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Assignments**

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Toward a More General Theory of Revenue Assignments¹

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Abstract

Despite the extensive international experience with the assignments of revenue sources to different levels of government, the public finance literature still lacks a general theory of revenue assignments. Two sets of arguments have been separately developed in the literature to explain and guide the practice of revenue assignments. The first is based on Musgrave and Oates' tradition, and emphasizes the benefit principle and other means for increasing accountability and efficiency in the allocation of public expenditures. The second is based on optimal taxation principles, which emphasizes the marginal cost of public funds and the correct mix of revenue instruments. The two approaches provide important insights to the problem, but they remain practically unconnected. This paper develops a theory of revenue assignments that integrates the two approaches. We discuss the validity and scope of currently applied revenue assignment rules, and provide practical recommendations to implement an optimal assignment of revenue sources.

Keywords: revenue assignments, fiscal federalism, optimal taxation, marginal cost of funds, public expenditures

JEL codes: H21, H40, H71

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1. Introduction

Even though the assignment of own revenue sources to subnational governments is a central policy concern in all fiscally decentralized countries around the world, there is still no agreement in the public finance literature about the principles that should guide revenue assignment decisions.² In this paper we review some of the main contributions to this literature and develop a model that integrates what are so far two divorced approaches to the revenue assignment problem.

The revenue assignment problem can be thought as comprising three interlocked questions. First, what is the optimal level of overall financing available to subnational governments? Second, how much of this financing should come from own revenues and how much from central government transfers? And third, what taxes, and to what extent, should each one of them be used in raising subnational governments' own revenues? In the current literature we can roughly distinguish two broad approaches to answering these questions. The first one aims to utilize the revenue structure to improve efficiency on the expenditure side of the budget; while the second focuses on reaching efficiency on the revenue side of the budget. The expenditure-side approach emphasizes the benefit principle, which states that as long as public goods or services are excludable, it is efficient to make those who use the services pay for their costs. When the application of the benefit principle is feasible, equilibrium prices and quantities resemble the outcomes of competitive markets, and thus the problem of financing public expenditures can be solved efficiently. As a consequence, the theory of revenue assignments, as well as this paper, deals primarily with the problem of financing public expenditures for which the application of the benefit principle is not feasible.

The expenditure-side approach to revenue assignments is grounded in the tradition of Musgrave (1959) and Oates (1972), and attempts to identify those attributes of taxation that may help foster efficient expenditure decisions.³ In this paper we analyze three policy rules produced under this tradition, which are widely accepted revenue assignment principles. The first rule states that in order to set the amount of revenue collections at the level of expenditures most compatible with voters' preferences, subnational authorities should enjoy "autonomy at the margin." This rule was first put forward by McLure (2000), and its rationale is closely related to Oates' (1972) Decentralization Theorem, according to which whenever centralized expenditure policies are common across jurisdictions and preferences are heterogeneous, social welfare can be increased by decentralized autonomous decision-making. Effective autonomy in the expenditure side of the budget, however, requires autonomy to change the amount of revenues, thus the ability to efficiently satisfy local preferences calls for both expenditure and revenue autonomy at the margin.

² We use the term "subnational" to refer to any government unit below the central or "national" level. There are several possible levels of subnational governments, including the state or regional, provincial, and municipal or local levels. The analysis in the paper is in principle applicable to any subnational level.

³ Detailed discussions about the revenue assignment problem under the expenditure-side approach can be found in McLure (1998), Martinez-Vazquez (2007) and Bird (2010).

The second policy rule calls for the subnational governments to collect a significant proportion of own revenues in order to create and enhance accountability mechanisms. Own revenues promote citizens' participation in subnational decisions and reinforce in the authorities a sense of dependency on taxpayers' contributions. Indeed, the ability of the population to effectively influence budgetary decisions at the subnational level is essential to realize the efficiency gains that justify the decentralization process itself (Bahl and Martinez-Vazquez 2006). Moreover, to have a relevant effect on accountability, own revenues must be combined with a "hard budget constraint," such that local authorities and the local community can expect to fully bear the costs of deficient budgetary management (Rodden, Eskeland and Litvack 2003). The first and second rule of the expenditure-side tradition are focused on process but say little about the overall adequacy or level of financing of subnational budgets. This limitation has been addressed by a third rule, suggesting revenue sources be assigned to subnational governments up to the point where own revenues are enough to cover the expenditure needs (net of conditional transfers) of the wealthiest jurisdiction(s) (Bird 1993).

The expenditure-side tradition informs us about the importance of revenue autonomy and the overall level of financing for revenue assignments but, beyond the limited use of direct charges under the benefit principle, it falls short of guiding the full set of choices related to the optimal structure of subnational revenues. In particular, it does not specify the extent to which alternative revenue sources should be utilized; neither does it provide an explicit framework for assessing the benefits and costs of adhering to its policy prescriptions.⁴ For example, under the expenditure-side tradition it is not clear when the use of a certain source of own revenues become excessive, and there is no way to determine if self-financing in the wealthiest jurisdiction is in fact the welfare maximizing policy.

The optimal structure of subnational revenues is one of the main focuses of what we call here the revenue-side approach to the revenue assignment problem. This approach is based on optimal taxation theory, and it generally aims to minimize the costs of raising tax revenues. The most relevant policy rule developed under this tradition states that revenues are collected optimally when the marginal cost of raising public funds is equalized across tax instruments and all government units (Dahlby and Wilson 1994; Smart 1998; Dahlby 2009). According to this rule subnational governments should rely more on those revenue sources that are more productive under the optimal level of the marginal cost of funds. The revenue-side approach provides powerful insights to identify those revenue sources that can be efficiently administered by subnational governments, as well as the extent to which they should be exploited. Surprisingly, however, the revenue-side and expenditure-side approaches to the revenue assignment problem remain unconnected in the literature on fiscal decentralization. On the one hand, the concept of

⁴ In order to assist the choice of specific revenue instruments the expenditure-side approach describes a number of ideal or desirable characteristics of subnational taxes including few distortionary effects, equity and fairness, revenue adequacy, low administration and compliance costs, political acceptability, not exportable unless matched by benefits to non-residents; evenly distributed and relatively immobile and stable bases; highly visible and transparent to increase accountability and so on. See, for example, McLure (1998), Bahl and Bird (2008), and Bird (2010).

marginal costs of funds is rarely mentioned by studies under the expenditure-side tradition of revenue assignments (Dahlby 2009). On the other hand, the literature in the revenue-side tradition does not explicitly consider the efficiency gains associated with greater budgetary autonomy and accountability, as emphasized in the expenditure-side tradition, and it typically does not provide advice with direct practical applicability for policymakers.

Given that the optimal marginal cost of public funds depends on the amount of transfers received, the revenue structure problem becomes one of finding the optimal vector of intergovernmental transfers. The literature on optimal intergovernmental transfers is extensive and diverse. It generally focuses on the design of equalization transfer programs, aimed to close the vertical and horizontal imbalances created by the decentralization of expenditure and revenue responsibilities, but for the most part it abstracts from the problem of choosing among alternative own revenue sources. An important branch of this literature, based on Buchanan and Wagner (1970), Buchanan and Goetz (1972) and Flatters et al (1974), has focused on fiscally induced mobility across jurisdictions and the use of equalization transfers to obtain an efficient allocation of production factors and population (Boadway and Flatters 1982; Sato 2000; Boadway et al 2003; Boadway and Tremblay 2006, 2010).

In this paper we take an alternative approach to the problem of optimal equalization transfers, and attempt to organize its normative and positive aspects in a way that more closely represents actual international practices. As is most often the case in federal and decentralized countries, we assume that the normative goal of the equalization transfer program is to ensure that all subnational governments are able to provide a standard level of public goods and services at a comparable level of tax effort. The extent of equalization varies in accordance to non-economic considerations in each country. In our model we consider that normative decision as exogenous and equivalent to determining the specific bundle of public goods and services that are subject to equalization.

Once expenditure responsibilities have been assigned and equalization transfers have been distributed, we allow for subnational governments to define their own tax and expenditure policies autonomously. In general, we can expect that subnational autonomy would likely lead to inter-jurisdictional differences in the amount and composition of public expenditures, tax and expenditure incidence, and factor productivities; and that these differences would in turn promote mobility across the national territory. We do not interpret this outcome as necessarily inefficient; instead, we consider it the consequence of selecting a federal or decentralized framework where jurisdictions are meant to retain some degree of independence, as opposed to a unitary state with centralized uniform fiscal policies (Scott 1964; Mieszkowski and Musgrave 1999).⁵ The extent of equalization can be understood as a national decision about what goods and services should meet minimum national standards –as if they were provided in a centralized fashion, and to what extent

⁵ Of course, this does not imply that mobility is irrelevant to the problem. Mobility is an important determinant of the optimal equalization transfers in our framework, as it determines the distribution of tax bases across jurisdictions and thus also the marginal cost of funds for available tax instruments.

these and other goods and services should be tailored to local preferences and needs by means of subnational autonomy in a decentralized framework. We contend that imposing an additional efficiency condition about mobility of population and factors would actually distort the conditions created for the provision of standardized goods and services, and would limit the efficiency gains arising from a better fit of the preferences and needs of the population. These are, after all, the very gains to be obtained from the decentralization reform. In this sense, our approach can be seen as an alternative to the approach of imposing an additional resource allocation restriction to the system, and both may be suitable to different situations defined in accordance to the specific normative decisions of each country.

A relevant concern among scholars and policy makers is the limited applicability of some policy prescriptions derived from the analysis of revenue assignments. For example, it may not be realistic to expect that government authorities and politicians will be able or willing to equalize the marginal cost of public funds across tax instruments and jurisdictions. Indeed, a concern for practical policy relevance may well be the reason for the apparent divorce between the expenditure-side approach to the revenue assignment problem, with a clear tradition of practical policy recommendations, and the more theory-intensive revenue-side approach. One of the goals of this paper is to derive feasible policy prescriptions from the theoretical model that can effectively guide policymakers in the assignment of revenue sources. In particular, we will argue that policy makers need not to observe the marginal cost of funds to implement the optimal revenue assignment policy. Instead, it is sufficient for them to rely on an equalization transfer program designed on the basis of expenditure needs and fiscal capacity of subnational governments, two variables that are extensively estimated around the world using methodologies of varied degrees of complexity and feasibility. This program can be used to set the marginal cost of funds at the appropriate level for all (or most) subnational governments.

This conclusion is important because it implies that the solution to the optimal revenue assignment can actually be made readily operational. Once revenue sources have been assigned to different levels of government, the optimal revenue structure can be achieved by means of a properly implemented equalization transfer program.

The main goal of this paper is to develop the foundations of a more general theory of revenue assignments by bringing together the expenditure and revenue side approaches in the current literature. We provide answers to the three fundamental questions of the revenue assignment problem: overall level of financing; the share of own revenues and transfers in total revenues; and composition—which tax instruments-- of own revenues. We do so in a sequence of analytical frameworks of increasing complexity. In section two we start by analyzing the optimal fiscal decisions of an individual subnational government. This allows us to answer the first and third questions of the revenue assignment problem. We show that the policy rules from the expenditure-side and revenue-side approaches to revenue assignments are jointly relevant for addressing the questions of overall level of financing and the optimal composition of own-revenue sources at the subnational level. In section three we extend the model to a typical decentralization

setting with two levels of government (central and subnational) and two government units at the subnational level. In this context we address the question of the optimal share of own revenues and transfers for subnational governments from a national perspective, where intergovernmental transfers can be used to set the marginal cost of funds faced by all government units at the optimal level. In section four we show that in order to determine the optimal degree of revenue decentralization the negative externalities –erosion of tax bases—imposed by subnational government tax decisions on other government units must be weighed against the accountability gains from using own tax revenues. In section five we discuss how the analysis in the paper may help guide the process of revenue assignments in practice from a policy perspective. Section six concludes.

2. The optimal level of overall financing and own revenue composition at the subnational level

In this section we analyze the optimal expenditure and revenue decisions of a single subnational government. This can be seen as a first step in building a more general model where revenue structure also depends on the interactions with other government units. We first illustrate the case in which the subnational government operates in a non-cooperative decentralized system, and relies entirely on its own revenues to finance public expenditures. Then we incorporate intergovernmental transfers as an exogenous variable, and examine their effect on the optimal provision of public goods and the optimal composition of revenue sources. For simplicity, public savings and borrowings are assumed to be zero and thus the optimal amount of revenue collections must be equal to the optimal provision of public goods and services.

The subnational government maximizes a utilitarian social welfare function equal to the sum of the utilities of N identical taxpayers. The preferences of the representative taxpayer are represented by a quasi-concave utility function u that increases with the consumption of the private good x and the local public good available in his or her jurisdiction, G , which may plausibly be fully congestible.⁶ We do not model explicitly the behavior of the representative taxpayer. Instead, we assume that taxpayers' behavioral responses to the tax instrument i –which may comprise changes in the supply of labor or in the decisions about tax evasion and tax avoidance, lead to a reduction of the size of the individual tax bases b^i and have no effect on the base of other tax instruments.⁷

Subnational governments can finance public goods with own tax revenues or with exogenous intergovernmental transfers from the central government, T . Own revenues are collected with two tax instruments t^i , $i = 1, 2$, whose bases $B^i = Nb^i$ may or may not be shared

⁶ We typically use capital letters to represent aggregate variables, and lower case to represent individual (taxpayer level) variables.

⁷ Tax rate increases in one tax instrument may increase (decrease) the size of the tax bases of other tax instruments due to substitutability (or complementarity). Higher tax rates can also be expected to increase overall non-compliance and evasion. Although not necessarily trivial, these are effects of secondary importance for the discussion in this paper.

with the central government.⁸ We assume that tax bases are mutually exclusive, like in the case of two excise taxes, or the case of taxes on labor income and capital income. This is a rather strong assumption, but it does not affect the conclusions of the analysis. Each tax instrument is associated with a cost function A^i , which summarizes all the monetary costs of raising revenues from the tax instrument i , including the costs of administration, collection and enforcement.⁹ The cost function A^i is assumed to be increasing in the amount of tax collections $R^i = t^i B^i$, while the tax base B^i depends only on the choice variable t^i in addition to t^{ic} , the tax rate imposed by the central government on the same base.¹⁰ Note that A^i and B^i cannot be directly modified by subnational government authorities, whose discretion is limited only to the choice of the statutory tax rate t^i .

We account for the expected efficiency gains from greater accountability of decentralized revenue raising by introducing the parameter $\rho \in [0,1]$, defined as the subnational government responsiveness to taxpayers preferences, or the extent to which government decisions about public goods provision truthfully represent the preferences of the constituents. If $\rho = 1$, government expenditures perfectly represent the preferences of the constituents. A value lower than unity implies that a share $(1 - \rho)$ of subnational government funds is “wasted” due to the mismatch between expenditure decisions and the true preferences of the community. Some examples of these imperfections include the inaccurate representation of preferences, production inefficiencies, corruption and fraud. Following one of the principles of the expenditure-side approach we assume that the value of ρ increases (at a decreasing rate) with total own revenue collections, $R = \sum_{i=1}^2 t^i B^i$. Using subscripts to represent derivatives, this implies that $\rho_R > 0$ and $\rho_{RR} < 0$; in addition, ρ_R is assumed to approach zero as ρ approaches unity. These assumptions formalize the argument of the expenditure-side literature in favor of revenue decentralization. Greater use of own revenue financing is expected to stimulate citizens participation in budgetary decisions and this in turn would force subnational authorities to make a more efficient use of the available public funds. Even though there is no formal theory and very scarce direct empirical evidence in support of a positive relation between own tax collections and responsiveness or accountability of subnational governments,¹¹ we consider this to be a logical requirement of any economic theory of

⁸ Either the subnational tax rate or the central tax rate could be set equal to zero to represent a tax instrument that has been assigned exclusively to the central or subnational government, respectively.

⁹ The costs associated with the use of a tax instrument could possibly include the political costs faced by government authorities, as considered by Hettich and Winer (1984). In our analysis, however, political costs are not considered because they do not directly affect social welfare.

¹⁰ By assuming that administrative costs increase with revenue collections we attempt to capture potential economies of scale in tax administration, collection and enforcement. We acknowledge, however, that revenue collection technologies might be more complex. For instance, Slemrod and Yitzhaki (2002) argue that tax administration cost functions may be discontinuous because slight changes in administrative practices and policy decisions lead to discrete changes in administrative costs.

¹¹ A recent empirical study suggests that own-tax revenues increase accountability more than transfers, and that this effect is driven by a sense of citizens’ ownership over public funds (Palmer 2012). Numerous authors argue that accountability plays a key role in decentralization; for a formal argument based on incomplete contracts between citizens and political representatives, see Seabright (1996). Additional but indirect evidence can be found, for instance, in the literature on voter turnout. Blais, Anduiza and Gallego (2011) show that decentralization increases turnout rates at the regional level in Canada and Spain.

revenue assignment. Without a source of marginal efficiency gains from tax assignments to subnational governments there would be no economic case for revenue decentralization and fiscal decentralization would be all just about expenditures assignments financed with transfers from centrally raised tax revenues. The problem faced by the subnational government can be described by the maximization of the following Lagrangean:

$$\begin{aligned} \mathcal{L} = & Nu[\sum_{i=1}^2(1 - t^{ic} - t^i)b^i, G] \\ & + \mu \left\{ -G + \rho[\sum_{i=1}^2 t^i B^i] \{ \sum_{i=1}^2 (t^i B^i - A^i[t^i B^i]) + T \} \right\}, \end{aligned} \quad (1)$$

where the first expression in the utility function represents the private good x , defined as the sum of the (mutually exclusive) tax bases after central and subnational tax rates t^{ic} and t^i have been applied.¹² The Lagrange multiplier, μ , corresponds to the marginal cost of government revenues; it multiplies the budget constraint of the subnational government, by which public goods provision G is equal to the amount of revenues that is available after paying for tax collection costs and correcting for the degree of government responsiveness, ρ .¹³

The first order condition for the optimal amount of public goods G^* is given by:

$$Nu_G - \mu = 0, \quad (2)$$

which states that the sum of marginal utilities from public good provision for the N taxpayers in the jurisdiction must be equal to the marginal cost of government revenues. Moreover, the first order condition for the optimal tax rate of each tax instrument i , t^{i*} , can be written as:

$$X_i u_x + \mu R_i^i \left\{ \rho(1 - A_R^i) + \rho_R \{ \sum_{i=1}^2 (t^i B^i - A^i[t^i B^i]) + T \} \right\} = 0, \quad i = 1, 2,$$

where R_i^i is the change in tax collections due to a marginal change in t^i . Using (2) and rearranging terms we can rewrite this condition as:

$$N \frac{u_G}{u_x} = \frac{-X_i}{R_i^i} \cdot \frac{1}{\rho(1 - A_R^i) + \rho_R \{ \sum_{i=1}^2 (t^i B^i - A^i[t^i B^i]) + T \}}, \quad i = 1, 2. \quad (3)$$

¹² Once we incorporate the proportion of waste of public funds ρ , we may also consider that a share δ of those wasted funds will report benefits to the corrupted government officials. In that case, the decision maker may be interested in adding the term $(1 - \rho)\delta R$ to his objective function, such that he would face a tradeoff between improving social welfare and increasing his own gains. This term would be relevant for describing a more general solution to the problem at hand by including political economy aspects to the decision process. However, we believe this political economy aspect would not significantly contribute to the goals of this paper. Thus, for simplicity we will assume $\delta = 0$ and restrict the scope of the model to a welfare maximizing government that is subject to inefficiencies in the delivery of services without being corrupt.

¹³ The degree of government responsiveness can be alternatively modeled by introducing the parameter ρ in the utility function, which leads to equivalent first order conditions. In this way the lack of accountability would be reflected in the lower utility reported by a particular level of expenditure to residents with the Lagrangean expression being:

$$\mathcal{L} = Nu[\sum_{i=1}^2(1 - t^{ic} - t^i)b^i, \rho[\sum_{i=1}^2 t^i B^i] \cdot E] + \mu \left\{ -E + \{ \sum_{i=1}^2 (t^i B^i - A^i[t^i B^i]) + T \} \right\},$$

where E stands for the total amount of public expenditures.

This is the “adjusted” Samuelson condition for the optimal provision of public good under a second-best scenario where lump-sum taxation is unavailable. The right hand side of (3) corresponds to what is called in the literature the marginal cost of public funds (MCF), a measure of the welfare costs paid by society for a marginal increase in government revenues.¹⁴ As shown in (3), the relevant measure of the MCF for a subnational government considers only the welfare costs paid by the local community. The welfare costs borne by taxpayers outside the jurisdiction, represented for instance by the negative effect that t^i may have on the central government tax collections inside the same jurisdiction, are normally disregarded by subnational authorities. This issue will be addressed in section 4, where we will analyze the problem of revenue decentralization in the presence of tax externalities.

The second ratio in the right hand side of (3) contains in the denominator two adjustments to the marginal cost of funds that are normally not considered in the literature. One adjustment is given by the term $\rho(1 - A_R^i)$, which describes the effect of administration costs. Greater marginal administration costs lead to a greater marginal cost of funds for any level of public goods and degree of government responsiveness; thus if economies of scale are present we would expect the central government to face a lower marginal cost of funds than subnational governments. The other adjustment is given by the term $\rho_R \{ \sum_{i=1}^2 (t^i B^i - A^i [t^i B^i]) + T \}$, which describes the potential gains from improving government responsiveness due to accountability. Greater government responsiveness ($\rho_R > 0$) implies that *all* the resources available to the government are going to be better used, and this reduces the marginal cost of funds for any given level of public goods. Subnational authorities do not need to consciously consider this efficiency gain when choosing the optimal provision of public goods and services; instead, they are simply compelled by the taxpayers to make better expenditure decisions that increase the productivity of revenues collected. Accordingly, here we define the total amount of revenues collected, net of tax collection costs and corrected by the efficiency gains due to greater responsiveness, as total effective own revenues R^E .

The left hand side of (3), the sum of marginal rates of substitution between public and private goods, represents the marginal benefits of public goods provision, and from (2) it is necessarily identical for any tax instrument i . The optimal solution for the marginal cost of funds must, therefore, be identical for all tax instruments in the jurisdiction. This is a basic result in optimal taxation theory, and implies that the solution to the problem of determining the optimal amount of total effective revenues (and public good provision) also solves the problems of optimal revenue composition. The reason is that the optimal marginal cost of funds is associated with a certain amount of revenue collections for each tax instrument and, provided that transfers are exogenously determined, then also with a total amount of revenues and expenditures.

¹⁴ Ballard and Fullerton (1992) and Dahlby (2008) provide extensive discussions of the concept of the marginal cost of funds. Examples of formal definitions of the concept can be found also in Håkonsen (1998) and Auerbach and Hines (2002). The term X_i in the numerator of the expression is usually reduced to B^i . In the case of a labor income tax, for instance, this is because the reduction of labor supply entails welfare gains for society; however, here we omit preferences for leisure in order to simplify the discussion.

Figures 1.a and 1.b describe the solution to the problems of optimal public goods provision and revenue composition as solved by condition (3). The horizontal axes represent public goods and the vertical axes the marginal costs and benefits of public funds. Initially, the government relies exclusively on two tax instruments, 1 and 2 –with marginal cost of funds' functions MCF^1 and MCF^2 in Figure 1.a, and it is interested in minimizing the cost of collecting any given amount of revenues. In this context, the revenue collection problem can be seen as a multi-plant production problem in which the tax authority must produce one commodity, revenues, and it minimizes the overall costs by choosing among different plants or tax instruments with different cost functions.

As a general principle, a cost minimizing tax authority will always finance a marginal increase of revenues with the revenue source with the lowest marginal cost of funds. For example, if the government is initially collecting no revenues and needs to provide public goods for an amount of G^1 , then it should use only tax 1, because it has a lower marginal cost than tax 2 in the relevant range. Any amount of public goods greater than G^1 would require the government to assume marginal costs higher than $MCF(G^1)$. However, over that level the government will collect revenues from the two tax instruments, such that the amount of revenues that can be collected at each marginal cost of funds is greater than in the presence of only one tax instrument. As a result, if we assume that cross tax elasticities of the tax bases are zero, then the overall marginal cost function $MCF(G)$ is given by the horizontal summation of MCF^1 and MCF^2 , which passes through points p , q and e^a .¹⁵

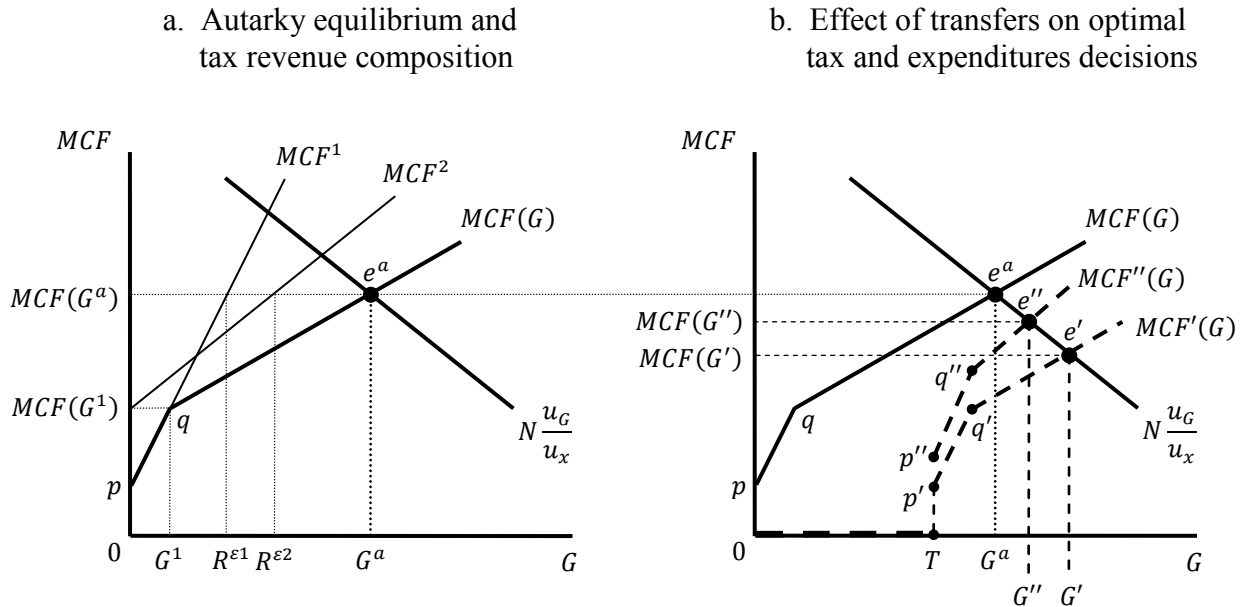
In a non-cooperative intergovernmental system where the subnational government must fully finance all public expenditures inside the jurisdiction, the welfare maximizing solution to the public goods problem is found in the intersection between the marginal cost of funds' function $MCF(G)$ and the benefits function. In Figure 1 this equilibrium is represented by point e^a –with a standing for “autarky”; where the optimal public goods provision is G^a and the marginal cost of funds is $MCF(G^a)$. According to condition (3) the optimal tax rate for taxes 1 and 2 are found at the points where their marginal cost of funds is equal to $MCF(G^a)$, which leads to optimal amounts of effective own revenues of $R^{\varepsilon 1}$ and $R^{\varepsilon 2}$, respectively.

As the analysis in Figure 1.a illustrates, the shape of the MCF functions for the available tax instruments determine not only the optimal amount of total revenues, but also the optimal tax mix. When a tax instrument has a relatively steep MCF function (as tax 1 in the figure), then its share over tax revenues decreases as the optimal MCF goes up. Similarly, flatter MCF functions characterize more revenue productive tax instruments, which are expected to become more important in the subnational budget as total tax revenues increase.¹⁶

¹⁵ The same reasoning is applied to the problem of tax composition by Hettich and Winer (1984) and Kenny and Winer (2006), when they provide a solution to the problem of revenue structure that depends on the political costs of taxation, as opposed to the traditional marginal costs of funds that depends on the welfare costs of taxation.

¹⁶ Note that under this framework the decision to use several tax instruments to collect revenues requires all MCF functions to be increasing at the optimal solution to the government problem. If one or more tax instruments were displaying decreasing MCF functions, then it would be efficient to collect all tax revenues through the tax instrument associated with the lowest MCF. Any other tax source would be redundant, and thus the problem of tax composition

Figure 1. Optimal revenue composition and optimal level of public expenditures



Even though at the optimum all own tax revenues can be expected to have the same MCF, this will not be the case for other revenue sources. Any revenue source over which the subnational government has limited autonomy will be subject to a different, presumably lower, MCF. This is the case of intergovernmental transfers or revenue sharing arrangements, which may be perceived by the subnational government as having no or negligible marginal costs.

From the perspective of the subnational government, and leaving aside user charges and fees, all revenue sources can be ranked from those with the lowest MCF to those with the greatest MCF.¹⁷ Intergovernmental transfers are particularly cheap revenue sources for subnational government, and their marginal cost could even be zero if they are financed entirely with taxes collected in other jurisdictions. In Figure 1.b we first describe the effect of exogenous and “costless” intergovernmental transfers T on the optimal amount of tax collections and public expenditures. The after-transfer marginal cost function $MCF'(G)$ is defined jointly by the segment OT and the segment $p'q'e'$. The immediate effect of transfers is to reduce the MCF faced by the subnational government for any given level of G .¹⁸ This allows the subnational government to substitute away own tax collections and to increase public goods provision from G^a to G' . In Figure 1 the initial optimal level for the MCF is given by $MCF(G^a)$, which is reduced to $MCF(G')$ after transfers have been received.

would have a trivial solution. In this sense, the fact that several tax sources are being used by most central and subnational governments around the world suggests that the MCF is, in practice, an increasing function of tax collections for all tax instruments.

¹⁷ As explained, in the cases of user charges and fees, the revenue assignment problem is already efficiently “solved”.

¹⁸ A similar proposition is found in Smart (1998) who argues that equalization transfers reduce the MCF because they help to avoid part of the distortionary effects of local tax increases. See Dahlby (2008, p.247) for additional discussion.

In addition, less own tax collections may lead to a reduction of government responsiveness ρ , which according to condition (3) would increase the MCF for any level of public expenditures. The positively sloped portion of the marginal cost function $MCF'(G)$ shifts upwards and thus the new function, denoted here as $MCF''(G)$, is defined by the segment $p''q''e''$.

Most commonly, however, intergovernmental transfers impose positive, although relatively low or subsidized, marginal costs to subnational governments. This is because a share of the transfers received may have been financed with taxes collected inside the jurisdiction, and so they may either erode subnational tax bases or require some degree of subnational tax effort. Revenue sharing on a derivation basis is an example of transfers fully financed with internally raised tax collections. Given that the central government administers these taxes, the subnational governments face no collection costs, but the arrangement may still impose greater marginal costs (negative externalities) if the central government tax rates erode subnational tax bases. In the case of piggyback taxes the recipient government is given autonomy to set the tax sharing rate, usually within a predetermined range. The advantage in this case is that subnational authorities are directly responsible for a marginal tax rate increase, so that the value of ρ can be expected to increase. According to condition (3), this would in turn reduce the MCF of *all* own tax sources for any given level of public expenditures. Another example of subsidized revenue sources are matching transfers, which are usually defined as conditional and computed as a predetermined proportion of the expenditures executed in a certain program or function. Since these expenditures are expected to be partially self-financed, then matching transfers can be interpreted as a proportional reduction of the marginal cost of own-revenue collections.

The extent to which each type of intergovernmental transfers will affect the MCF faced by the recipient government will depend on the specific aspects of their design, the sensitivity of tax bases, the reduction of government responsiveness, and so on. As explained, lower MCF sources are preferable from the recipient government's point of view, while those with the greatest MCF are going to be used only if they are justified by large enough marginal social benefits. If provided in the right amount, transfers would allow subnational governments to reach more efficient and/or fairer levels of expenditures, but at the cost of substituting away own revenues and worsening government responsiveness. Consequently, even though intergovernmental transfers can generally be expected to reduce the MCF and stimulate public goods provision, the opposite result is also possible if they induce a significant loss of government responsiveness.

Another important limitation of intergovernmental transfers is that they are normally exogenously determined, thus they are not necessarily an effective tool to enhance decision making autonomy in expenditure choices.¹⁹ As McLure (2000, p. 626) puts it, subnational

¹⁹ The literature on the soft budget constraint focuses on the problems created by the use of transfers to assist governments under financial stress, which suggests that intergovernmental transfers can actually be influenced by subnational governments (see Rodden, Eskeland and Litvack 2003). Accordingly, a number of empirical studies treat intergovernmental transfers as an endogenous variable (Knight 2002; Gordon 2004; Dahlberg et al 2008). In our discussion, we assume that transfers are exogenous and so subnational governments have no incentives to deviate from efficient behavior.

expenditure autonomy requires not only the assignment of own revenue sources, but also that subnational governments are “able to control the level of revenue *at the margin*; that is, they must be able to set the level of taxes to correspond to the desires of voters”.²⁰ Note that autonomy at the margin is a precondition for solving the model described in this section. It would not be possible to equalize MCF across tax instruments inside the jurisdiction if the tax authority is not able to adjust tax revenue collections, which in our model can only be done through discretionary changes of tax rates.²¹

In summary, in this section we have shown that as long as own revenues increase government accountability and responsiveness, greater reliance on own revenue collections will reduce the marginal cost of funds for any given level of public expenditures. Because of this reason, and in accordance to the expenditure-side literature on the revenue assignment problem, greater reliance on own revenue collections can help increase efficiency in the use of public funds at the subnational level. Autonomy at the margin and significant own revenue collections are necessary conditions to maximize welfare at the subnational level; however, these policy rules do not help to determine the extent to which own revenue sources should be used.²² In contrast, the revenue-side principle of equal MCF across tax instruments fully solves the problem of the optimal amount of own revenue collections as well as the problem of revenue composition. Provided that the efficiency gains from greater responsiveness are accounted for in the measures of MCF, the subnational government should use each revenue source up to the point where its MCF reaches the optimal level.

3. The optimal structure of own revenues and transfers

In the previous section we described the optimal tax and expenditure decisions of a subnational government, and show the effect of exogenous intergovernmental transfers and the way own revenue collections can foster efficient subnational government behavior. In this section we take a broader perspective and analyze the problem of the optimal structure of revenues across all government units in a country. In this setting intergovernmental transfers become an endogenous choice variable of the central government.

We now consider explicitly a central government and, for simplicity, only two subnational jurisdictions $j = 1, 2$ at the same level of government. As in the previous section, there are only two tax instruments $i = 1, 2$, whose tax bases are co-occupied by the central government and the

²⁰ Emphasis in the original.

²¹ Under certain conditions we could also consider financial debt as an equally effective source of fiscal autonomy. Similar to the cost structure associated with own tax instruments, the interest rate of a loan provides a direct measure of marginal costs that, the same as a MCF function, would have an increasing form because of the additional risk associated with greater financial debt. Besides interest costs, the MCF associated with debt would also include the MCF of future revenues raised to pay the debt back.

²² The expenditure-side rule by which the wealthiest government should fully finance its expenditure needs is not applicable in this case because here we are analyzing one local government in isolation. The problem of the optimal structure of subnational revenues in a context of several government units is analyzed in the next section.

subnational government in the respective jurisdiction. The central government tax rate t^{ic} applies identically in both jurisdictions, and each subnational government retains autonomy to define its own tax rate t^{ij} . Taxpayers are assumed to be identical inside each jurisdiction, although the number of taxpayers, the tax bases and the preferences of the representative taxpayers may differ between the two jurisdictions. For simplicity, we do not consider mobility of the population or any factor of production, nor any horizontal externality imposed by local tax and expenditure decisions.²³

In this section we describe the central government decisions about the amount of national public goods G^c and the transfers T^j that maximize overall welfare in the two jurisdictions. The central government tax rate t^{ic} determines the affordability of the transfers system, but that decision is analyzed in the next section in the context of our discussion about the optimal degree of revenue decentralization.

The central government decision about the optimal amount of intergovernmental transfers to each jurisdiction j , T^{j*} , is subject not only to feasibility constraints but also to important assumptions about the role of government. On the one hand, the choice of T^{j*} defines the total amount and the composition of revenues (and expenditures) of each government unit. On the other hand, the choice of T^{j*} may depend on formal or informal goals of the central government that are not necessarily compatible with the traditional welfare maximizing model used in normative public economic theory. At one extreme, the central government may decide to set up an uncooperative system where each government unit must rely on its own revenue collections to fulfill its expenditure responsibilities. The solution for this system would be no transfers, and the outcome observed in each jurisdiction could be characterized by the “autarky” solution presented in the previous section. At the opposite extreme, the central government may engage in a fully cooperative system and attempt to maximize welfare in all and each jurisdiction. As long as the central government has perfect information of subnational preferences for subnational public goods, this system would provide the first best solution to the welfare maximization problem, where the extent of decentralization is tailored for each jurisdiction. However, under this scheme there would be no justification for a fiscally decentralized system of government, and thus no reason for subnational governments to exist.²⁴ In practice, neither of these extremes describes the way countries around the world organize their fiscally decentralized systems of government.

²³ Mobility may affect the optimal central government decisions through its effects on tax bases, but it is treated as an exogenous variable that does not alter the prevailing normative goals of welfare maximization and (partial or full) equalization. Horizontal fiscal externalities may also be relevant, but their effects on optimal revenue structure at the national and local levels are of a similar nature to those of vertical fiscal externalities considered in the model.

²⁴ Here we follow Oates’ (1972) Decentralization Theorem, which is based on the assumption that central government policies are constrained to be uniform across jurisdictions. This assumption has been challenged, for instance, by Lockwood (2002) and Beasley and Coate (2003), who developed alternative rationalities for decentralization based on political economy arguments. Other arguments in favor of decentralization are provided by Seabright (1996), who focuses on accountability mechanisms, and Tanzi (2000) who argues that there are better information flows at the subnational level.

In countries where the case for fiscal decentralization has been made and subnational governments are responsible for providing local public goods and services inside their jurisdictions, the central government finances part of subnational expenditures with transfers. The central government usually determines common standards for subnational public expenditures and revenue effort, and delivers the amounts of transfers that allow all subnational governments to meet those standards. This strategy results in a system of “equalization” transfers, in which the ability to finance comparable or standard baskets of public goods and services is equalized across all governments of the same level, and most often is associated to one single degree of revenue decentralization common to all jurisdictions. Indeed, besides the case of metropolitan and other economically advanced areas, which are usually subject to special assignment rules due to their atypical characteristics in the national context, there are not many examples of asymmetric decentralization of revenue sources.²⁵

Subnational public expenditures can be divided into two categories. One encompasses the expenditures on a standard package of public goods and services G^{sj} , which are meant to be jointly financed by equalization transfers T^j and by own revenues collected with a standard level of tax effort. We can think of the standard package of public expenditures as fixed proportions of money spent on certain public goods and services, and whose amount per capita is equal and changes simultaneously for all jurisdictions. In addition, here we represent the standard level of tax effort for each tax instrument i by a tax rate t^{is} and an administrative costs function A^{is} , which are the same for all jurisdictions j .

The other expenditure category includes all the spending on non-standard, autonomous and discretionary public goods and services G^{dj} , which should be financed entirely with the subnational governments’ own revenue collections. Thus, under this category we include public expenditures on the same public goods and services considered in the standard package, but only to the extent that they deviate from that standard, as well as all other spending on other public goods that the jurisdiction discretionally provides and which are not part of the national standard package.

The distinction between standard and discretionary expenditures is important to model central government intervention in a system where subnational governments are granted some degree of fiscal autonomy. In such a system subnational governments are allowed to offer different amounts and types of public goods and services, and the central government cannot, and should not, account for those differences when maximizing social welfare.

Formally, if we assume that: (i) the central government maximizes a utilitarian welfare function; (ii) transfers to jurisdiction j , T^j , are only intended to equalize the ability of the subnational government to finance G^{sj} ; and (iii) all government units must keep a balanced

²⁵ One example is given by the “special charter” regions in Spain –Basque Country and Navarre, which are given distinctive revenue assignments due to historical reasons (López Laborda and Monasterio 2007). Other cases are examined in Bird and Ebel (2007).

budget, then the central government problem can be written as: ²⁶

$$\begin{aligned} \mathcal{L}^c = & \sum_{j=1}^2 N^j u^j [\sum_{i=1}^2 (1 - t^{ic} - t^{ij}) b^{ij}, G^{sj} + G^{dj}, G^c] \\ & + \sum_{j=1}^2 \mu^{sj} \left\{ -G^{sj} + \rho^j [\sum_{i=1}^2 t^{ij} B^{ij}] \{ \sum_{i=1}^2 t^{is} B^{ij} - A^{isj} [t^{is} B^{ij}] + T^j \} \right\} \\ & + \sum_{j=1}^2 \mu^{dj} \left\{ -G^{dj} + \rho^j [\sum_{i=1}^2 t^{ij} B^{ij}] \{ \sum_{i=1}^2 (t^{ij} - t^{is}) B^{ij} - (A^{ij} [t^{ij} B^{ij}] - A^{isj} [t^{is} B^{ij}]) \} \right\} \\ & + \mu^c \{ -G^c - \sum_{j=1}^2 T^j + \sum_{i=1}^2 (t^{ic} B^i - A^{ic} [t^{ic} B^i]) \} , \end{aligned} \quad (4)$$

where $G^{sj} + G^{dj} = G^j$ is total subnational expenditures in jurisdiction j ; while μ^{sj} , μ^{dj} and μ^c are the Lagrange multipliers associated with the budget constraints of the subnational governments (on standard and discretionary expenditures) and the central government. ²⁷

The first order condition for the optimal provision of national public goods is given by:

$$\sum_{j=1}^2 N^j u_{G^c}^j - \mu^c = 0 , \quad (5)$$

which states that the central government should provide G^c up to the point where the sum of marginal benefits from the national public goods for all jurisdictions is equal to the marginal cost of raising central government revenues.

Determining the optimal equalization transfers T^{j*} requires an additional (normative) assumption. In order to provide the right incentives to subnational governments, the computation of equalization transfers needs to be based on the assumption that $\rho^j = 1$ for any jurisdiction j . Otherwise, the central government would be endorsing and rewarding less responsive behavior of subnational authorities, and the anticipation of central government decisions may lead to a soft budget constraint problem and inefficient expenditure policies at the subnational level. Using this assumption and the maximization problem in (4), the first order condition for the optimal amount of intergovernmental transfers to any jurisdiction j is given by:

$$\mu^{sj} - \mu^c = 0 , j = 1, 2 . \quad (6)$$

The optimal vector of intergovernmental transfers must make the marginal cost of collecting own revenues under standard conditions in any jurisdiction j equal to the marginal cost of own revenues at the central level. In other words, at the optimal solution, the marginal cost of financing standard public expenditures at any level of government should be identical for all governments across the nation. Moreover, common standards should be defined in real (not only nominal) terms. It follows that for any jurisdiction j we can divide condition (6) by a common marginal utility of income u_x

²⁶ The problem of the subnational governments in (1) can be rewritten to account for the distinction between standard and discretionary public expenditures. In Appendix I we analyze that problem and show that the results presented in the previous section for the case of a subnational government in an autarkic system are still valid under this new framework.

²⁷ The central government may also face problems of accountability and responsiveness to taxpayers, which may arguably be worse than those faced by subnational governments; however, for simplicity, we ignore those problems and assume that ρ is equal to 1 at the central level.

and impose equality of marginal rates of substitution in the whole national territory.²⁸ As a result, and making use of (5) and the definition of the marginal cost of funds in (3), condition (6) implies:

$$\mu^{S^*}/u_x = MCF^{C^*} = MCF^{Sj^*} . \quad (7)$$

Condition (7) extends a well-known result from optimal taxation theory (the equality of MCF across tax instruments) to the equality of MCF for standardized public goods and services across jurisdictions. A similar condition was presented by Dahlby and Wilson (1994), who were the first to analyze the optimal design of intergovernmental transfers in the framework developed by the MCF literature; however, to date, that literature has not distinguished between standard and discretionary subnational expenditure decisions. Condition (7) is important for two reasons. First, it implies that any normative decision about the subnational standard bundle of public goods and services can be supported by an optimal vector of equalization transfers. Second, the condition applies exclusively to the financing of standardized public goods and services, allowing for the marginal cost of financing discretionary expenditures to be determined autonomously by each subnational government, as it should be the case in a fiscally decentralized system.

Expenditure needs, fiscal capacity and fiscal disparities

Condition (7) establishes the equality of marginal costs of funds and marginal benefits for all government units in a decentralized system, a notion that has recently been exploited by Dahlby (2009) to define the concepts of expenditure needs, fiscal capacity and vertical and horizontal fiscal imbalances within the MCF framework. Here we build upon the work of Dahlby and provide slightly different definitions for the same concepts. We use Figure 2 to illustrate these definitions for any given jurisdiction, and omit the symbol j to simplify notation. Assume that a jurisdiction is initially in equilibrium at e^0 , where the function $MCF^S(G^S)$ intercepts the function representing the social marginal benefits of standard public goods and services.²⁹ If the central government assumes $\rho = 1$ (and the true ρ is smaller than one), then the relevant MCF function, represented by $MCF_{\rho=1}^S(G^S)$, would display a lower marginal cost at any level of public goods provision.

The optimal amount of intergovernmental transfers T^* to the jurisdiction and the optimal marginal cost of tax collections μ^{S^*} must be defined simultaneously. Let's assume for illustration purposes that transfers are costless for the recipient government, so the function $MCF_{\rho=1}^S(G^S)$ shifts rightward to $MCF_{\rho=1}^{S'}(G^S)$ in an amount equal to T^* . At the new optimum e^* , the amount of public goods provided $G^S(\mu^{S^*})$, is equal to the amount of effective own revenues $R^{SE}(\mu^{S^*})$ collected under $\rho = 1$ and the standard level of tax effort, plus the amount of optimal transfers T^* .

²⁸ Equality of u_x across jurisdictions is here used only to define the standard of real marginal cost of revenues (relative to private goods); it does not mean that the government would commit to equating the marginal utility of income for all individuals.

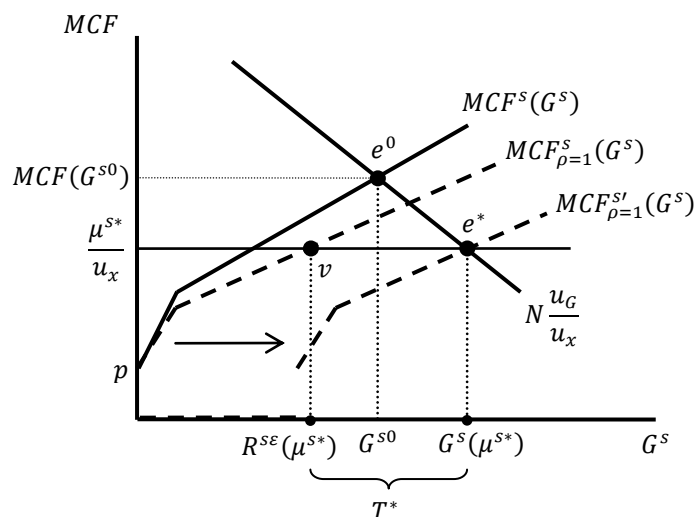
²⁹ Recall that the autarky equilibrium described in Section 2 is obtained by considering the preferences of the community for all possible public goods and services, which may differ from the "standardized" bundle of subnational public goods and services subject to equalization.

Following Dahlby (2009), here we define expenditure needs, EN , as the amount of public goods and services that a subnational government should provide when facing the same (optimal) MCF as the other subnational governments, but we restrict the scope of this definition to the case of *standard* (centrally determined) public goods and services only. Formally, the expenditure needs of the jurisdiction are defined simply as:

$$EN^* = G^S(\mu^{S*}) . \quad (8)$$

This definition is compatible with the traditional notion of expenditure needs, typically related to a “comparable” or “standard” package of goods and services, which in this case is made affordable for a given level of tax effort at the optimal MCF. Among two otherwise similar jurisdictions, a relatively needy jurisdiction can be expected to display a marginal benefit function above the average or “representative” marginal benefit function, and consequently its expenditure needs at the optimal MCF would also be greater than average.³⁰

Figure 2. Fiscal capacity, expenditures needs and optimal equalization transfers



Similarly, we can define here own revenue potential or fiscal capacity, FC , as the amount of effective (after collection costs) own revenues that a subnational government would be able to collect at the optimal MCF with a standard level of tax effort and with no waste of public funds ($\rho = 1$). Formally, fiscal capacity of the jurisdiction is:

$$FC^* = R^{SE}(\mu^{S*}) . \quad (9)$$

This definition differs from that in Dahlby (2009), who divides the tax base by its tax elasticity in order to account for the negative effect of the sensitivity of the tax base on fiscal capacity. We do not do that, however, because the sensitivity of the tax base is already accounted for in the slope of

³⁰ A discussion about the concept, measurement methodologies and use of expenditure needs estimates is provided, for example, by Boex and Martinez-Vazquez (2007).

the MCF function; thus, definition (9) provides a simpler definition of fiscal capacity, which is also more consistently related with the definition of expenditure needs. Definition (9) is largely compatible with the traditional notion of fiscal capacity, according to which fiscal capacity corresponds to the ability to raise own revenues from the assigned tax bases given a standard level of tax effort.³¹

Now the concept of fiscal gap, FG , can be defined for any jurisdiction j as the difference between its expenditure needs and its fiscal capacity:

$$FG^{j*} = EN^{j*} - FC^{j*} . \quad (10)$$

A positive fiscal gap means that the amount of revenues raised under a given level of tax effort are not enough to cover the expenditure needs of the jurisdiction, and thus additional resources in the form of an equalization transfer are required in order to provide a standard bundle of public goods and services. In contrast, a negative fiscal gap implies that the jurisdiction has a “surplus” and is able to provide more or better public services without any financial assistance.

Given that preferences, needs and tax bases vary widely across jurisdictions, it is normal to observe significant differences in the value of the fiscal gap among governments of the same level. These differences are called horizontal imbalances, and equalization transfers are frequently aimed to reduce, if not to eliminate, these imbalances. In practice, countries around the world make use of three possible equalization strategies. Some countries distribute equalization transfers in accordance to relative expenditure needs only; others attempt to equalize only the differences in fiscal capacity, and others consider both factors simultaneously and attempt to equalize fiscal gaps (Boex and Martinez-Vazquez, 2007; Dafflon, 2007). To the extent that one monetary unit of additional expenditure needs has exactly the same impact on the public budget as the reduction of one monetary unit of fiscal capacity, both factors are equally important and the equalization of fiscal gaps can be regarded as the best approach to equalization. Indeed, the optimal transfer vector under condition (7) can be seen as an equalization transfer program that equalizes fiscal gaps across all jurisdictions of the same level. Note that in order to achieve the optimal revenue structure it is not necessary to know the marginal cost of funds’ functions faced by each subnational government. In practice, it is sufficient to define the national standards for the provision of public goods and services and the national standard of tax effort for the collections of revenues, and to disburse the equalization transfers in accordance with the estimated fiscal gaps.

Under this framework the notions of standard public expenditures and standard tax effort are relevant only for the purpose of computing the optimal equalization transfer vector. Once optimal equalization transfers have been determined, each jurisdiction is free to adjust its demand for public goods and services and the amount of own revenue collections to the level that better represents local preferences. Higher (lower) preferences for local public goods can be represented with a rightward (leftward) shift of the marginal benefit function. As a result, the welfare

³¹ Methodologies to estimating fiscal capacity can be found, for instance, in U.S. Advisory Commission on Intergovernmental Relations (1986).

maximizing decision of the subnational government would increase (decrease) the optimal MCF and the level of tax effort in the jurisdiction. In this context, the actual level of tax effort in each jurisdiction can vary in accordance to the preferences and characteristics of each community, and there is nothing inherently wrong with choosing a low tax effort.

The differences observed in the type and depth of the expenditure and revenue decentralization processes lead to different fiscal gaps across levels of government. These differences are usually referred to as vertical imbalances, and any transfer from the government level with negative fiscal gap (usually the central government) to the government level with positive fiscal gap would help reduce the vertical imbalances. Given standard public expenditures and tax effort, the size of the vertical imbalance between the central and subnational governments VI under the optimal solution described by (7) is given by:³²

$$VI^* = \sum_{j=1}^2 FG^{j*} .$$

Similarly, under the same assumptions horizontal imbalances can be defined as the differences in fiscal gaps across governments of the same level. By using our definition of fiscal gap, therefore, we can clearly define the concepts of vertical and horizontal imbalances.³³ Moreover, the size of the vertical imbalance would be equal to the total amount of transfers required to fully close the horizontal imbalances only if the governments with negative fiscal gaps transfer all their surpluses to the governments with positive fiscal gaps.³⁴ More commonly, however, governments with negative fiscal gaps do not contribute to the equalization transfer fund and thus the amount of resources required to fully eliminate the horizontal imbalances is greater than the vertical imbalance.³⁵ As a consequence, neither the horizontal nor the vertical fiscal imbalances will be closed optimally (Boadway and Tremblay, 2006).

There are a number of possible limitations to the ability of the system to close fiscal gaps. Besides the impossibility of collecting contributions from (richer) jurisdictions with negative fiscal gaps, countries use transfers to fulfill objectives different from equalization, like pro-poor programs or infrastructure investments. The resources used for these purposes will help to close the vertical imbalance, but not necessarily the horizontal imbalances. In general, if the central government is unable to reduce the marginal cost of funds nationwide to the optimal level, then there will be a downward adjustment to the standard of expenditure needs that can be guaranteed by the system.

³² There is no clear agreement in the literature about the right terminology to be used to define these concepts. Boadway and Tremblay (2006, 2010), for instance, use the term ‘fiscal gap’ to refer to what we call here vertical imbalance, and in turn they use the term ‘fiscal imbalance’ to refer to deviations from the optimal equilibrium.

³³ Bird and Tarasov (2004) argue that the two concepts cannot be cleanly separated, and for that purpose they suggest considering the vertical imbalance closed at the point where the fiscal gap of the wealthiest jurisdiction is zero.

³⁴ Such an arrangement is known as the “fraternal” (or Robin Hood) approach to equalization, and it is relatively common among European countries.

³⁵ When some jurisdictions remain with negative fiscal gaps, the optimal transfer condition in (6) is not fulfilled for those jurisdictions. Formally, for some jurisdictions k , $\mu^{sk} + \alpha^k = \mu^c$, with $\alpha^k > 0$.

4. The optimal degree of revenue decentralization in the presence of tax externalities

The central government's decision about how much tax revenue to collect simultaneously determines the amount of national public goods and the magnitude of the intergovernmental transfer programs. In reality, these three decisions are made at the same time, but we have postponed the analysis about the optimal choice of central government tax rates because it entails additional complications.

Positive central government decisions ensuring affordability in the system are different in nature from normative decisions determining the amount of transfers that subnational governments should receive. In the previous section we modeled the decision about the optimal amount of equalization transfers as a normative decision based on the hypothetically efficient behavior of subnational government, characterized by perfect government responsiveness ($\rho^j = 1$) and standard level of tax effort. These assumptions were made with the double purpose of achieving fairness and preserving efficiency in the system while avoiding perverse incentives. In contrast, in order to ensure affordability, the central government must consider the actual effects of its tax policies on the tax bases commonly used with the subnational governments, on the subnational governments' decisions about t^{ij} –which are here represented as t_{ic}^{ij*} , and the consequent changes in subnational governments' responsiveness ρ^j .

The normative transfer's decision and the positive central government tax rates' decision can be seen as two different aspects of the same problem described in (4). In order to fully solve this problem, the central government must satisfy simultaneously the optimal conditions associated with the two decisions. In the previous section we derived the optimal transfer condition (6), which solves the central government problem under our normative assumptions. In the following discussion we relax those assumptions to obtain the (positive) central government tax rate conditions, but impose (6) to ensure that both normative and positive conditions are simultaneously satisfied.

The first order condition for the optimal choice of the central government tax rate t^{ic} is derived from the central government's problem in (4). Using the condition for subnational optimal tax decisions in (3) the equality of marginal revenue costs in (6), and imposing $u_x^j = u_x$, the optimal condition for t^{ic} can be reduced to the following MCF rule:³⁶

$$\frac{\sum_{j=1}^2 N^j u_{G^c}^j}{u_x} = \frac{-\sum_{j=1}^2 X_i^j}{\sum_{j=1}^2 t^{ij} B_i^{ij} \{ \rho^j (1 - A_R^{ij}) + \rho^j (R^j - A^j + T^j) \} + \{ B_i^{ij} + t^{ic} B_i^{ij} (1 + t_{ic}^{ij*}) \} (1 - A_R^{ic})}, \quad (11)$$

where $R^j = \sum_{i=1}^2 t^{ij} B_i^{ij}$ and $A^j = \sum_{i=1}^2 A^{ij} [t^{ij} B_i^{ij}]$, and where we have assumed that $\mu^{dj} = \mu^{sj} = \mu^c$ to avoid central intervention in discretionary subnational decisions and to account for the fact that the central government can only guarantee standard public goods and services. The MCF faced by the central government at its optimal tax decision increases with the sensitivity of the tax

³⁶ Appendix II presents a detailed derivation.

bases, with greater administrative costs, and with the effects of central tax rates on subnational tax rates (which multiply a negative change on the respective tax base). In particular, the central government must account for the endogenous response of subnational tax policy, t_{ic}^{ij*} , in order to correct for inefficient subnational tax decisions. These inefficiencies are due to the fact that subnational governments typically ignore the negative externalities their decisions impose outside their jurisdictions. In our model, for example, higher subnational tax rates may erode the tax bases within the jurisdiction and thus impose a negative vertical externality on the central government by reducing its tax revenues (Boadway and Keen 1996; Dahlby 1996; Boadway, Marchand and Vigneault 1998; Keen 1998; Dahlby and Wilson 2003).³⁷

A socially efficient subnational tax decision should consider all costs imposed to all government units. The optimal condition for such a decision can be derived from the problem in (4), where the benefits and costs of all individuals in the nation are accounted for. Assuming again that $\mu^{dj} = \mu^{sj} = \mu^c$, then the “true” (social) marginal cost of funds associated with the optimal subnational tax rate t^i is:

$$N^j \frac{u_{G^j}}{u_x} = \frac{-X_i^j}{R_i^{ij} \left\{ \rho^j (1 - A_R^{ij}) + \rho^j \left\{ \sum_{i=1}^2 (t^i B^i - A^i [t^i B^i]) + T \right\} \right\} + t^{ic} B_i^{ij} (1 - A_R^{ic})} \quad i = 1, 2. \quad (12)$$

The term $t^{ic} B_i^{ij} (1 - A_R^{ic})$ in the denominator of (12) represents the negative tax externalities imposed by subnational taxation on central government tax collections. This term is not present in the MCF function faced by the subnational government in (3), implying that the subnational governments underestimate the true (social) marginal cost of their funds.

In order to evaluate the appropriateness of decentralizing a revenue source we need to compare the costs and benefits of collecting taxes at the subnational level with the costs and benefits of doing it centrally. In our model the benefits and costs of subnational collections are summarized by the adjustments made to R_i^{ij} in (12). The gains of subnational taxation are represented by greater government responsiveness and accountability, while the losses by negative tax externalities and presumably their greater administrative costs, due, for example, to their inability to take full advantage of economies of scale in tax collections.

With no revenue decentralization, and provided that the same tax rate t^{ic} is applied in all jurisdictions, the optimal condition for efficient public spending can easily be derived from (11), making $t^{ij} = 0$. Assuming for simplicity that central government responsiveness to local preferences ρ is identical throughout the country, then the relevant condition would be:

$$\frac{\sum_{j=1}^2 N^j u_{G^j}}{u_x} = \frac{-\sum_{j=1}^2 X_i^j}{\rho \sum_{j=1}^2 R_i^{ij} (1 - A_R^{ic})}. \quad (13)$$

³⁷ Revenue externalities (positive or negative) can also be imposed on governments of the same level, but we have ruled out this possibility for simplifying purposes. In any case, the effects and implications of horizontal externalities are similar to those of vertical externalities. See, for instance, Gordon (1983) and Bucovetsky and Smart (2006).

The denominators in the right hand side of (12) and (13) describe the effect of taxation on marginal effective revenues collected through the tax instrument i by the subnational government of jurisdiction j , or by the central government, respectively. By comparing the marginal effective revenues under revenue decentralization (for the two jurisdictions) with the marginal effective revenues that would otherwise be faced by the central government we can identify the relative benefits and costs of subnational taxation. A greater decentralization of the tax instrument i would be welfare enhancing if:

$$\sum_{j=1}^2 R_i^{ij} \left\{ \rho^j (1 - A_R^{ij}) + \rho_R^j \left\{ \sum_{i=1}^2 (t^i B^i - A^i [t^i B^i]) + T \right\} \right\} + t^{ic} B_i^{ij} (1 - A_R^{ic})$$

$$> \rho \sum_{j=1}^2 R_i^{ij} (1 - A_R^{ic}) .$$

In practice, however, authority to determine the tax rate of a tax instrument is a binary variable; the subnational government may have it or not. The decentralization of the tax instrument i would lead to a welfare improvement as long as the total gains from greater accountability, net of the loss of central government revenues, exceed the total gains of collecting the tax centrally, which will presumably be associated with lower administrative costs but also with less government responsiveness. Tax instruments for which subnational governments face lower MCF than the central government in the relevant range should be fully decentralized, with subnational governments having full discretion to set their own tax policy. It is important to note that for these taxes the negative externalities imposed on central government revenues must be necessarily compensated by the efficiency gains due to increased accountability and improved responsiveness; otherwise, the tax instrument should not be decentralized in the first place. This conclusion contradicts the widely held principle that the negative tax externalities associated with decentralized tax revenues should be ‘fully corrected’ in order to avoid inefficiencies and welfare losses.³⁸ If we can expect that in the aggregate the marginal benefits of decentralization would compensate the marginal costs of negative tax externalities, then there is no case for a full compensation of these externalities. The correction might be justified, however, on a differential basis at the level of individual jurisdictions, because the net efficiency gains from decentralizing tax instruments would likely differ across jurisdictions, and some of them may become a source of net efficiency losses for the country. Aligning incentives to promote efficient subnational behavior would require the equalization of the net efficiency gains across jurisdictions. This differential correction can be understood as an adjustment to the marginal cost of funds faced by each jurisdiction, and it would lead to an adjustment to the optimal equalization vector implicitly described by condition (7).

These simple revenue assignment guidelines also contrast with the rule of self-financing the wealthiest subnational government, which would lead to a proper assignment of revenues only if the wealthiest government is able to cover its expenditure needs at the optimal MCF. The

³⁸ Bucovetsky and Smart (2006) and Kotsogiannis (2010) describe the modifications required by a standard equalization transfer formula in order to achieve efficient subnational taxation in the presence of horizontal and vertical tax externalities, respectively.

problem is that it may well happen that self-financing is associated with an excessively high MCF. In that case the optimal degree of revenue decentralization would be found at a point where the wealthiest subnational government requires transfers from the center to cover its expenditure needs under the prevailing standards. After we account for the gains from accountability, what matters is that own tax collections face the optimal MCF, not their specific proportion on total revenues.

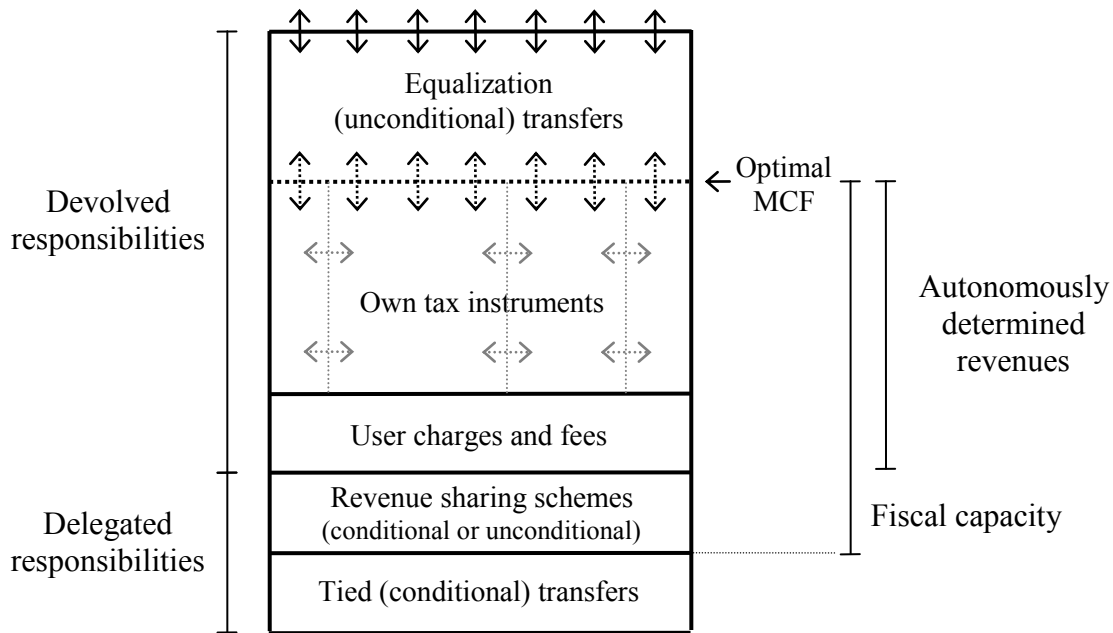
5. The implementation of the optimal revenue assignment from a policy perspective

In this section we show how the analysis developed in this paper can be utilized to address the revenue assignment problem from a practical policy perspective. Figure 3 represents an ideal structure of revenues for a typical subnational government. One of the most important distinctions among expenditure functions is about delegated and devolved responsibilities. Delegated expenditure responsibilities are carried out by subnational governments, but decision making authority as well as the ultimate political responsibility is retained by the central government. These responsibilities can be related with minimum standards of public services to be met along the national territory, either because they are considered as basic needs or rights, or because they have become national goals. In order to ensure that minimum standards are met the central government should provide the required resources via tied or conditional transfers (at the bottom of the figure). These transfers are generally exogenous to the subnational decision and their MCF is relatively low from the subnational perspective, but nothing really ensures that they will be large enough to fully cover the delegated responsibilities.

In contrast, all aspects of devolved expenditure responsibilities are meant to be fully determined by subnational governments. In such cases subnational authorities require effective revenue autonomy to adjust the level of public expenditures to the needs and preferences of the community. Ideally, autonomous decision making should be financed by revenue sources that satisfy the benefit principle. For instance, when public goods and services are excludable and it is possible to apply user charges and fees, then there would be no need for other revenue sources.

The proper assignment of revenue sources becomes a problem only when delegated responsibilities are not fully financed with conditional grants and autonomous decision making cannot be financed with user charges and fees. In order to enjoy effective revenue autonomy subnational governments must have access to their own tax instruments. The expenditure-side approach to the revenue assignment problem is associated with a number of normative prescriptions based on the desirable properties of subnational tax instruments. Among these we find, for instance, the properties of revenue adequacy, low administration and compliance costs, neutrality with respect to geographical location decisions, taxes should not be exportable, they should be highly visible, and bases should be relatively immobile and stable. These are guidelines to select the best possible own revenue sources for subnational governments, which can be interpreted as desirable characteristics that reduce the true social MCF faced under a particular tax instrument. In this sense, they are compatible with the revenue-side tradition that focuses on the MCF functions to select the best subnational revenue sources.

Figure 3. Implementation of an optimal subnational revenue structure



Among all available revenue sources, subnational governments will prefer to use first those with the lowest MCF. This means that, other than user charges and fees, the first revenues to be used are presumably the transfers received from the central government, which have a low MCF for the subnational government because it faces no collection costs. Moreover, if delegated expenditure responsibilities are mostly financed with conditional transfers, then the problem of revenue assignment turns to be one of financing the autonomous decisions related with devolved responsibilities. Generally, this can be done either with own revenues or with unconditional transfer programs, among which the most important (or most recommendable) are those distributed with the equalization transfer program.

The implementation of the optimal equalization transfer vector ensures that all jurisdictions face the same MCF, while the efficient tax revenue choices inside each jurisdictions ensure that the same MCF is equalized across each own revenue source. More (less) equalization transfers reduce (increase) the MCF faced by the subnational government under each own tax instrument. The change of the MCF is represented in Figure 3 by the vertical dotted arrows. In turn, a change of the MCF is associated with adjustments of the optimal structure of own tax instruments, which are represented by the horizontal (grey) dotted arrows in the figure.

If well designed, an equalization transfer program allows the system of intergovernmental fiscal relations to simultaneously satisfy the goals of fairness and efficiency. This is a result derived by the revenue-side approach to the revenue assignment problem, and suggests that other unconditional transfer programs are not essential to obtain an optimal revenue structure, and in

some cases they could even have unintended negative consequences. For instance, revenue sharing schemes in a derivation basis are popular revenue sources in many decentralized countries, and they have been accepted in the fiscal decentralization literature as a useful alternative to the financing of subnational expenditures. Under this type of arrangements a subnational government is given a share of the revenues collected by the central government from one or several tax instruments inside its jurisdiction. Since revenues are collected by the central government, they likely impose a relatively low MCF for the recipient subnational governments. The problem is that whenever the tax bases are unevenly distributed, which is the most typical situation, revenues shared in a derivation basis tend to exacerbate horizontal disparities. As a result, regardless whether they are defined as conditional or unconditional, they will likely divert scarce resources from the most efficient uses.

The equalization transfer program can also be used to reduce, at least to some extent, the additional horizontal disparities created by other transfer programs. In order to do this it is only necessary to incorporate these transfers programs into the measure of fiscal capacity (and adjust accordingly the measures of expenditure needs), and to distribute the funds available for equalization in accordance to the corrected measures of fiscal gap. Of course, the size of these transfer programs may still exceed the amount required to close the fiscal gap of some subnational governments, thus some inefficiencies may still remain. In order to avoid this scenario, it is recommendable to limit the amount transfers other than equalization by the cost of providing the delegated expenditure functions (Martinez-Vazquez and Sepulveda, forthcoming). This makes sure that the system will be able to set the optimal MCF for all subnational governments via the equalization transfer program.

Another important element of the revenue assignment problem, not discussed in this paper, is the use of financial debt at the subnational level. The same as own revenue sources, subnational borrowings are associated with positive and increasing marginal costs. This is because interest rates increase with the risk of the borrower, and in turn the risk increases with financial exposure. Moreover, an additional cost of financial debt comes from the fact that it must be repaid with future taxes, with their own marginal cost of funds. In all, financial debt could be used as another source of subnational revenues, which similar properties than own tax instruments.

6. Conclusions

The revenue assignment problem has long been an important focus of the public finance literature, but to date there is no agreement about the way countries should decentralize the available revenue sources. We pay special attention to two approaches to the topic, which remain largely unconnected one from the other. On the one hand, the expenditure-side approach attempts to provide the subnational governments with incentives to make more efficient spending decisions. On the other hand, the revenue-side approach, based on optimal taxation theory, describes the optimal revenue structure in terms of the marginal cost of funds faced by each government unit. This approach implicitly assumes that subnational governments only require facing the optimal

marginal cost of funds to behave efficiently. Both approaches provide useful insights, but they fall short of providing clear normative rules to guide the revenue decentralization process.

In this paper we integrate these two approaches into one single, more general, model of revenue assignment. We show that most of the insights provided by the two approaches are correct, but some refinements and additional considerations are required in order to fully describe the optimal assignment of revenue sources between levels of government. For instance, the expenditure-side rules of autonomy at the margin and significant share of own revenues seem both to be necessary conditions for maximizing welfare in each jurisdiction, but they do not inform about the extent to which different tax instruments should be exploited at each level of government. Moreover, the rule of self-financing the wealthiest jurisdiction suggests what the total amount of subnational own revenues should be, but nothing ensures that such an amount is optimal. The revenue-side approach provides more precise insights about these matters. The optimal marginal cost of funds is associated with the optimal vector of intergovernmental transfers, and it defines how much revenue should be collected with each tax instrument. However, this rule is somewhat vague in the sense that it does not identify the best candidates for subnational taxes.

One of the most relevant contributions of the paper consists of providing formal, but simple, definitions for some of the most common concepts of the fiscal decentralization literature. Here we build upon the work of Dahlby (2009), who to the best of our knowledge is the first in attempting to define expenditure needs, fiscal capacity, fiscal gap and fiscal imbalances in terms compatible with the two approaches to the revenue assignment problem. In addition, in order for the model to be more applicable to the international practice of fiscal decentralization, we have incorporated key assumptions reflecting common public policy practices and goals. For instance, even though a welfare maximizing central government with perfect information would determine a different optimal marginal cost for each jurisdiction, that is generally not the case in actual practice, so we have restricted the solution to the problem to a unique optimal marginal cost of funds for all subnational governments. We have also incorporated into the discussion some transfers different from equalization, which are extensively used in decentralized countries but often excluded from the discussion about revenue assignments in the context of optimal taxation.

In all, the paper develops a formal model that characterizes key aspects of actual fiscal decentralization processes. Within that framework we evaluate the normative rules currently proposed by the literature and describe the characteristics of an optimal assignment of revenue sources. It is our view that central governments around the world have all the means they require in order to implement a sound system of intergovernmental fiscal relations. After the application of the benefit principle and the transfer of resources to goals other than equalization, the problem of revenue assignment deals with choosing the revenue sources to be decentralized and with implementing a transfer program that equalizes fiscal gaps across subnational governments of the same level. The choice of the revenue sources should consider their marginal costs as well as the efficiency gains due to better accountability and responsiveness. Of course, revenue sources that better approximate the benefit principle and impose less negative externalities and costs will be

preferable, but we have shown that by itself the decentralization of revenue sources may entail efficiency gains that should not be undervalued. In particular, we showed that even though it is true that subnational tax collections may impose negative externalities, a tax instrument would be a good candidate for decentralizations if the gains from decentralizing more than offset the costs. This means that it would not be necessary to correct for the negative externalities generated by those taxes that pass the traditional cost-benefit test.

The key instrument allowing the system to reach a welfare maximizing equilibrium is the equalization transfer program, which should be aimed at reducing the horizontal disparities of fiscal gaps. Good estimates of expenditure needs and fiscal capacity are crucial public policy instruments, as they are required to achieve a situation where the goals of efficiency and equity are simultaneously satisfied. In particular, transfers provided under revenue sharing arrangements on a derivation basis should not exceed the expenditure needs associated with delegated responsibilities. Otherwise, they would limit the effectiveness of the equalization transfer program to set the optimal marginal cost of funds across all government units.

There are several aspects of the model that can be improved or extended by future research. For instance, a political economy approach to the topic may provide additional, maybe more realistic, assumptions about the behavior of central and subnational authorities. There are a number of simplifying assumptions that may be reconsidered. This is the case of our assumptions about homogeneity of taxpayers within each jurisdiction, the absence of mobility and positive fiscal externalities from expenditure policies, or the complementarity and substitutability of tax bases. Relaxing these assumptions might provide additional insights regarding the effects of decentralizing specific tax instruments.

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Appendix I. Subnational government problem with standard and discretionary expenditures

The central government problem in (4) explicitly distinguishes standard from discretionary public goods and services. The same distinction can be made by a subnational government, such that the problem described in (1) can be rewritten as:

$$\begin{aligned} \mathcal{L} = & Nu \left[\sum_{i=1}^2 (1 - t^{ic} - t^i) b^i, G^s + G^d, G^c \right] \\ & + \mu^s \left\{ -G^s + \rho \left[\sum_{i=1}^2 t^i B^i \right] \left\{ \sum_{i=1}^2 t^{is} B^i - A^{is} [t^{is} B^i] + T \right\} \right\} \\ & + \mu^d \left\{ -G^d + \rho \left[\sum_{i=1}^2 t^i B^i \right] \left\{ \sum_{i=1}^2 (t^i - t^{is}) B^i - (A^i [t^i B^i] - A^{is} [t^{is} B^i]) \right\} \right\}, \end{aligned} \quad (\text{A.I.1})$$

where superscripts j have been omitted to facilitate notation $G^s + G^d = G^j$ is total subnational expenditures. The subnational government chooses the amount of discretionary public expenditures G^d and the tax rates t^i that maximize welfare in the jurisdiction. The first order condition for optimal discretionary public expenditures is:³⁹

$$Nu_{G^j} - \mu^d = 0, \quad (\text{A.I.2})$$

while the first order condition for optimal tax rate t^i is given by:

$$\begin{aligned} & X_i u_x \\ & + \mu^s \left\{ t^{is} B_i^i \rho (1 - A_R^{is}) + R_i^i \rho_R \left\{ \sum_{i=1}^2 t^{is} B^i - A^{is} [t^{is} B^i] + T \right\} \right\} \\ & - \mu^d t^{is} B_i^i \rho (1 - A_R^{is}) \\ & + \mu^d R_i^i \left\{ \rho (1 - A_R^i) + \rho_R \left\{ \sum_{i=1}^2 (t^i - t^{is}) B^i - (A^i [t^i B^i] - A^{is} [t^{is} B^i]) \right\} \right\} = 0. \end{aligned} \quad (\text{A.I.3})$$

Moreover, an individual government operating in an autarkic system would also choose the amount of standard public goods G^s , and the corresponding first order condition would be:

$$Nu_{G^j} - \mu^s = 0, \quad (\text{A.I.4})$$

From (A.I.2) and (A.I.4) we know that $\mu^d = \mu^s = \mu$, and the first order condition in (A.I.3) can be reduced to:

$$X_i u_x + \mu R_i^i \left\{ \rho (1 - A_R^i) + \rho_R \left\{ \sum_{i=1}^2 t^i B^i - A^i [t^i B^i] + T \right\} \right\} = 0,$$

which leads to the adjusted Samuelson condition in (3).

Appendix II. Derivation of (11)

The optimal tax rate t^{ic} is derived from the central government problem in (4). In order to ensure affordability in the system we allow for t^{ic} to affect B^{ij} and t^{ij} —and so also government responsiveness $\rho^j [t^{ij} B^{ij}]$. The first order condition for the optimal tax rate t^{ic} is:

³⁹ This condition is equivalent to the optimal condition in (2), where a subnational government is assumed to maximize welfare within the jurisdiction autonomously, or in an autarkic system with no interaction with other government units.

$$\begin{aligned}
& \sum_{j=1}^2 X_i^j u_x^j \\
& + \sum_{j=1}^2 \mu^{sj} B_i^{ij} \left\{ t^{is} \rho^j (1 - A_R^{isj}) + t^{ij} \rho_R^j \left\{ \sum_{i=1}^2 t^{is} B^{ij} - A^{isj} [t^{is} B^{ij}] + T^j \right\} \right\} \\
& - t^{is} \sum_{j=1}^2 \mu^{dj} B_i^{ij} \rho^j (1 - A_R^{isj}) \\
& + \sum_{j=1}^2 \mu^{dj} t^{ij} B_i^{ij} \left\{ \rho^j (1 - A_R^{ij}) + \rho_R^j \left\{ \sum_{i=1}^2 (t^{ij} - t^{is}) B^{ij} - (A^{ij} [t^{ij} B^{ij}] - A^{isj} [t^{is} B^{ij}]) \right\} \right\} \\
& + \mu^c \sum_{j=1}^2 (B^{ij} + t^{ic} B_i^{ij}) (1 - A_R^{ic}) \\
& + \sum_{j=1}^2 \left\{ -B^{ij} + (1 - t^{ic} - t^{ij}) B_i^{ij} \right\} u_x^j t_{ic}^{ij*} \\
& + \sum_{j=1}^2 \mu^{sj} \left\{ t^{is} B_i^{ij} \rho^j (1 - A_R^{isj}) + (B^{ij} + t^{ij} B_i^{ij}) \rho_R^j \left\{ \sum_{i=1}^2 t^{is} B^{ij} - A^{isj} [t^{is} B^{ij}] + T^j \right\} \right\} t_{ic}^{ij*} \\
& - t^{is} \sum_{j=1}^2 \mu^{dj} B_i^{ij} \rho^j (1 - A_R^{ij}) t_{ic}^{ij*} \\
& + \sum_{j=1}^2 \mu^{dj} (B^{ij} + t^{ij} B_i^{ij}) \left\{ \rho^j (1 - A_R^{ij}) + \rho_R^j \left\{ \sum_{i=1}^2 (t^{ij} - t^{is}) B^{ij} - (A^{ij} [t^{ij} B^{ij}] - A^{isj} [t^{is} B^{ij}]) \right\} \right\} t_{ic}^{ij*} \\
& + \mu^c \sum_{j=1}^2 t^{ic} B_i^{ij} (1 - A_R^{ic}) t_{ic}^{ij*} = 0 .
\end{aligned}$$

Using (A.I.3) this first order condition can be reduced to:

$$\begin{aligned}
& \sum_{j=1}^2 X_i^j u_x^j \\
& + \sum_{j=1}^2 \mu^{sj} B_i^{ij} \left\{ t^{is} \rho^j (1 - A_R^{isj}) + t^{ij} \rho_R^j \left\{ \sum_{i=1}^2 t^{is} B^{ij} - A^{isj} [t^{is} B^{ij}] + T^j \right\} \right\} \\
& - t^{is} \sum_{j=1}^2 \mu^{dj} B_i^{ij} \rho^j (1 - A_R^{isj}) \\
& + \sum_{j=1}^2 \mu^{dj} t^{ij} B_i^{ij} \left\{ \rho^j (1 - A_R^{ij}) + \rho_R^j \left\{ \sum_{i=1}^2 (t^{ij} - t^{is}) B^{ij} - (A^{ij} [t^{ij} B^{ij}] - A^{isj} [t^{is} B^{ij}]) \right\} \right\} \\
& + \mu^c \sum_{j=1}^2 (B^{ij} + t^{ic} B_i^{ij}) (1 - A_R^{ic}) + t^{ic} B_i^{ij} (1 - A_R^{ic}) t_{ic}^{ij*} = 0 .
\end{aligned} \tag{A.II.1}$$

We have shown in (6) that the optimal equalization transfer program implemented by the central government makes μ^{sj} and μ^c equal across the national territory, while on the other hand μ^{dj} would likely vary due autonomous and efficient subnational decisions. However, because of the very nature of autonomous public expenditures, it is not the role of the central government to ensure their affordability. Instead, its role is to ensure affordability of national standards of public expenditures at the optimal MCF described in (7), and for that purpose the central government must simply assume that $\mu^{dj} = \mu^{sj} = \mu^c = \mu$. Otherwise, it would be accounting for autonomous deviations from the national standards that are not supposed to be influenced by central government intervention. In this context, (A.II.1) can be reduced to:

$$\begin{aligned}
& \sum_{j=1}^2 X_i^j u_x^j \\
& + \mu \sum_{j=1}^2 t^{ij} B_i^{ij} \left\{ \rho^j (1 - A_R^{ij}) + \rho_R^j (R^j - A^j + T^j) \right\} \\
& + \mu \sum_{j=1}^2 (B^{ij} + t^{ic} B_i^{ij}) (1 - A_R^{ic}) + t^{ic} B_i^{ij} (1 - A_R^{ic}) t_{ic}^{ij*} = 0 .
\end{aligned} \tag{A.II.2}$$

where $R^j = \sum_{i=1}^2 t^{ij} B^{ij}$ and $A^j = \sum_{i=1}^2 A^{ij} [t^{ij} B^{ij}]$, equation that can be arranged as the adjusted Samuelson condition in (11).