lag order. The number of lags must be selected in order to insure that error terms (ε) are white noise. Each equation also includes a time trend t_t with coefficients that vary according a set of fixed characteristics: metropolitan area (k), central city (c), suburb (s) and suburb interacted with distance to the central city (d_{jk}). These trends pretend to isolate the estimated effects from regional business cycles and national trends affecting either central cities or suburbs. The system of equations to be estimated is obtained after substituting the long-run relationships (8a) to (8d) in expressions (11a) to (11d):

$$\begin{aligned}\Delta p_{jk,t} &= \alpha_0' + \alpha_{11}'.\mathbf{z}_{jk,t-1} + \alpha_{12}'.\overline{\mathbf{z}}_{jk,t-1} + \alpha_{13}'.\overline{\mathbf{Z}}_{jk,t-1} + \alpha_{21}'.\overline{p}_{jk,t-1} + \alpha_{22}'.\overline{P}_{jk,t-1} \\ &+ \alpha_{23}'.p_{i,t-1} + f_i^p + \sum_l \phi_l^p.\Delta\mathbf{x}_{jk,t-l} + \sum_k (\mu_k + \mu_S.(1+d_{jk})).t_t + \varepsilon^p_{jk,t}\end{aligned} \qquad (12a)$$

$$\begin{aligned}\Delta y_{jk,t} &= \beta_0' + \beta_{11}'.\mathbf{z}_{jk,t-1} + \beta_{12}'.\overline{\mathbf{z}}_{jk,t-1} + \beta_{13}'.\overline{\mathbf{Z}}_{jk,t-1} + \beta_{21}'.\overline{y}_{jk,t-1} + \beta_{22}'.\overline{Y}_{jk,t-1} \\ &+ \beta_{23}'.y_{jk,t-1} + f_i^y + \sum_l \phi_l^y.\Delta\mathbf{x}'_{jk,t-l} + \sum_k (\eta_k + \eta_S.(1+d_{jk})).t_t + \varepsilon^y_{jk,t}\end{aligned} \qquad (12b)$$

$$\begin{aligned}\Delta P_{jk,t} &= \delta_0' + \delta_{11}'.\mathbf{Z}_{jk,t-1} + \delta_{12}'.\overline{\mathbf{z}}_{jk,t-1} + \delta_{21}'.\overline{p}_{jk,t-1} \\ &+ \delta_{22}'.P_{jk,t-1} + f_i^P + \sum_l \phi_l^P.\Delta\mathbf{x}_{jk,t-l} + \sum_k (\mu_k + \mu_c).t_t + \varepsilon^P_{jk,t}\end{aligned} \qquad (12c)$$

$$\begin{aligned}\Delta Y_{jk,t} &= \gamma_0' + \gamma_{11}'.\mathbf{Z}_{jk,t-1} + \gamma_{12}.\overline{\mathbf{z}}_{jk,t-1} + \gamma_{21}'.\overline{y}_{jk,t-1} \\ &+ \gamma_{22}'.Y_{jk,t-1} + f_i^Y + \sum_l \phi_l^Y.\Delta\mathbf{x}_{jk,t-l} + \sum_k (\eta_k + \eta_c).t_t + \varepsilon^Y_{jk,t}\end{aligned} \qquad (12d)$$

The simultaneous introduction of variables in differences and in levels allows us to disentangle short run causality (differences) from long run causality (levels). Results of the estimation of these equations will allow the identification of the parameters of the long-run relationship. For example, the long-run effect of **z** on p (α_{11}) can be obtained as:

$$\partial p^*_{jk,t} / \partial \mathbf{z}_{jk,t-1} = \alpha_{11} = -(\alpha_{11}' / \alpha_{23}') \qquad (13)$$

and where $\alpha_{23}' = \lambda_p$, the coefficient of the error correction model, that measures the speed of adjustment to equilibrium. The other coefficients are identified similarly.

3.3 *Unit of analysis and data*

The model presented in (12a) to (12d) will be estimated with data of 28 metropolitan areas in Spain for the period 1992-2001. These areas contain 537 suburban localities and 28 central cities. The procedure used to select these metropolitan areas and localities can be described as follows. In the Spanish case, it does not exist a formal administrative register of metropolitan areas and the jurisdictions belonging to them. Given this constrain, in this paper we have proceeded to define the metropolitan areas of big Spanish cities using economic and geographical criteria. First, we follow the rule applied by the Urban initiative (European Commission) and select the big cities to be analysed as the ones with more than 100,000 inhabitants in 2001. In the case of Spain, 36 central cities overcome this size. However, eight of them lack a suburban area of significant size and have been eliminated from the sample[9]. Second, the metropolitan area for each city has been defined as the area containing the jurisdictions located less than 35 km from the central city. This geographical criteria is also used in the *Report on the big cities and the areas of urban influence,* carried out by the Spanish Ministry of Public Administrations in 2001. Due to statistical limitations, the jurisdictions with less than 3.000 inhabitants have not been considered. Finally, we obtain a database of 28 central cities and adding the jurisdictions that belong to their metropolitan areas, the sample has 565 jurisdictions.

Population data is obtained from the Population Censuses elaborated by the Spanish National Institute of Statistics. The variable measuring cities's output is an estimate elaborated by a financial institution since 1967 (*Annual Spanish Economic Report, Banesto-La Caixa*)[10]. Seven different variables are included in the vector of fiscal treats of suburbs and central cities (**z** an **Z**). The first three variables are the tax rates applied in the three main taxes available to local governments in Spain: the property tax, the

[9] The cities eliminated from the sample are those in which the population of surrounding jurisdictions represents less than 15% of the population of the central city.

[10] This is the so-called *market share* and is calculated as a function of different economic activity indicators (e.g., phones, bank offices, vehicles and commercial activities). For the whole analysed period, 1992-2001, it is the only available information at the local level. There is a high correlation between *market share* and GDP at regional (NUTS 2) level (0.99 every year) so we consider that this variable is a good proxy of the GDP of each jurisdiction.

business tax and the motor vehicle tax[11]. In the business and vehicles taxes, our tax variable is the main tax rate set by the municipality: the *common* business tax rate and the vehicle's tax rate, respectively[12]. In the property tax only one nominal tax rate is used. However, the property tax base is the assessed value of the property, and reassessments are carried out in different years for each municipality[13]. To solve this problem we have computed an effective property tax rate, adding to the nominal tax rate the percentage increase in assessed value per property after a reassessment. The data sources used to compute these variables are presented in Table 1 while descriptive statistics are in Table 2.

[Insert Tables 1 and 2 about here]

The other four fiscal variables are variables related to the public services provided by Spanish local governments. Since it is virtually not possible to obtain data on service's outputs or outcomes we will use public expenditures per head. The first two variables included are operating expenditure per head and an estimate of the capital stock per head. The capital stock has been computed by the perpetual inventory method, using a depreciation rate of 4%[14]. To compute this capital stock we have used municipal capital expenditure since 1983. Although we admit this is a short history of investment, the reader should note that democratic local governments in Spain begun its work just in 1979. Capital deficits were huge before that date and capital investment was very high during the eighties[15]. We use two additional variables that try to differentiate among

[11] The property tax is the main municipal tax in Spain, accounting for nearly half of tax receipts and a 20% of current revenues. The property tax is borne both by residential and business real state at the same nominal tax rate. The business tax accounts for about 20% of tax receipts and is a license-type tax borne both by corporations and individual firms. The motor vehicle tax accounts for a 15% of tax receipts; the tax is borne by all vehicle owners, firms and individuals, and is paid according the power of the vehicle.

[12] In the business tax, two proportional tax rates are applied to the tax base: the first one is common to all taxpayers but the second depends on the category of the street where the firm is located. In the vehicle tax, different tax rates are applied to different kinds of vehicles (autos, trucks, vans,...).

[13] In this situation, nominal tax rates will give a misleading impression of the evolution of tax burden. For example, after a reassessment, municipalities tend to compensate (totally or partly) tax base increases with tax rate reductions. Therefore, when one looks at nominal tax rates, municipalities with recent reassessments tend to appear as having low relative tax burdens.

[14] This depreciation rate is the one implicit in the capital stocks for urban infrastructure computed by IVIE (Valencian Institute of Economic Research) at the NUTS II level (vid IVIE, 1996, *The capital of Spain and its regional distribution*).

[15] For example, using IVIE's data, the stock of urban infrastructures multiplied by more than two during the period 1983-92.

expenditure directed to households and expenditure directed to firms. The first one is the percentage of expenditure on personal services. We include in this category the expenditure in education, health, social services and culture and sports. The second one is the percentage of expenditure on business promotion. We include in this category the expenditure on training and job promotion, tourism and commercial site promotion, and direct aids to business. The categories not included in these two variables are sewers, streets and parks, water delivery, traffic control and protection.

3.4 *Estimation of the model*

There are two main difficulties in the estimation of the model presented in (12a) to (12d). First, in order to check if the VECM specification is appropriate it is necessary to test for the stationarity of each of the variables. The availability of only 10 years questions the validity of the standard unit root tests carried out city by city. However, recent papers have developed more powerful unit root tests that exploit the panel structure of the data. We use two of these tests developed by Breitung and Meyer (1994) and Im *et al.* (1995). The results show that in most of the cases the null hypothesis of a unit root in the series in levels can not be rejected[16].

Second, the use of a Vector Error Correction Model (VECM) requires that all the series are I(1) but also that (at least) a linear combination of themselves is I(0). That is to say, it is necessary that the series are co-integrated or that it exists a long run relationship among them. For different reasons, the co-integration procedure of Engle and Granger (1987) is not appropriate in our case[17]. In this work, an alternative procedure suggested by Kremers *et al*. (1992) is used. This procedure consists of verifying the co-integration hypothesis by means of a test of joint significance of the variables in levels included in

[16] The only doubt arises in the case of the business tax rate (both in the suburbs and in the central city) and in the cases of spending on personal services and on promotion in the central city. The results of the unit root tests are not included to save space but are available upon request.

[17] In time series models co-integration relationships are usually estimated by means of the two stage procedure of Engle and Granger (1987). The first stage consists of estimating an equation in levels (cointegration equation) and to test for the stationarity of the residuals. In a second stage the model is estimated in differences including the residuals of the first stage regression as an additional variable. This procedure is justified because the first stage estimators converges at a rate T instead of a rate $\sqrt{T}$ of the second stage estimators. However, as Breitung and Meyer (1994) point out, this argument is not applicable to the panel data analyses that assume T is fixed. Also, just as Kremers *et al*. (1992) show, in occasions the traditional method presents a limited power to detect unit roots, due to the common factor constraint that it imposes.

the VECM[18]. This method has the additional advantage of not assuming the existence of a single long run relationship among the variables.

There is, however, an additional difficulty in the application of this procedure in the presence of individual effects. The OLS estimation of (12a) to (12d) will give biased estimators for values of T fixed and $N \rightarrow \infty$ (Nickell, 1981). But, as Breitung and Meyer (1994) demonstrate, in this case the typical instrumental variables estimators for dynamic panel data models (e.g., Arellano and Bond, 1991) can neither be used, because they are not valid when unit roots are present. To solve this problem we will apply the method proposed by Breitung and Meyer (1994), which consists of eliminating the fixed effect subtracting to both sides of the equation the first observation of the sample[19]. After differentiating the model in this way the four equations have been estimated jointly by SURE.

4. Results

The results of the estimation of the VECM are presented in Table 3. As we explained above the four equations of the model were estimated jointly by SURE after eliminating the individual effects[20]. The model also includes two lags of the variables in differences although its coefficients are not presented in Table 3 because are not the primary interest of the paper[21].

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[18] For fixed T, the LR statistic, that compares the log-likelihood function of the model with and without the variables in levels, is distributed as a χ^2 with degrees of freedom equal to the number of variables included. These authors show that the results of this procedure are very similar to those of the maximum likelihood procedure developed by Johanssen (1988).

[19] As these authors show, the OLS estimator of the differenced model is also biased, although the bias is much smaller that in the rest of procedures if the dispersion of the individual effects is high.

[20] Table 3 includes a LR test of joint significance of the individual effects. This test has been carried out from the OLS estimation of (12a) to (12b) considering the individual effects as constants. This procedure will not be the one applied later to estimate the model. It is used only to test the significance of the individual effects.

[21] Table 3 also includes a LR specification test on the appropriate number of lags of the variables in differences ($\Delta \mathbf{x}$). We start with 3 lags, testing for the possibility to reduce them successively. The LR test indicates that the model with two lags is preferred to the one with one lag, but that there are not big differences between the three and two lag models.

[Insert Table 3 about here]

The explanatory capacity of the model is quite satisfactory, with an R^2 higher than 0.50. All the different sets of variables included in the equation appear to have some explanatory capacity. The LR tests presented in the bottom of Table 3 show that none of them can be excluded from the equations. Following Kremers *et al*. (1992) the LR test on the joint significance of all the variables in levels can be interpreted as a co-integration test. As can be checked from the Table 3 the χ^2 statistic is significant at the 95% in all the equations[22]. However, the other LR tests suggests that neither neighbour's output and population, nor own and neighbour's fiscal variables can be excluded from the long-run relationship. The LR test also confirms that specific time trends must be included in all the equations. The results for the control variables are also as expected. Land availability has a positive effect on output and population growth both in the suburbs and in the central city, although in this last case the coefficients are not statistically significant at conventional levels. The different trends included are also significant. During the period analysed suburbs have grown at a higher rate than central cities, and this is true both for output and for population. However, the suburbs that are more distant form the central city have experienced lower output and population growth rates.

Therefore, we can conclude that our specification is appropriate and that both fiscal and growth spillovers are relevant determinants of output and population growth. But more insight is to be gained when looking at the effects of concrete variables. In analysing each group of variables it will be useful to compare not only the estimated VECM coefficients but also the long-run effects, that are presented in Tables 4 and 5.

[Insert Tables 4 and 5 about here]

4.1 *Tax rates*

The effects of own tax rates on output and population growth are similar in the suburbs than in the central city. All of them have a negative effect, both on output and on

[22] Of course, this does not mean that all the variables in levels belong to the long-run relationship since some of them are not individually significant.

population. However, the only coefficients that are statistically significant are those of the property and vehicle tax rates and only in the output equations. Moreover, the coefficients of the vehicle tax rate are only significant at the 90% level. Suburb's tax increases have similar effects in other suburbs and in the central city. The effect is positive in all the cases, although as happened with own tax effects, only the coefficients of the property and vehicle taxes in the output equations are statistically significant. The effects of tax increases in the central city on growth in the suburbs are similar to the former and positive. But now high business tax rates in the central city foster suburban output growth (the coefficient is significant at the 90% level) and high property and vehicle taxes foster also suburban population growth.

Therefore, the results obtained suggest that tax rates harm output growth in the locality (both in a suburb and in a central city) and foster output growth in the neighbourhood. These conclusions are valid mainly for the property tax and for the vehicle tax, and are more dubious for the business tax. However, the fact that the coefficients of the business tax also have the expected sign (negative own effects and positive neighbour effects), and the significant positive effect of central city's business tax rates on suburb's growth, suggest that also in this case some effect may be at work.

The results show that taxes have effects not only in the own locality but also in the neighbourhood. The signs obtained for the spatially lagged variables suggest that in this case the *competition effect* dominates. The long-run elasticities presented in Table 4 may help to analyse the strength of this effect. Since the effects on population are negligible we will concentrate on the effects of taxes on output. Both in the suburbs and in the central city, the own long-run elasticities are near -0.4 for the property and business tax rates and slightly lower than -0.3 for the vehicle tax rate. The neighbours' tax effects have in all the cases an elasticity higher than one. This high value, however, merits an appropriate interpretation, since it is influenced by the method used to compute tax accessibility measures. The formula used can be written in the case of accessibility to suburbs' tax rates as:

$$\bar{t}_{jk,t} = \sum_{i \neq j} \frac{t_{ik,t}}{d_{ji}}$$

Therefore, the long-run output change as a result of a tax increase must be expressed as:

$$\partial y^{*}_{jk,t} / \partial t_{jk,t-1} = \alpha_{11}/d_{ji}$$

The effect depends thus on the distance between localities *j* and *i*. For example, if the distance is 2 km (the minimum distance between two points in the sample), the long-run estimated elasticity should be divided by two. Just below the long-run elasticity estimates of Table 4, we include in brackets the values of this elasticity computed at distances of 5 and 10km. The property tax elasticity computed at 5 km are a little lower (in absolute value) than the own tax elasticity. The 5 km vehicle tax elasticity are quite similar to the own elasticity. Note that the elasticity values are similar irrespective of the direction of the spillover: suburb-to-suburb, suburb-to-central city or central city-to-suburb.

The own tax-elasticity results are similar to those obtained by Solé and Viladecans (2001). However, when compared with American studies, this magnitude is similar or even higher to the one obtained in intermetropolitan[23] analysis but much lower than the one obtained in intra-metropolitan studies. To understand these results note, first, that our analysis makes use both of intra and intermetropolitan variation in tax rates and, second, that the level of local taxation in Spain is relatively modest (compared to the US case) both because local governments have a more limited scope (e.g., they have few responsibilities in the provision of education) and a because a non-negligible portion of expenditure is financed by transfers (roughly 40%). There are few studies estimating the tax spillover effects and none of them differentiate between spillover types. However, the suburb-to-suburb property tax elasticity is similar to the one found in the intra-metropolitan analysis of Solé and Viladecans (2001), although the numbers are not exactly comparable because in that paper the spatial weights were standardised. The geographical scope of these spillovers is also similar to the one found in Houdebine and Schneider (1997), that found that the most intense locational effects of business tax differences in France are felt at distances of less than 10km.

4.2 *Expenditure and capital stock*

The effects of own operating expenditure and capital stocks on output and population

[23] As surveyed by Bartik (1991) many intermetropolitan studies fail to obtain significant effects of local taxes on economic activity.

growth is positive, both in the suburbs and in the central city, although the significance and size of coefficients are not the same for all the variables. In the case of suburbs, operating expenditure is not statistically significant in the population equation and is significant at the 90% in the output equation. In the case of the central city this variable is statistically significant in both equations, but only at the 90% in the population equation. Capital stock per capita is statistically significant in all the cases but only at the 90% in the central city's population equation. Also, as expected, spending on personal services has a positive effect on population growth, although in the case of the central city the coefficient is significant only at the 90%. Spending on promotion has a positive effect on output growth but not on population growth, although only in the case of the central city the coefficient is statistically significant at the 90% level.

Expenditure and capital stocks in the neighbourhood are also important for output and population growth, but the pattern is different from that shown by tax rates. Operating spending and capital stock in the suburbs have a positive effect on output growth both in the suburbs and in the central city, although the coefficients of the capital stock are not statistically significant at conventional levels. Spending on personal services in the suburbs does not have any effect on output growth but spending on promotion has a negative and significant effect on growth, although with a quite small coefficient. These results are confirmed when analysing the effects of the central city on the suburbs; but in this case both operating spending and the capital stock of the central city have positive and significant effects on suburban output growth. These positive effects suggest that firms not only benefit from services provided where they are located but also from services provided by other localities in the metropolitan area (both by the suburbs and by the central city). This ultimately means that the *spillover effect* is higher than the *competition effect*. Note however, that this does not mean that the *competition effect* is not present: the positive effect of neighbour's tax rates and spending in promotion suggest that these instruments may be used to attract firms from other localities. The only meaning of these result is that, in the case of expenditure policies not targeted to firm attraction (picked up by the variables operating expenditure and capital stock), the spillover effect dominates over the competition effect.

To analyse the magnitude of these effects it is necessary to have a look at the long-run output elasticity shown in Table 4. First, the long-run own expenditure elasticity

(Operating spending and capital stock) are around 0.2, slower (in absolute value) than the long-run own tax elasticity. Second, these own expenditure elasticities are much higher in the case of the central city: 0.755 and 0.540 for operating spending and the capital stock, respectively. Third, own long-run elasticity for spending on promotion are very low (around 0.04). Fourth, regarding spillover effects, the effects of suburb's operating spending is higher in the suburbs (with a long-run elasticity of 0.2, similar to the own effect) than in the central city (0.14 and much lower than the own effect). The effects of central city's expenditure policies on the suburbs is much higher (the long run elasticity is 0.31 for operating spending and 0.652 for the capital stock) than when these policies are undertook by other suburbs (0.20 for operating spending and 0.14 and not statistically significant for the capital stock). These are perhaps the most important results of the paper: the effects of public spending (measured both by operating expenditure and the capital stock) are much higher when provided by the central city than when provided by localities in the suburbs. Moreover, expenditure and capital stocks in the central city provide substantial benefits (in terms of output growth) for the suburbs. Although it is true that suburbs expenditures also provide services both to other suburbs and to the central city, the suburb-to-suburb and suburb-to-central city expenditure spillovers are much lower than the central city-to-suburb spillovers.

The effects of expenditure policies on population growth show a different pattern. The variables that appear to be statistically significant (depending on the equation: operating spending, capital stock and spending on personal services) have a negative effect on population growth, irrespective of the direction of the spillover: suburb-to-suburb, suburb-to-central city and central city-to-suburb. Therefore, in this case the *competition effect* seems to dominate over the *spillover effect* in all the policy instruments. The long-run elasticity, presented in Table 4, will help us to assess the magnitude of these effects. Own population expenditure elasticities are lower than in the output case and similar in the suburbs and in the central city. The elasticity of the capital stock is slightly higher than the one corresponding to spending on personal services, and both are much higher than the one of operating spending. Turning to the spillover effects, the long-run elasticity of suburb's expenditures is similar in magnitude to the own effect. However, the effects of central city's expenditures are really high: -0.444 for operating spending and -0.602 for spending on personal services. In the case of this last variable, for example, the long-run elasticity computed at 5 km is -0.12, just the same than the own long-run elasticity. This effect is much higher than the own effects but also than the effects that suburb's expenditures have both on other suburbs and on the central city. However, the effect of suburb's on the central city are also quite high (the long-run elasticity of central city's population to spending on personal services in the services is -0.26, higher than the suburb-to-suburb effects, that have in this case an elasticity of -0.101).

Therefore, in the case of population growth, not only the *competition effect* dominates over the *spillover effect*, but there is also evidence that competition takes place both among the suburbs and between the suburbs and the city. However, we have to note that in the case of population, the magnitude of the long-run elasticities is quite low. Moreover, given that many expenditure and tax variables are not statistically significant in this case, we must conclude that fiscal interactions are less relevant than in the case of economic activity.

The spillover effect of central city's capital stock on suburban localities is similar to the one in Haugwhout (1998), that found that an increase of a 1% of the central city's capital stock increases suburban house values by a 0.13%. However, as this estimate comes from an hedonic model it is difficult to compare it with our results. Contrary to Haugwhout (1998), however, is the fact that in our case the spillovers coming through the operating spending are not lower than those coming through the capital stock. The author gives various explanations to this result, but none of application to our case, since by definition of the kinds of services accounted for in the operating expenditure and capital stock variables are very similar.

4.3 *Growth spillovers*

Table 3 also provides evidence of *growth spillovers* among suburbs and between the suburbs and the central city. First, the output level in the central city has positive effects on output growth in the suburbs, but the reverse is not true: higher output in the suburbs does not foster growth in the central city. Moreover, an increased accessibility to suburbs' output harm output growth of suburban localities. The strength of these effects can be checked by looking at the long-run coefficients presented in Table 4. A 1% increase in the output of the central city increases long-run suburban output by 0.371%.

Of course, also in this case the effect is mitigated by distance: this effect is of only 0.174 at two km and 0.074 at five km. The suburb-to-suburb output effect is even stronger, since a 1% increase in the accessibility to suburb's output will in the long-run reduce the output of the locality by a 1%. Therefore, while growth of suburbs and the central city is complementary, growth in different suburbs is substitutive: growth in one suburban locality occurs at the expense of the growth in the neighbourhood.

These spillover effects also appear in the population equation. A 1% growth in the population of the central city increases long-run suburban population by nearly 1%. As in the output equations, the reverse is not true: accessibility to suburban populations do not raise central city's population in the long-run. Accessibility to suburban population also harms long-run population in a given suburban locality, but in this case the coefficient is not significant.

With these results, and using expression (7), we are able to assess the relevance of *direct* vs. *indirect spillovers*. For example, as show Table 4, the direct effect on suburbs output of a 1% increase in the city's capital stock is 0.652. However, a 1% increase in the city capital stock will raise city's output by 0.540; as the effect of 1% increase of city's output in suburb's output is 0.371, the indirect effect of city's capital stock is $0.371\times0.540=0.2$. Therefore, 76% of public capital *spillovers* are *direct* (i.e., 0.652/(0.652+0.2)) and the remaining 24% are *indirect growth spillovers*. In the case of operating spending, direct effects are 0.310 and indirect effects are $0.371\times0.775=0.29$. In this case, *indirect growth spillovers* are as important as *direct spillovers*.

5. Conclusions

This paper has presented some empirical evidence on two hypothesis: a) public services provided by the central city foster growth in the suburbs, and b) growth in the central city fosters growth in the suburbs. Regarding the first hypothesis, the results show that increases in operating spending and the capital stock in the central city have positive effects on long-run output growth in the suburbs. Operating spending in the suburbs also has positive effects on output growth both in the suburbs and in the central city, but the magnitude of these effects is much lower. Although this evidence is consistent with the existence of *benefit spillovers*, the results corresponding to other policy instruments suggest that suburbs and central cities *compete* to attract economic activity. For example, we have found positive effects of central city's taxes and negative effects of central city's promotion spending on suburbs output growth. In this case the effects caused by cities and suburbs' have the same sign and similar magnitude. This means that the *competition effect* occurs both among suburbs and between suburbs and the central city. Some of these effects are also present in the case of population growth, but in general, fiscal variables are less able to explain population than output growth.

Regarding the second hypothesis, the results show that output growth in the suburbs is higher the higher is the output of the central city. Long-run population growth is also higher the higher is central city's population. Therefore, *growth spillovers* seem to be also a relevant empirical fact, at least in the sample analysed. Moreover, the results show that in this case the spillovers only go from the central city to the suburbs; there are no spillovers from the suburbs to the central city or among suburbs.

The evidence provided in the paper may have important economic policy implications. If central city's services provide benefits (direct or indirect) to suburban residents and firms, it may be of interest to them to guarantee that the central city is not in financial trouble. Therefore, this evidence may be used by central city mayors to claim for improvements in its funding system. In fact, unconditional transfers to Spanish municipalities are currently under discussion. One the one hand, some people argue about the need to keep the high population weights for big cities in the calculation of expenditure needs. On the other hand, there is a proposal to reinforce the privileges of big cities (those with more than 500 thousand inhabitants) and even to extent them to the cities with more than 100 thousand inhabitants. The results of the paper can be used to evaluate the effect of change in the design of that transfer, consisting in transferring funds from the small localities in the suburbs to the central cities, but without changing the total amount of the transfer.

To perform this simulation, note in Table 1 that the stock of capital and operating spending per head are not very different in the suburbs and in the central city. Therefore, if we assume that a change in transfers is fully converted to a change in expenditures[24], the effect of a transfer of resources from the suburb to the central city will have, more or less, the same per cent impact (but of opposite sign) on spending per head. If we use the parameters in Table 4, a 1% increase in the capital stock of the central city provokes a total (direct+indirect effect) increase of 0.852% in suburbs' output, wile a 1% drop in suburbs capital stock provokes a reduction of only 0.24% in suburbs' output. If the adjustment is made through operating spending, the total spillover effect provokes an increase of 0.6% in suburbs' output, while the own effect provokes a reduction of 0.2% in suburbs' output. Therefore, not only the central city[25] but also the suburbs would gain from the reallocation of transfers.

[24] This is only one of the possible policy simulation that can be conducted. The conclusions may change if one assumes that increased funds to the central city must be financed with suburban taxes.

[25] In the case of the central city, the own effect (0.775 for operating spending and 0.540 for the capital stock) clearly dominates the direct spillover effect (0.141 for operating spending and 0.051 for the capital stock; see Table 4). Note that in this case there are no indirect growth spillovers.

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Table 1:
Descriptive statistics,years 1992, 2001 *and average* 1992-2001.

	Mean			*Standard Deviation*		
	1992	2001	1992-2001	1992	2001	1992-2001
Suburbs:						
- *Output* (*y*)	116.80	172.84	140.63	182.29	216.92	215.62
- *Population* (*p*)	23,027	24,429	23,634	36,368	36,139	35,992
- *Property tax rate*	0.675	0.878	0.754	0.254	0.709	0.443
- *Business tax rate*	1.560	1.594	1.584	0.261	0.302	0.284
- *Vehicle tax rate:*	1.297	1.515	1.431	0.229	0.177	0.223
- *Operating spending/head.:*	188.09	372.52	275.15	63.55	74.60	86.21
- *Capital stock/ head*	397.84	1,007.57	702.71	65.56	234.96	181.06
- *% Spending on personal services*	0.458	0.420	0.435	0.042	0.165	0.140
- *% Spending on promotion*	0.018	0.031	0.017	0.064	0.097	0.050
- *Land available/ head.*	114.90	108.77	110.00	115.35	120.93	119.30
Central cities:						
- *Output* (*y*)	2,690.78	3,176.48	2,923.10	4,206.94	4,648.13	4,376.91
- *Population* (*p*)	394,792	414,607	410,123	583,049	574,620	572,628
- *Property tax rate*	0.655	0.767	0.705	0.210	0.271	0.249
- *Business tax rate*	1.450	1.475	1.460	0.446	0.467	0.453
- *Vehicle tax rate:*	1.200	1.318	1.255	0.176	0.228	0.206
- *Operating spending/ head.*	232.59	357.98	270.34	110.03	135.70	124.46
- *Capital stock/ head*	416.74	1,042.45	729.60	104.54	203.15	172.02
- *% Spending on personal services*	0.512	0.535	0.529	0.011	0.080	0.072
- *% Spending on promotion*	0.025	0.018	0.021	0.017	0.047	0.030
- *Land available/ head.*	31.43	34.70	32.52	15.96	26.22	21.41

Notes: Output is measured in thousand of euro, operating spending per capita and capital stock per capita are measured in euro; the property tax rate is expressed in % but the other two tax rates are coefficients that multiply minimum taxes, so they can not be interpreted as a %; land available per capita is expressed in m^2.

Table 2: *Variable definition and statistical sources*

	Definition	*Statistical sources*
- *Output* (*y*)	GDP estimation called *Market share* and computed using a battery of economic activity indicators	*Anuario Económico de España*: Banesto-"La Caixa", various years
- *Population* (*p*)	Population counts for 1996 and official estimates for the other years	Instituto Nacional de Estadística (INE)
- *Property tax rate*	Nominal tax rate (%) and adjustment for years after a property value reassessment campaign	Tax rates, year of reassesment and number of urban properties taken from the "Property tax data file" from Centro de Gestión Catastral, Ministerio de Economía, various years
- *Business tax rate*	"Tax burden coefficient"	*Tipos impositivos y coeficientes de los impuestos municipales*, Ministerio de Economía, various years
- *Vehicle tax rate*	Tax rate on autos	
- *Operating spending/ head.*	Spending on personnel, materials and current transfers; interest payments excluded	"Municipal outlays data file", Ministerio de Economía, various years
- *Capital stock/ head*	Accumulated sum of investment made by the locality since 1983, allowing for a linear depreciation rate of 4%	"Municipal outlays data file", Ministerio de Economía, 1992-2001, and "Municipal budget data file", 1983-1991
- *% Spending on personal services*	Operating spending on social services (function 3 of the budget), health (function 4.1), education (function 4.2), and culture and sports (functions 4.4 and 4.5) over total operating spending	"Municipal outlays data file", Ministerio de Economía, various years
- *% Spending on promotion*	Operating spending on promotion of economic activities (functions 6 and 7 of the budget)	"Municipal outlays data file", Ministerio de Economía
- *Land available/ head.*	Area of not developed urban land	"Property tax data file" from Centro de Gestión Catastral, Ministerio de Economía

Table 3: *Results of the SURE estimation of the Vector Error Correction Model (*VECM*).*(*N*=565, *T*=10)

	Effects on suburbs:		*Effects on central city:*	
	Δy	Δp	ΔY	ΔP
i.- *Own fiscal effects, suburbs*: $\mathbf{z}$ (t-1)				
- *Property tax rate*	-0.027	-0.008	--.--	--.--
	(-3.124)**	(-1.604)		
- *Business tax rate*	-0.031	0.001	--.--	--.--
	(-1.430)	(0.333)		
- *Vehicle tax rate*	-0.017	-0.014	--.--	--.--
	(-1.867)*	(-1.102)		
- *Operating spending/hab.*	0.014	0.012	--.--	--.--
	(1.775)*	(1.462)		
- *Capital stock/hab*	0.017	0.008	--.--	--.--
	(2.002)**	(3.687)**		
- *% Spending on personal services*	-0.018	0.006	--.--	--.--
	(-0.736)	(2.550)**		
- *% Spending on promotion*	0.002	0.000	--.--	--.--
	(0.939)	(0.020)		
ii.- *Own fiscal effects, central city:* $\mathbf{Z}$ (t-1)				
- *Property tax rate*	--.--	--.--	-0.034	-0.034
			(-2.236)**	(-1.302)
- *Business tax rate*	--.--	--.--	-0.041	-0.052
			(-0.861)	(-0.311)
- *Vehicle tax rate*	--.--	--.--	-0.024	-0.019
			(-1.984)*	(-0.905)
- *Operating spending/hab.*	--.--	--.--	0.065	0.021
			(2.877)**	(1.854)*
- *Capital stock/hab*	--.--	--.--	0.045	0.004
			(2.632)**	(1.955)*
- *% Spending on personal services*	--.--	--.--	0.002	0.015
			(0.888)	(1.965)*
- *% Spending on promotion*	--.--	--.--	0.003	0.000
			(1.954)*	(0.101)
iii.- *Fiscal effects of suburbs:* $\bar{\mathbf{z}}$ (t-1)				
- *Property tax rate*	0.088	0.017	0.097	0.025
	(3.202)**	(1.441)	(2.112)**	(0.761)
- *Business tax rate*	0.046	0.011	0.061	0.064
	(0.314)	(0.621)	(1.103)	(1.231)
- *Vehicle tax rate*	0.072	0.030	0.126	0.022
	(2.354)**	(1.203)	(1.923)*	(0.984)
- *Operating spending/hab.*	0.015	-0.003	0.012	0.008
	(2.112)**	(-2.441)**	(2.269)**	(0.711)
- *Capital stock/hab*	0.010	0.007	0.004	-0.012
	(1.651)	(0.862)	(1.306)	(-1.725)*
- *% Spending on personal services*	0.003	-0.005	-0.002	-0.029
	(0.666)	(-2.412)**	(-0.088)	(-2.799)**
- *% Spending on promotion*	-0.004	-0.000	-0.003	0.000
	(-2.123)**	(-0.428)	(-2.300)**	(0.504)
iv.- *Fiscal effects of central city:* $\bar{\mathbf{Z}}$ (t-1)				
- *Property tax rate*	0.074	0.026	--.--	--.--
	(5.604)**	(2.623)**		
- *Business tax rate*	0.068	0.038	--.--	--.--
	(1.814)*	(0.901)		
- *Vehicle tax rate*	0.083	0.058	--.--	--.--
	(4.699)**	(4.011)**		
- *Operating spending/hab.*	0.022	-0.023	--.--	--.--
	(4.870)**	(-2.112)**		
- *Capital stock/hab*	0.046	0.005	--.--	--.--
	(5.112)**	(0.944)		
- *% Spending on personal services*	-0.004	-0.031	--.--	--.--
	(-0.804)	(-2.125)**		
- *% Spending on promotion*	-0.005	0.001	--.--	--.--
	(-2.766)**	(0.244)		

Table 3: (continued)

Results of the SURE estimation of the

*Vector Error Correction Model (*VCE*).(*N=565, T=10)

	Effects on suburbs:		*Effects on central city:*	
	Δy	Δp	ΔY	ΔP
	v.- *Output*			
Own effects, suburbs: y (t-1)	-0.071 (-5.700)**	--.--	--.--	--.--
Own effects, central city: Y (t-1)	--.--	--.--	-0.084 (-2.116)**	--.--
Effects of suburbs: $\bar{y}$ (t-1)	-0.105 (-8.445)**	--.--	0.014 (0.436)	--.--
Effects of central city: $\bar{Y}$ (t-1)	0.016 (6.231)**	--.--	--.--	--.--
	vi- *Population*			
Own effects, suburbs: p (t-1)	--.--	-0.052 (-2.325)**	--.--	--.--
Own effects, central city: P (t-1)	--.--	--.--	--.--	-0.112 (-2.223)**
Effects of suburbs: $\bar{p}$ (t-1)	--.--	-0.046 (-1.325)	--.--	-0.053 (-1.424)
Effects of central city $\bar{P}$ (t-1)	--.--	0.051 (1.721)*	--.--	--.--
	vii.- *Land availability*			
Own effects, suburbs: n (t-1)	0.009 (5.112)**	0.009 (5.665)**	--.--	
Own effects, central city: N (t-1)	--.--	--.--	0.002 (1.324)	0.006 (1.625)
	viii – *Trends*			
Suburbs: $d_S \times .t_t$	0.012 (8.123)**	0.006 (3.305)**	--.--	--.--
Central city: $d_C \times .t_t$	--.--	--.--	-0.003 (-0.400)	0.003 (1.955)*
Distance to central city: $(d_{ij} \times 100).t_t$	-0.006 (-2.236)**	-0.005 (-3.671)**	--.--	--.--
R2	0.544	0.514	0.666	0.595
Panel Durbin-Watson	1.985	1.833	2.100	2.110
LR. Test (*variables in levels*)	107.21**	97.05**	90.21**	87.25**
LR. Test. (*neighbours' population and output*)	15.20**	17.31**	31.00**	29.34**
LR. Test (*own fiscal variables*)	59.33**	33.45**	25.64**	10.18**
LR. Test. (*neighbours' fiscal variables*)	69.65**	50.33**	46.39**	39.38
LR. Test (*area trends*)	98.47**	44.64**	55.94**	61.22**
LR. Test (*individual effects*)	69.11**	80.41**	69.10**	101.46**
LR. Test (3 *to* 2 *lags*)	8.26	8.20	7.34	3.27
LR. Test (2 *to* 1 *lag*)	30.64**	41.11**	35.11**	62.19**

Notes: (1) t-statistics are shown in parenthesis, **=statistically significant at the 95% level, *=statistically significant at the 90% level, (2) Equations estimated as a system after the elimination of individual effects, (3) Two lags of the differenced variables included but not shown, (4) Specific area time trends included but not shown, (5) LR tests performed equation by equation and distributed as a $\chi 2(n)$ with n=number of variables excluded, (6) The LR test on the joint significance of the individual effects ha been performed on the LSDVresults.

Table 4:
Long-run parameters

	i.- *Effects on output*				
	i.1.- *Effects on suburbs*			i.2.- *Effects on central city*	
	Own effects ($\mathbf{z}$)	*Effects of suburbs* ($\bar{\mathbf{z}}$)	*Effects of central city* ($\bar{\mathbf{Z}}$)	*Own effects* ($\mathbf{Z}$)	*Effects of suburbs* ($\bar{\mathbf{z}}$)
- *Property tax rate*	**-0.380**	**1.241** **[0.248; 0.124]**	**1.042** **[0.208; 0.104]**	**-0.400**	**1.151** **[0.230; 0.115]**
- *Business tax rate*	-0.440	0.655 [0.130; 0.065]	**0.965** **[0.192; 0.096]**	-0.492	0.733 [0.146; 0.073]
- *Vehicle tax rate*	**-0.241**	**1.011** **[0.202; 0.101]**	**1.170** **[0.234; 0.117]**	**-0.294**	**1.500** **[0.300; 0.150]**
- *Operating spending/hab.*	**0.200**	**0.201** **[0.040; 0.020]**	**0.310** **[0.062; 0.031]**	**0.775**	**0.141** **[0.028; 0.014]**
- *Capital stock/hab*	**0.240**	0.141 [0.028; 0.014]	**0.652** **[0.130; 0.065]**	**0.540**	**0.051** **[0.010; 0.005]**
- *% Spending on pers. ser.*	-0.025	0.042 [0.008; 0.004]	-0.062 [-0.012; -0.006]	0.025	-0.023 [-0.004; -0.002]
- *% Spending on promotion*	0.032	**-0.062** **[-0.012; -0.006]**	**-0.070** **[-0.014; - 0,007]**	**0.043**	**-0.045** **[-0.009; -0.004]**
- *Output*	--.--	**-1.050** **[-0.210; -0.105]**	**0.371** **[0.074; 0.037]**	--.--	0.170 [0.034; 0.017]

	ii.- *Effects on population*				
	ii.1.- *Effects on suburbs*			ii.2.- *Effects on central city*	
	Own effects ($\mathbf{z}$)	*Effects of suburbs* ($\bar{\mathbf{z}}$)	*Effects of central city* ($\bar{\mathbf{Z}}$)	*Own effects* ($\mathbf{Z}$)	*Effects of suburbs* ($\bar{\mathbf{z}}$)
- *Property tax rate*	-0.150	0.333 [0.066; 0.033]	**0.500** **[0.100; 0.050]**	-0.300	0.225 [0.044; 0.022]
- *Business tax rate*	0.020	0.211 [0.042; 0.021]	0.730 [0.146; 0.073]	-0.461	0.571 [0.114; 0.057]
- *Vehicle tax rate*	-0.273	0.584 [0.116; 0.058]	**1.120** **[0.224; 0.112]**	-0.142	0.200 [0.040; 0.020]
- *Operating spending/hab.*	0.048	**-0.065** **[-0.013; -0.006]**	**-0.444** **[-0.088; -0.044]**	0.041	**-0.070** **[-0.014; -0.007]**
- *Capital stock/hab*	**0.154**	0.131 [0.026; 0.013]	0.100 [0.020; 0.010]	**0.194**	0.071 [0.014; 0.007]
- *% Spending on pers. ser.*	**0.121**	**-0.101** **[-0.020; -0.010]**	**-0.602** **[-0.120; -0.060]**	**0.131**	**-0.260** **[0.052; -0.026]**
- *% Spending on promotion*	0.000	-0.000 [0.000; 0.000]	0.021 [0.004; 0.002]	0.000	0.000 [0.000; 0.000]
- *Population*	--.--	-0.881 [-0.176; -0.088]	**0.981** **[0.196; 0.098]**	--.--	-0.472 [-0.094; -0.047]

Notes: (1) Values shown are long-run elasticities, identified by dividing parameters of Table 3 by the coefficient of the lagged dependent variable in each equation, (2) Bold numbers indicate that the elasticities are statistically significant at the 95% or at the 90% levels, (3) Numbers in brackets are elasticities computed at distances of 5 and 10 km, respectively.

SÈRIE DE DOCUMENTS DE TREBALL DE L'IEB

2000

2000/1 - Esteller, A.; Solé, A., "Vertical Income Tax Externalities and Fiscal Interdependence: Evidence from the US"
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