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Tax decentralisation, the *flypaper effect*, and growth

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The aim of this paper is to determine a theoretical linkage between tax decentralisation and growth. For this purpose, we consider a two-tier framework of local and federal government originally developed to examine how changes in taxes and transfers affect long-term equilibrium values of consumption and capital stock. In this framework we introduce a tax decentralisation indicator, take into account the existence of the flypaper effect and specify a Cobb-Douglas form for the production technology. As a result we are able to determine the level of tax decentralisation that will maximise the long-term equilibrium per capita income. Such level depends on private and public capital productivities, the tax burden rate in the absence of decentralisation and the intensity of the flypaper effect, as we illustrate using reasonable values of these parameters. The results obtained in this paper could be empirically tested in several economies.

Con este trabajo se pretende establecer una relación teórica entre la descentralización impositiva y el crecimiento económico. Para ello, se considera un escenario con dos niveles de gobierno, local y federal, que originalmente había sido desarrollado para estudiar cómo determinados cambios en impuestos y niveles de transferencias afectaban los valores de equilibrio de largo plazo del nivel de consumo y el stock de capital en una región tipo. En dicho escenario se introduce un indicador de descentralización impositiva, se tiene en cuenta la existencia del efecto flypaper y se considera una tecnología de producción Cobb-Douglas. A partir de ahí, se puede determinar el nivel de descentralización impositiva que maximiza el valor de equilibrio de largo plazo de la renta per cápita en la región tipo. Este nivel depende de las productividades del capital público y privado, de la tasa impositiva en ausencia de descentralización y de la intensidad del

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efecto flypaper, como se ilustra partiendo de valores razonables de los parámetros del marco teórico. El resultado obtenido podría ser evaluado empíricamente a partir de datos de distintas economías.

Keywords: tax decentralisation; the *flypaper effect*; economic growth; general equilibrium analysis
JEL classification: H77; O40; R10

1. Introduction

Studies of the possible effect of fiscal decentralisation processes on economic growth opened up a new line of research in the latter half of the 1990's. This arose out of a much wider tradition concerned with the relationships between fiscal decentralisation and a series of economic and political goals, which was founded on the seminal work of Tiebout (1956), Stigler (1957), Musgrave (1959) and Oates (1972). In addition to economic growth *per se*, these goals included public spending efficiency, horizontal fiscal equity, controlling the government size, macroeconomic stability, fostering appropriate conditions in the markets and for government, and poverty reduction.

The main spur to the development of this new line of research has been the devolution process from central to lower tiers of government, a process that has taken place mainly in transitional and developing economies with the encouragement of various international bodies, particularly the World Bank. The intuition that these processes might not only affect the efficiency of public spending, horizontal fiscal equity and macroeconomic stability, comprising what might be called the traditional effects, but could also influence economic growth has led researchers at this and other international institutions to analyse this possible effect. Previous works focused on the study of the opposite effect, that of economic growth on fiscal decentralisation, found a positive relationship, this is the case of Kee (1977), Pommerehne (1977), Bahl and Nath (1986), Wasylenko (1987) and Panizza (1999).

The emergence or re-emergence of debate on the subject of fiscal decentralisation in numerous developed economies in recent decades has, meanwhile, motivated scholars to take up or continue this line of research. Consequently, the process holds an important place in the study of these economies with research focusing on the possible relationship with economic growth, one of the basic academic concerns.

A detailed review of the research into the question of the effect of fiscal decentralisation on economic growth was done in Martínez-Vázquez and McNab (2003). These scholars drew attention to the paucity of empirical work in this area, which contrasted sharply with the profusion of informal literature on the economic consequences of fiscal decentralisation. Moreover, they argued that a series of problems need to be overcome if we were to arrive at consistent estimates of the relationship between fiscal decentralisation and economic growth and avoid accepting potentially erroneous results. At the same time, they highlighted the need to develop the theoretical basis for this relationship further by answering the question of why we should expect fiscal decentralisation to have any effect on economic growth. The aim of this paper is precisely to contribute to this theoretical development.

Let us, previously, clarify the concept of fiscal decentralisation. We mean by this expression those processes by which policy is devolved from central to lower tiers of government, without specifying whether this refers to spending or revenue raising powers. Hence, when we want to refer explicitly to the transfer of spending, we shall use the term "expenditure decentralisation", and when devolution affects revenues either "revenue decentralisation" or "tax decentralisation".

Martínez-Vázquez and McNab (2003) drew a clear distinction between the direct and indirect effect of fiscal decentralisation on economic growth, indicating that the latter may be identified via the traditional effects of fiscal decentralisation. In this paper, however, we shall concentrate on the direct effect, which is clearly described in Oates (1993)[1], who transposes the essence of his proposition concerning the positive impact of fiscal decentralisation on economic efficiency to the dynamic sphere of economic growth, though without formal analysis. The economic efficiency proposition was developed within a static framework in Oates' 1972 Decentralisation Theorem and was further reinforced with the population mobility arguments, put forward by Tiebout (1956). Thus, regional and national economic growth could be increased if decisions concerning investment in different types of capital were taken at lower tiers of government, because of the greater local knowledge, political accountability and transparency existing at these levels.

[1] Nevertheless, other scholars of fiscal federalism also described effects on economic growth. See, for example, Bahl and Linn (1992), Rivlin (1992), Bird (1993) and Gramlich (1993).

With some exceptions, Oates' argument has been taken as the starting point for the empirical and theoretical research undertaken between the second half of the 1990s and the present to study the existence of possible fiscal decentralisation effects on economic growth. This series of studies includes eminently empirical work seeking to quantify the effect, such as Woller and Phillips (1998), Zhang and Zou (1998), Lin and Liu (2000), Yilmaz (2000), Thiessen (2000 and 2003), Akai and Sakata (2002), Desai *et al.* (2003), Rodríguez-Pose and Bwire (2004), Iimi (2005) and Thornton (2007) and papers that not only attempt to quantify the effect but also to construct a simple analytical model reflecting the relationship existing between the two phenomena, these include papers by Davoodi and Zou (1998), Xie *et al.* (1999), Zhang and Zou (2001), and Martínez-Vázquez and McNab (2005). Finally, there is the work of Brueckner (1999 and 2006) and Gong and Zou (2002 and 2003), who focus exclusively, and therefore in greater detail, on the construction of the analytic framework.

Our aim here is to add to the latter group of papers, which is to say those that seek to establish an analytical framework that would describe as fully as possible the relationships existing between the phenomena of fiscal decentralisation and economic growth, and for this reason we shall concentrate on the general equilibrium analysis done in Zou (1996). In this paper, the author identifies long-term effects from taxes and transfers on the accumulation of private and public capital in a representative region and, therefore, on regional economic growth. However, he does not include a process for fiscal decentralisation. Let us note here that in modelling the fiscal decentralisation process within the framework of growth models the literature has hitherto concentrated on expenditure decentralisation to arrive at growth-maximising expenditure shares among different levels of government[2], while disregarding any consideration of the effects of revenue decentralisation on economic growth. It is this limitation in the literature on the subject, which we seek to resolve in this paper. Where we determine the level of revenue decentralization that maximises the long term equilibrium per capita income in the representative region and the main factors on which depends.

The paper is structured as follows. Firstly, we briefly present the analytical framework described in Zou (1996) and its key results. We then

[2] See, inter alia, Davoodi and Zou (1998), Xie et al. (1999), and Zhang and Zou (2001).

go on to describe how tax decentralisation might be considered in such framework and identify its effects on local growth, which give rise to determine the optimal level of tax decentralisation. Next we show that such level depends on private and public capital productivities, the tax burden rate in the absence of decentralisation and the intensity of the *flypaper effect* and we use simulations in order to show how such relationship works. We end with our conclusions and an indication of possible avenues to extend this research.

2. The analytical framework in Zou (1996)

Zou (1996)[3] considers a two-tier structure of local and federal government, each with their own income tax, a local consumption tax, intergovernmental transfers and balanced budgets. Based on this scenario, the author examines how changes in such taxes and transfers affect the long-term equilibrium values for private consumption and the stock of private capital, as well as local public consumption and stock of capital. In order to do that, under the assumption that the federal government does not invest or consume on its own behalf in the region, the author addresses dynamic optimisation by the private agent and the representative local government. Both seek to maximise the well-being of the agent, taking into account their respective budget constraints, based on the respective control variables (local private and public consumption: *c, E*) and state variables (local private and public investment: k_p, k_s), thereby obtaining a dynamic system that comprises four differential equations[4]:

$$\dot{k}_p = (1 - \tau_f - \tau_s)\, y - (1 + \tau_c)\, c \qquad [1]$$

$$\dot{k}_s = (\tau_s + \tau_f)\, y + \tau_c\, c - E \qquad [2]$$

$$\dot{c} = \frac{u'(c)}{-u''(c)} \left[(1 - \tau_f - \tau_s)\, y_p - \rho\right] \qquad [3]$$

[3] This work is the expansion of a previous paper, Zou (1994), which described a partial dynamic analysis focusing on the effects of intergovernmental transfers on local public consumption and investment but assuming that tax revenues were constant and ignoring any effects on private sector's consumption and investment.

[4] The initial analytical framework is detailed in the next section when a tax decentralisation indicator and the existence of the *flypaper effect* are introduced

$$\dot{E} = \frac{v'(E)}{-v''(E)} [\tau_s (1-\alpha)^{-1} y_s - \rho] \qquad [4]$$

where utility (u, v) and production (y) functions for the representative agent are increasing, concave and continuosly differentiable and ρ is the intertemporal discount rate. The author proves that this dynamic system, composed of these four equations, has a unique and stable equilibrium.

Table 1 summarises the main results obtained in Zou (1996). It reflects the effects of changes in the exogenous variables: federal income tax (τ_f), local income tax (τ_s), local consumption tax (τ_c), rate of investment done by the representative local government which is financed through matching grants (α), rate of consumption done by the representative local government which is financed through matching grants (β) on the long-term equilibrium values of the endogenous variables: stock of private capital ($\bar{k}_p$), stock of public capital ($\bar{k}_s$), private consumption ($\bar{c}$) and local public consumption ($\bar{E}$).

As a result, under the commonest preferences structure (the one that includes local public as well as private consumption as an argument in the utility function), it may thus be affirmed that any increase in federal taxation has negative effects on long-term capital accumulation and therefore on economic growth; that the effect of an increase on the local income tax is indeterminate; that an increase in local public investment transfers will stimulate economic growth; and that economic growth is not affected by changes in transfers for local public consumption. The complementary nature of private and local public capital is a determining factor for these results.

Table 1. Long-term effects of taxes and transfers. Zou (1996)

	Exogenous variables				
Endogenous variables	τ_f	τ_s	τ_c	α	β
$\bar{k}_p$	–	?	0	+	0
$\bar{k}_s$	–	?	0	+	0
$\bar{c}$	–	?	–	+	0
$\bar{E}$	?	?	+	+	0

This paper is the first to propose a general equilibrium framework to analyse the effects of changes in taxation and grants on local economic

growth, in order to do that a two-tier structure of local and federal government is considered. However, it has nothing explicit to say regarding the effects of a process for fiscal decentralisation. In subsequent research, Davoodi and Zou (1998), Xie *et al.* (1999), and Zhang and Zou (2001), within the framework of endogenous growth, consider the possible effects of expenditure decentralisation arriving as we have said at growth-maximising expenditure shares among different levels of government. These turn out to be the ratios of individual productivity over the aggregate productivity of spending by different levels of government. Hence, if expenditure allocations do not coincide with these ratios, a simple reallocation can lead to higher economic growth without altering the total budget share in GDP[5]. The effects of revenue decentralisation on growth have yet to be investigated, and we shall address this issue in the next section.

3. Tax decentralisation, the *flypaper effect*, and growth

Leaving aside the local consumption tax (τ_C) for the sake of simplicity, and given that the exclusion of this tax does not alter the results we are interested in, our basic aim is to incorporate a process of tax decentralisation into the analytical framework described above and identify the effects of such type of decentralisation on long-term economic growth in the representative region. The process of tax decentralisation may be viewed as a gain for the tax autonomy of the region, insofar as the percentage of total local government funding obtained through federal government transfers will decline accordingly or, to look at the other side of the coin, because the percentage of total funding raised through the local income tax will rise.

In the first place, we need to define a tax decentralisation indicator. Starting from the representative local government budget constraint:

$$\tau_s y + \alpha \dot{k}_s + \beta E = \dot{k}_s + E \qquad [5]$$

Dividing both terms by total expenditure ($\dot{k}_s + E$) and reordering the expression, we may obtain an indicator of the proportion of total local expenditure funded by own taxes ($\tau_s y$):

$$\tau_s y / (\dot{k}_s + E) = 1 - (\alpha \dot{k}_s + \beta E) / (\dot{k}_s + E) \qquad [6]$$

Let us call this indicator Φ.

[5] This result was obtained using CES and Cobb-Douglas technologies.

If we consider that equal percentages are transferred for local public consumption and investment ($\alpha = \beta$), the tax decentralisation indicator would be reduced to the expression:

$$\tau_s \, y \, / \, (\, \dot{k}_s + E) = 1 - \alpha \qquad [6']$$

which is to say,

$$\Phi = 1 - \alpha \qquad [6'']$$

Hence, if we wish to study the effects of a tax decentralisation process, we need to consider a reduction in transfers from federal to local government (α). As a consequence, the federal government will reduce its tax rate (τ_f), assuming same level of income, because of the fall in the cost of transfers. If the local government wishes for its part to maintain its level of expenditure, it will need to respond with an increase in the tax rate (τ_s) to offset the decline in the funds transferred.

On the other hand, empirical studies described in a large literature following Gramlich (1977) suggest that in general one monetary unit received in the form of transfers results in an increase in regional public expenditure that is greater than the increase generated in such expenditure by an increase of one monetary unit in regional income due to a federal tax cut. This phenomenon has been labelled as the *flypaper effect* because, according to the studies cited, money tends to "stick" in the first sector (public or private) where it "lands" [6].

In order to consider the *flypaper effect* in the model, let us denote τ to be total income tax rate when local public expenditure is financed exclusively through transfers. So, we have:

$$\tau_f = \tau \qquad [7]$$

[6] The explanation of the *flypaper effect* is highly debated. Bailey (1999, chapter 11) distinguishes two main groups of explanatory theories of such effect. On the one hand, those theories that attempt to modify the traditional neoclassical approach to intergovernmental grants. On the other hand, public choice theories, which consider the existence of a conflict of interests between voters and politicians (or public officials). In the latter group, is particularly though-provoking the "fiscal illusion model" developed, among others, by Oates (1979). As Bailey (1999, p. 245) describes it: "The model portrays local officials as output-maximizers constrained by

If local public expenditure is financed exclusively through local taxes we have, in turn:

$$\tau_s = \tau\,(1 - \pi), \qquad 0 \leq \pi \leq 1 \qquad [8]$$

where π would be an indicator of the intensity of the *flypaper effect*. So, for a certain level of tax decentralisation, Φ, we have:

$$\tau_f = \alpha\,\tau\,[1 - \pi\,\Phi] \qquad [9]$$

$$\tau_s = (1 - \alpha)\,\tau\,[1 - \pi\,\Phi] \qquad [10]$$

$$\tau_f + \tau_s = \tau\,[1 - \pi\,\Phi] \qquad [11]$$

Incorporating our definition of a tax decentralisation indicator and the existence of the *flypaper effect* and excluding the local consumption tax, the Zou (1996) analytical framework is defined by the following utility function, production function and budget constraints:

$$\int_0^{\infty} [\,u\,(c) + v\,(E)]\,e^{-\rho t}\,dt, \quad \text{with } 0 < \rho < 1 \qquad [12]$$

$$y = y\,(k_p, k_s) \qquad [13]$$

$$\tau_f\,y = \alpha\,(\dot{k}_s + E) \qquad [14]$$

$$\tau_s\,y = (1 - \alpha)\,(\dot{k}_s + E) \qquad [15]$$

Dynamic optimisation by the private agent and the representative local government is thus described by the following system of equations:

$$\dot{k}_p = [1 - \tau\,[1 - \pi\,\Phi]]\,y - c \qquad [16]$$

the preferences of the voters they represent. The marginal tax price to the local electorate is unaffected by the lump-sum grant. However, the local government uses the grant to deceive local voters into thinking that the cost is less, the average tax price. Since the average tax price is less than the marginal cost to the electorate, the level of output is excessive". Consequently, although a lump-sum grant and an increase in individual's incomes "may generate the same true budget constraint, they do not result in the same perceived budget constraint" (Oates, 1979, p. 29).

$$\dot{k}_s = \tau [1 - \pi \Phi] y - E \qquad [17]$$

$$\dot{c} = \frac{u'(c)}{-u''(c)} [[1 - \tau [1 - \pi \Phi]] y_p - \rho] \qquad [18]$$

$$\dot{E} = \frac{v'(E)}{-v''(E)} [\tau [1 - \pi \Phi] y_s - \rho] \qquad [19]$$

It is clear that this system has a single and stable equilibrium[7].

Note that, as we could see from equations [16] to [19], in the absence of the *flypaper* effect, that is to say $\pi = 0$, a process for tax decentralisation would not have any effect on the dynamic optimisation behaviour and consistently on economic growth. Therefore, the consideration of such effect in our model it is critical since allows us to identify the possible effects that tax decentralisation has on growth.

In order to determine the effects of a tax decentralisation process on regional economic growth, we shall consider that the production function takes a Cobb-Douglas form such that:

$$y = A\, k_p^{\gamma} k_s^{\eta} \qquad [20]$$

where $0 < \gamma < 1$, $0 < \eta < 1$, and $\gamma + \eta < 1$

Under this assumption the system's equilibrium is reduced to:

$$[1 - \tau [1 - \pi \Phi]] A\, \bar{k}_p^{\gamma}\, \bar{k}_s^{\eta} - \bar{c} = 0 \qquad [21]$$

$$\tau [1 - \pi \Phi] A\, \bar{k}_p^{\gamma}\, \bar{k}_s^{\eta} - \bar{E} = 0 \qquad [22]$$

$$[1 - \tau [1 - \pi \Phi]] \gamma\, \bar{y} / \bar{k}_p - \rho = 0 \qquad [23]$$

$$\tau [1 - \pi \Phi] \eta\, \bar{y} / \bar{k}_s - \rho = 0 \qquad [24]$$

where $\bar{k}_p$, $\bar{k}_s$, $\bar{c}$, $\bar{E}$ and $\bar{y}$ denote steady state variable values and the exogenous variables are τ, π and ρ.

Working out $\bar{k}_p$ and $\bar{k}_s$ from [23] and [24], we obtain:

[7] It can be shown following Buiter (1984), as in Zou (1996).

$$\bar{k}_p = [[1-\tau[1-\pi\Phi]]\,\gamma A/\rho]^{(1-\eta)/(1-\gamma-\eta)}\,[\tau[1-\pi\Phi]\,\eta A/\rho]^{\eta/(1-\gamma-\eta)} \quad [25]$$

$$\bar{k}_s = [\tau[1-\pi\Phi]\,\eta A/\rho]^{(1-\gamma)/(1-\gamma-\eta)}\,[[1-\tau[1-\pi\Phi]]\,\gamma A/\rho]^{\gamma/(1-\gamma-\eta)} \quad [26]$$

Since

$$\partial y/\partial\Phi = y_p\,(\partial k_p/\partial\Phi) + y_s\,(\partial k_s/\partial\Phi) \quad [27]$$

and

$$\partial \bar{k}_p/\partial\Phi = (A/\rho)^{1/(1-\gamma-\eta)}\,[\tau\pi/(1-\gamma-\eta)]\,[\eta\,\tau(1-\pi\Phi)]^{\eta/(1-\gamma-\eta)}$$
$$[\gamma(1-\eta)\,[\gamma[1-\tau(1-\pi\Phi)]]^{\gamma/(1-\gamma-\eta)} -$$
$$\eta\,[\gamma[1-\tau(1-\pi\Phi)]]^{(1-\eta)/(1-\gamma-\eta)}\,[\tau(1-\pi\Phi)]^{-1}] \quad [28]$$

$$\partial \bar{k}_s/\partial\Phi = (A/\rho)^{1/(1-\gamma-\eta)}\,[\tau\pi/(1-\gamma-\eta)]\,[\gamma[1-\tau(1-\pi\Phi)]]^{\gamma/(1-\gamma-\eta)}$$
$$[\gamma[\eta\,\tau(1-\pi\Phi)]^{(1-\gamma)/(1-\gamma-\eta)}\,[[1-\tau(1-\pi\Phi)]]^{-1} -$$
$$\eta\,(1-\gamma)\,[\eta\,\tau(1-\pi\Phi)]^{\eta/(1-\gamma-\eta)}] \quad [29]$$

After a series of calculations we may establish the following proposition:

Proposition 1. *An increase in tax decentralization as defined will:*
1. Generate economic growth if $\gamma \geq [1-\tau[1-\pi\Phi]]$ (which is equivalent to $\eta < \tau[1-\pi\Phi]$, given that $\gamma+\eta<1$).
2. Not generate economic growth if $\eta \geq \tau[1-\pi\Phi]$ (which is equivalent to $\gamma < [1-\tau[1-\pi\Phi]]$, given that $\gamma+\eta<1$).
3. Generate economic growth if $\gamma < [1-\tau[1-\pi\Phi]]$ and $\eta < \tau[1-\pi\Phi]$ provided that: $\gamma/\eta > [1-\tau[1-\pi\Phi]]/\tau[1-\pi\Phi]$

Let us note here that the scenario described in the first point of proposition 1 will only arise if the productivity of private capital or the effective tax rate are very high[8]. The scenario described in the second point,

[8] In the latter case, it would be necessary for the tax rate to be extremely high if public spending were financed exclusively by way of transfers. Moreover, the level of tax decentralisation would have to be low (or the level of the *flypaper effect* would have to be low, although this is highly unlikely according to Bailey (1999)).

on the other hand, would only arise if the productivity of public capital were fairly high or the effective tax rate were very low[9]. In any other case, we would be in the scenario described in the third point of the proposition. Thus, for a tax decentralisation process to generate economic growth, it will have to conform to the inequality reflected in this point. If this is the case, and we wish to maximize the equilibrium value of *per capita* income for the representative region, we will need to embark upon a continuous process of tax decentralisation. The limit of this process will be either total decentralisation ($\Phi = 1$) or the equality:

$$\gamma / \eta = [1 - \tau [1 - \pi \Phi]] / \tau [1 - \pi \Phi] \qquad [30]$$

whichever is the first to be achieved. Similarly, in the economic growth scenario described in the first point, if we wish to maximize regional growth, in terms of the level of tax decentralisation, we will need to increase decentralisation until it is complete ($\Phi = 1$) or the equality given in [30] is achieved, following a change of scenario from that described in the first to that described in the third point. Finally, in the scenario reflected in the second point the same objective would be attained by reducing the level of tax decentralisation until it was completely eliminated ($\Phi = 0$) or by arriving at the equality given in [30] after moving to the situation described in the third point.

Hence, we may formulate a second proposition, re-expressing [30] in terms of Φ:

Proposition 2. *The level of tax decentralisation as defined that will maximise the equilibrium per capita income for the representative region is:* $\Phi^* = [1 - \eta / \tau (\gamma + \eta)] / \pi$

Since $0 \leq \Phi \leq 1$ by definition, any values lower than zero on the right-hand side of the equation given in proposition 2 will indicate that the optimum level of tax decentralisation is null ($\Phi^* = 0$), while values over 1 will signify that total tax decentralisation ($\Phi^* = 1$) is the optimum[10].

[9] This would in turn require a fairly low tax rate in the case that public spending were financed exclusively by way of transfers, or a very high level of tax decentralisation.

[10] Note that values higher than 1 would refer to tax decentralisation processes seeking to maximise growth in the representative region that would arrive at total tax decen-

From the expression of proposition 2 we can also obtain the optimum effective tax rate:

$$\tau\,[\,1 - \pi\,\Phi^{*}] = \eta\,/\,(\gamma + \eta) \qquad [31]$$

4. Simulations

From the above expressions we may deduce certain interesting results with regard to the optimum level of tax decentralisation, which we shall reflect here in a few simulations. Let us focus on how a change in one of the parameters affects the optimum level of tax decentralisation given acceptable values for the other parameters ($\gamma = 0.4$; $\eta = 0.1$; $\pi = 0.775$; $\tau = 0.35$)[11]:

First, as may be observed in chart 1, the optimum level of tax decentralisation will increase the greater the productivity of private capital ($\partial\Phi^{*} / \partial\gamma > 0$), but it will decrease, as shown in chart 2, the greater the productivity of public capital ($\partial\Phi^{*} / \partial\eta < 0$). The reason for this result is that tax decentralisation releases public sector income to the private sector via the *flypaper effect*. Consequently, such decentralisation will be more efficient, and should therefore need to be taken further, the greater the productivity of private capital and the lower that of public capital. The limit for this process is the optimum effective tax rate, which will coincide with the coefficient between the productivity of public capital and the aggregate productivity of public and private capital.

Second, as can be seen in chart 3, the optimum level of tax decentralisation will decline the greater the *flypaper effect* ($\partial\Phi^{*} / \partial\pi < 0$).

tralisation before reaching equality between the ratio of the productivity of public and private capital and the ratio of percentage of available and subtracted income. Similarly, values lower than 0 would indicate processes of tax centralisation, once again seeking to maximise regional growth, that would eventually stop at null decentralisation but not because equality between the aforementioned two ratios had been reached.

[11] Values for the capital productivities, γ and η, are obtained, respectively, from Barro and Sala-i-Martin (1995), p. 380, and from De la Fuente (1997), as the average value for a panel of OECD countries. As for the *flypaper effect*, according to Bailey (1999), $\pi \in [0.6, 0.95]$, hence, we may take the arithmetic mean of the two extremes of this interval. Finally, the tax rate value, τ, is taken from OECD (2004), p. 18, as the average value for a panel of OECD countries.

This result arises because the more intense the effect the more income is released from the public to the private sector due to the tax decentralisation process, thereby arriving at the optimum effective tax rate at a lower level of tax decentralisation.

Finally, as shown in chart 4, the optimum level of tax decentralisation will increase the higher the tax rate that would exist if public spending

Chart 1: Optimum tax decentralisation versus productivity of private capital

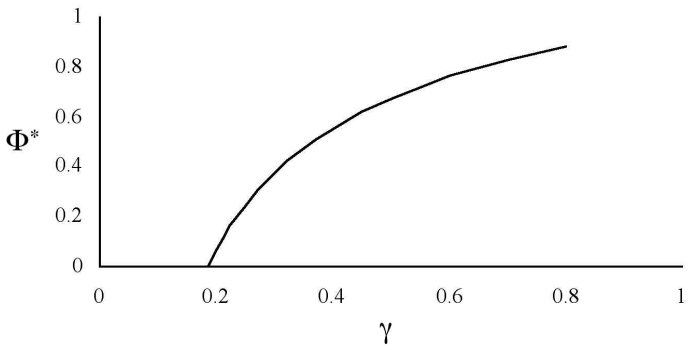
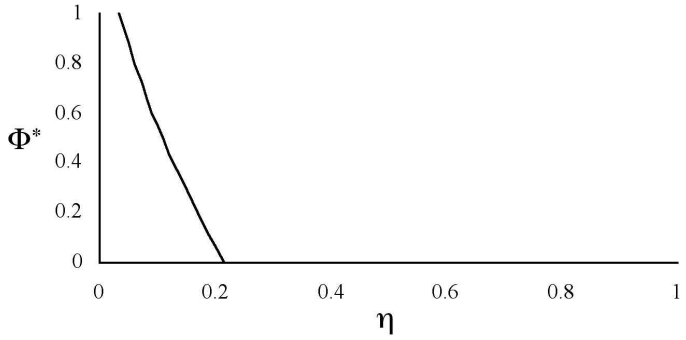


Chart 2: Optimum tax decentralisation versus productivity of public capital



were financed exclusively out of transfers ($\partial \Phi^* / \partial \tau > 0$). Naturally, the higher the tax rate in the absence of decentralisation, the more income will be released from the public to the private sector. Hence, the higher the level of tax decentralisation to achieve an effective tax rate that equals the coefficient between the productivity of public capital and the aggregate productivity of public and private capital.

Chart 3: Optimum tax decentralization rate versus *flypaper effect*

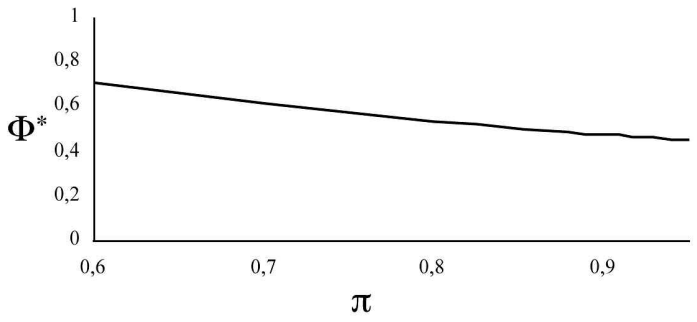
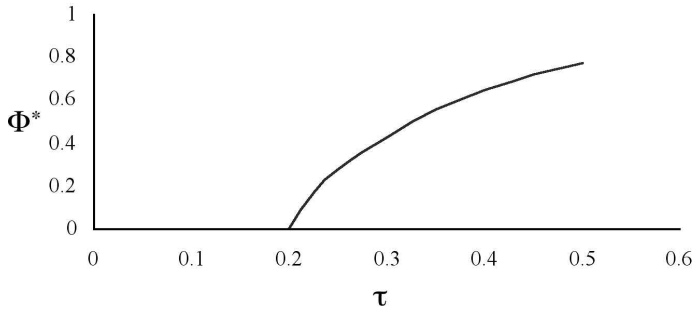


Chart 4: Optimum rate of tax decentralisation versus tax rate in the absence of decentralization



These results are consistent with other findings contained in the literature. With reference to the literature on economic growth, Barro (1990) uses a Cobb-Douglas technique to show that the tax rate that maximises economic growth corresponds to the share of output that government would receive if the goods and services it provides were an input offered on a competitive basis. From our model, we may deduce that the contribution of the production inputs considered, k_p and k_s, to a unit of output is $\gamma + \eta < 1$, where γ is the contribution of private capital and η that of public capital. Following Barro (1990), then, the share of output that should be received by the public sector in the form of the tax rate if growth is to be maximised will be $\eta / (\gamma + \eta)$, as reflected in the expression for the optimum effective tax rate in [31]. As Barro (1990) points out, when the tax rate exceeds this optimum level, the benefits obtained in terms of economic growth as a consequence of the generation of more public capital (let us remind that the two kinds of capital are complementary) does not offset the impediment to growth caused by the disincentive for private investment.

Meanwhile, in the literature on decentralisation and economic growth, on the one hand, Brueckner (1999, 2006) shows how a change from a unitary system to a federal system has a positive effect on economic growth, both on the short run and on the long run. On the other hand, Davoodi and Zou (1998), Xie *et al.* (1999) and Zhang and Zou (2001) link expenditure decentralisation to economic growth. These authors use CES or Cobb-Douglas technologies to obtain the optimum rate of expenditure decentralisation, which turns out to be the ratio of individual productivity over the aggregate productivity of spending by different levels of government. In its simplest form, however, this optimum rate depends only on the productivity of the different types of public capital considered, in contrast to the expression given in proposition 2. Moreover, null or total decentralisation will only appear as the optimum rate at extreme (null) values for the productivities on which it is based. This is not the case with the optimum rate of tax decentralisation obtained in this paper.

5. Concluding remarks

Taking as our starting point the analytical framework described in Zou (1996), we incorporate in such framework a tax decentralisation process and consider the existence of the *flypaper effect* in order to examine its effects on economic growth in a representative region. As a result,

we have been able to determine the optimal level of tax decentralisation for regional growth. This level, consistently with the literature, depends on private and public capital productivities, the tax burden rate in the absence of decentralisation and the intensity of the *flypaper effect*. We illustrate such relationships through simulations.

After considering not only expenditure decentralisation (Davoodi and Zou (1998), Xie *et al.* (1999), and Zhang and Zou (2001)) but also revenue decentralisation (this work), one possible avenue for the expansion of this research with regard to the further development of the theoretical basis for the relationship between fiscal decentralisation and economic growth would be to combine both phenomena in a single analytical framework. In addition, the results obtained in this paper could be empirically tested in several economies.

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