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SHOULD TAX BASES OVERLAP IN A FEDERATION WITH LOBBYING?

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ABSTRACT: We examine the tax assignment problem in a federation with two layers of government sharing an elastic tax base, in which Leviathan policy makers levy an excise tax in an imperfectly competitive market and producers lobby for tax rate cuts. If the lobby of producers is very influential on policy makers, we find that taxation by both layers of government might be optimal, provided that the market of the taxed good is highly concentrated; otherwise, it is optimal to assign the power to tax only to one level of government. Taxation by both layers of government is not optimal either when the influence of the lobby is weak, whatever the degree of market power. We also examine a richer set of tax setting outcomes, by considering the possibility that state policy makers have heterogeneous tax policy objectives.

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1 Introduction

According to the traditional fiscal federalism literature (Musgrave, 1959; Oates, 1972), decentralizing taxing powers is much more problematic than decentralizing expenditure functions, because of the tax-base mobility threat and also because of the likely violations of the principle of horizontal equity among identical individuals living in different jurisdictions of the federation. Despite these normative prescriptions, in the real world we observe important federal countries, like Canada and the United States, in which some of the main tax bases (e.g. corporate income, personal income, retail sales or excise taxes) are shared between the upper and the lower levels of government. Hence in these countries there is not a rigorous distinction between local and federal tax bases, as the traditional fiscal federalism theory prescribes. However, whenever this distinction does not occur, the tax bases of different layers of government overlap, giving rise to a common pool problem —the so-called vertical tax externality— with the tax decision of each level of government affecting the shared tax base, a fact generally leading to excessive taxation (Keen, 1995).

The literature analysing this issue (e.g. Boadway *et al.*, 1998; Keen and Kotsogiannis, 2002; Dahlby and Wilson, 2003) assumes welfare maximizing governments and therefore it takes a normative approach to the tax assignment problem. However, it is widely recognized that also political institutions play a crucial role in shaping fiscal policies, in addition to normative criteria. Indeed, the introduction of political factors into the traditional fiscal federalism models is the distinctive feature of the so-called 'second generation' theory of fiscal federalism (Oates, 2005). In this paper, our goal is to add a contribution to this field, by analyzing how the tax assignment problem in a federation is affected by the activity of a special interest group that lobbies the policy makers for moderate taxation when tax bases overlap.

In particular, we consider a federation composed of an upper level (federal) and a lower level (state) of government. Policy makers are assumed to be revenue maximizers and can levy an excise tax on a consumers' good that is produced in an imperfectly competitive market. There are no direct interactions between the state policy makers, since consumers are assumed to be immobile. If only one layer of government is allowed to tax, total taxation falls short of the social optimum, provided that firms succesfully lobby for tax rates reductions. When both layers of government are entitled to tax, total taxation may be either higher or lower than the social optimum, since the distortion

due to the vertical tax externality and the distortion due to lobbying work in opposite directions.

Our main finding concerns the link between market structure, influence of the lobby, and the optimal tax assignment. If the market is highly concentrated, and if lobbying is highly effective, then aggregate tax revenue is maximized by entitling both layers of government with the power to tax. A highly effective lobbying can therefore justify tax base sharing among government layers of a federal nation. In this case, lobbying by firms works as a 'private' solution to the vertical tax externality problem, that could make redundant the adoption of a 'public' solution in the form of a compensation transfer mechanism (Boadway and Keen, 1996; Kotsogiannis, *forthcoming*). On the other hand, if lobbying is not very effective in influencing policy makers, whatever the degree of market power, or if lobbying is highly effective but firms have low market power, it is then optimal to assign taxation only to one layer of government.

We also consider a special case in which the policy maker of the state in which production is located refrains from full tax revenue maximization, due to her concern about occupational levels in the taxed industry. The introduction of this kind of preference heterogeneity allows us to derive some interesting asymmetric equilibria that closely match observed tax policy in the real world.

Lobbying by special interest groups has been recently introduced in the fiscal federalism literature by Bordignon *et al.* (2008). They focus on the role of lobbying on the choice between centralization and decentralization of public policies, finding that centralization is better for social welfare when the lobbying groups have conflicting interests, whereas decentralization might be better when the lobbies interests are aligned. This paper introduces lobbying in a more specific context than the one examined by Bordignon *et al.* (2008). Moreover, while they appeal, to model lobbying behavior, to the many-principals, one-agent (Dixit *et al.*, 1997) and to the many-principals, many-agents (Prat and Rustichini, 2003) literature, we appeal in this paper to the one-principal, many-agents literature (Segal, 1999).

The rest of the paper is organized as follows. Section 2 sets up the basic model and characterizes the equilibrium in the oligopoly markets, for given tax rates. It also derives the social optimum, that is the tax rates that maximize the policy makers' objective functions in the benchmark case of no vertical tax externalities and no lobbying. Section 3 considers tax setting in the federation in the presence of vertical tax externalities between higher and lower levels of government. Section 4 introduces lob-

bying by producers and examines its impact on tax policy. Section 5 addresses the tax assignment problem, i.e. whether it is better to give the power to tax only to one level of government or to both levels. Section 6 provides conclusions and lines for future research.

2   The framework

Consider a federation composed of the central (or federal) government and two regional (or state) governments. Both layers of government might be entitled to levy an excise tax on a commodity that is consumed in both regions but that is produced only in one region.[1] We rule out the possibility of cross border shopping by assuming that consumers make purchases of the good only in their own region of residence. The number of producers is given and we assume that they compete *à la Cournot* in each regional market.[2] Policy makers at all levels are assumed to care for tax revenue collected. However, tax policy may not be exclusively determined by Leviathan behavior. Policy makers may also be interested in cashing campaign contributions offered by firms in exchange for tax rates cuts. Moreover, we consider the possibility that the policy maker in charge in the jurisdiction in which production takes place may refrain from setting a high tax burden, in order to limit the negative impact on production, and thus on occupational levels, in the taxed industry. Consumers' surplus, instead, is assumed to bear no weight whatsoever in tax policy setting.[3]

Tax setting is modelled as a two-stage process. In the first stage, the producers' association lobbies the policy makers in order to win tax rates cuts that increase firms' profits. In the second stage, the central and the local policy makers simultaneously and

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[1] This is just a stylized way for capturing the fact that production of some commodities is usually concentrated in some regions, whereas its consumption is uniformly distributed across regions.

[2] We consider consumption-based commodity-taxation only in a *specific* (or *excise*) form, although it is well known that specific and *ad valorem* taxes are not equivalent in terms of tax incidence if the taxed goods are exchanged in non-competitive markets (see, e.g. Myles, 1995, chapter 11, for a throughout survey). One reason for this choice is that we have in mind goods like cigarettes, gasoline or alcoholic drinks, that are generally taxed in a specific form, although in some countries a mix of both types of tax instruments is applied (Cnossen, 2009). Another reason is that our analysis focuses on the interplay between vertical tax externalities and lobbying and not, like most of the literature dealing with the comparison of the two types of tax instruments, on efficient tax structures.

[3] This is an extreme but simple way for capturing the idea that it is desirable to limit the consumption of the taxed good, either for paternalistic reasons (like in the case of unhealthy cigarettes smoking) or for correcting market failures (like in the case of pollution generating gasoline consumption).

independently set their own tax rate.[4] There is then a third and final stage in which local markets equilibrium is determined, given the tax rates set at the previous stages. The model is solved backward. We thus start from the final stage and solve for the equilibrium in the regional markets.

2.1   Regional oligopoly markets

We model an oligopoly market in each region i, $i = 1, 2$, in a partial equilibrium framework. All firms are located in region 2 and their number, $m \geq 1$, is fixed (the model encompasses a monopoly market as a limit case for $m = 1$). We also assume that all firms are identical, selling an homogenous good in both regions and producing at constant marginal (and average) costs $c > 0$ (there are no fixed costs).

Consumers are immobile and purchase the consumption good at the prevailing market price only in their own region of residence. They are also assumed to be identical both within and across regions, with an individual demand function that takes a linear form:

$$q = b(a - p), \tag{1}$$

where p is the consumer's price, q is quantity consumed, $a > 0$ and $b > 0$ are the demand parameters. Let Q_i be aggregate consumption and let $n_i > 0$, $i = 1, 2$, be the mass of consumers that are resident in region i; we also normalize the mass of consumers resident in the federation to unity, i.e. $n_1 + n_2 = 1$. By aggregating the individual demand (1) we then get the inverse market demand in region i as:

$$p_i = a - \frac{Q_i}{bn_i}, \quad i = 1, 2. \tag{2}$$

Let T and t_i be the specific tax rates levied, on a destination basis, respectively by the federal and the state i governments, on firms' sales.[5] Let q_{ji} be the quantity sold

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[4]An alternative modelling strategy would be to consider a Stackelberg game and therefore to split the second stage into two sub-stages, with the federal policy maker choosing first and the regional policy makers choosing second.

[5]We are assuming that producers make direct sales to consumers. Introducing a retail sector would not affect the analysis, provided that retailers operate at constant marginal costs, equal to average costs, in perfectly competitive markets. Under these hypotheses, it is equivalent to levy the tax on producers or to retailers. Moreover, only producers make positive profits and have an incentive to lobby for tax rates reductions.

by firm j in region i, so that

$$\sum_{j=1}^{m} q_{ji} = Q_i. \tag{3}$$

Firm j's profits are then defined as:

$$\Pi_j = \sum_{i=1}^{2} (p_i - c - T - t_i) q_{ji}. \tag{4}$$

In each market i, firms compete *à la Cournot* by setting simultaneously and independently their own quantity sold. By differentiating (4) with respect to q_{ji}, $i = 1, 2$, subject to (2) and (3), the necessary first order conditions for profit maximization by firm j can be written as:[6]

$$\alpha - T - t_i - \frac{\sum_{k \neq j} q_{ki}}{bn_i} - \frac{2q_{ji}}{bn_i} = 0, \quad i = 1, 2, \tag{5}$$

where we define $\alpha = a - c$ to simplify the notation. By summing equations (5) over $j = 1, \ldots, m$, one gets:

$$m(\alpha - T - t_i) - \frac{(m-1)Q_i}{bn_i} - \frac{2Q_i}{bn_i} = 0, \quad i = 1, 2.$$

From the latter equation we then obtain the equilibrium aggregate quantity as a function of the relevant tax rates:

$$Q_i(T, t_i) = \frac{m}{1+m} b(\alpha - T - t_i) n_i, \quad i = 1, 2. \tag{6}$$

Notice that, since we are assuming identical firms, the equilibrium is symmetric, with $q_{ji}(T, t_i) = m^{-1} Q_i(T, t_i)$, $j = 1, \ldots, m$. In what follows we restrict the analysis to market equilibria such that $\alpha > T + t_i$, in order to ensure that $Q_i(T, t_i) > 0$.

By substituting $Q_i(T, t_i)$ into (2) and then solving for p_i we get the equilibrium consumers' price:

$$p_i(T, t_i) = c + T + t_i + \frac{\alpha - (T + t_i)}{1 + m}, \quad i = 1, 2. \tag{7}$$

For given tax rates, the consumers' price is decreasing in the number of firms, ranging from its highest level when the market is monopolized ($m = 1$) to its asymptotically lowest level (marginal cost pricing) when the market approaches perfect competition ($m \to \infty$).

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[6]Under the given hypotheses (linear demand and linear production costs) the necessary first order conditions for profit maximization are also sufficient.

Finally, by aggregating Π_j in (4) over $j = 1, \ldots, m$, and then substituting for $p_i(T, t_i)$ and $Q_i(T, t_i)$, we compute aggregate firms' profits (*net* of excise taxes, but *gross* of contributions spent on lobbying activity, see Section 4):

$$\Pi(T, t_1, t_2) = \sum_{i=1}^{2} \frac{m}{(1+m)^2} b(\alpha - T - t_i)^2 n_i. \tag{8}$$

Notice that, as expected, profits are decreasing in m and tend to zero for $m \to \infty$. Moreover, taxation reduces profits, giving an incentive to firms to lobby the policy makers for tax rates reductions.[7]

2.2 Social optimum

We define the social optimum as the tax policy that maximizes the unweighted sum of the policy makers' objective functions. In this case, neither vertical tax externalities nor lobbying by firms distorts tax policy. The federal policy maker, as well as state 1 policy maker, are assumed to be *pure* Leviathans, aiming at maximizing tax revenue. In addition to tax revenue, state 2 policy maker cares about workers' welfare in the taxed industry.

Using the expression for $Q_i(T, t_i)$ in (6), it is immediate to derive the formulae for tax revenue for, respectively, the federal and the state governments:

$$R(T, t_1, t_2) = \sum_{i=1}^{2} Q_i(T, t_i) T = \sum_{i=1}^{2} \frac{m}{1+m} b(\alpha - T - t_i) n_i T, \tag{9}$$

$$r_i(T, t_i) = Q_i(T, t_i) t_i = \frac{m}{1+m} b(\alpha - T - t_i) n_i t_i, \quad i = 1, 2. \tag{10}$$

As a proxy for workers' welfare, consider aggregate production costs in the taxed industry:

$$C(T, t_1, t_2) = \sum_{i=1}^{2} c Q_i(T, t_i) = \sum_{i=1}^{2} \frac{m}{1+m} c b(\alpha - T - t_i) n_i. \tag{11}$$

It is then assumed that the objective function of state 2 policy maker is given by a weighted sum of tax revenue and production costs:

$$r_2(T, t_2) + \omega C(T, t_1, t_2), \tag{12}$$

[7]Taxation has always a negative impact on profits when the market is monopolized ($m = 1$). In oligopoly ($m \geq 2$), taxation may cause price overshifting, and therefore it may *increase* profits, provided that the slope of the demand curve is of a particular type (Seade, 1985). With a linear demand, however, taxation always reduces profits also in oligopoly.

where $\omega \in [0,1]$. There are at least two alternative ways of interpreting the term $\omega C(.)$ in the objective function (12). If we assume that labor is the only input into production, so that $C(.)$ represents total wages paid to workers, then ω represents a taste parameter, showing that the policy maker is ready to give up one dollar of tax revenue provided that wage outlays are increased by at least ω dollars. If, instead, we assume that labor costs account for only a part of total costs $C(.)$, and that the policy maker is ready to substitute tax revenue and wage outlays one dollar for one dollar, then the parameter ω represents the labor costs' share in production costs $C(.)$.

Given these hypotheses, the social optimum is defined by the tax rates that maximize:

$$W(T, t_1, t_2) = R(T, t_1, t_2) + \sum_{i=1}^{2} r_i(T, t_i) + \omega C(T, t_1, t_2). \qquad (13)$$

It is immediate to see, from the expressions for tax revenues (9)–(10) and for production costs (11), that the objective function (13) depends on the total tax rates (i.e. $T + t_i$, $i = 1, 2$) in each region, since federal and state taxation are perfect substitutes. The social optimum, that we characterize in the following proposition, corresponds therefore to the tax policy that would be chosen by a single decision maker aiming at maximizing the objective function (13).

Proposition 1 *In the social optimum, the optimal tax rates are:*

$$\hat{T} + \hat{t}_i = \frac{1}{2}\alpha - \frac{1}{2}\omega c, \quad i = 1, 2. \qquad (14)$$

Proof. Substituting for $T + t_i = \tau_i$, $i = 1, 2$, in eq. (13) one gets:

$$W(\tau_1, \tau_2) = \frac{m}{1+m} \sum_{i=1}^{2} b(\alpha - \tau_i) n_i(\tau_i + \omega c).$$

By differentiating this expression with respect to τ_i we then get the first order condition $\alpha - 2\tau_i - \omega c = 0$ that gives the solution $\hat{\tau}_i$ in (14). ∎

Since federal and state tax rates are, within each region, perfect substitutes, the social optimum defines only the total level of taxation, leaving undetermined its sharing between the upper and lower layers of government. As expected, the optimal tax rates are a decreasing function of ω, since labor costs are monotonically decreasing in the level of taxation. If all policy makers are pure Leviathans (i.e. $\omega = 0$) then the social optimum implies the maximization of aggregate tax revenue, at the bliss point of the

Laffer curve in each region. Notice also that the optimal tax rates are uniform across regions, since the aggregate objective function (13) treats symmetrically labor costs ('located' in region 2) and tax revenue in all regions and at all levels of government. Notice finally that the optimal tax rates are independent of market structure (the number of firms, m), although the optimal levels of tax revenue are increasing in m.

3 Tax policy in the absence of lobbying

In this section we consider tax policy in the absence of lobbying by firms. Therefore, each policy maker sets, simultaneously and independently from the other policy makers, its own tax rate. The Nash equilibrium of this game is characterized in the following:

Proposition 2 *Suppose there is no lobbying by firms and that each policy maker non-cooperatively and simultaneously sets its own tax rate. In the unique Nash Equilibrium, tax rates are:*

$$\tilde{T} = \frac{1}{3}\alpha + \frac{n_2}{3}\omega c, \tag{15}$$

$$\tilde{t}_1 = \frac{1}{3}\alpha - \frac{n_2}{6}\omega c, \tag{16}$$

$$\tilde{t}_2 = \frac{1}{3}\alpha - \left(\frac{n_2}{6} + \frac{1}{2}\right)\omega c, \tag{17}$$

while total tax rates are:

$$\tilde{T} + \tilde{t}_1 = \frac{2}{3}\alpha + \frac{n_2}{6}\omega c, \tag{18}$$

$$\tilde{T} + \tilde{t}_2 = \frac{2}{3}\alpha + \left(\frac{n_2}{6} - \frac{1}{2}\right)\omega c. \tag{19}$$

Proof. Denote with $T(.)$, $t_1(.)$ and $t_2(.)$, respectively, the best response function (or reaction function) of the federal, state 1 and state 2 policy makers to any given tax policy chosen by the other policy makers. Formally, by maximizing $R(.)$ in (9) with respect to T, $r_1(.)$ in (10) with respect to t_1, and $r_2(.) + \omega C(.)$ in (12) with respect to t_2, and then solving for the relevant tax rate, we obtain, respectively,

$$T(t_1, t_2) = \frac{1}{2}(\alpha - n_1 t_1 - n_2 t_2), \tag{20}$$

$$t_1(T) = \frac{1}{2}(\alpha - T), \tag{21}$$

$$t_2(T) = \frac{1}{2}(\alpha - T - \omega c). \tag{22}$$

The best response functions (20)–(22) form a system of linear equations in the tax rates T, t_1 and t_2. Its solution gives the unique Nash equilibrium (15)–(17) and the total tax rates (18)–(19). ∎

Taxation is uniform, both between layers of government and across regions, if all policy makers are pure Leviathans ($\omega = 0$). Taxation is instead asymmetric, with $\tilde{T} > \tilde{t}_1 > \tilde{t}_2$ for individual tax rates, and $\tilde{T} + \tilde{t}_1 > \tilde{T} + \tilde{t}_2$ for total tax rates, if the policy maker in state 2 attaches some weight on wage outlays in the taxed industry ($\omega > 0$). The size of the asymmetry depends not only on the size of ω but also on the mass, n_2, of consumers that are resident in state 2. The sources of the asymmetry are clear by looking at the reaction functions (20)–(22). The state 2 policy maker's concern for workers' welfare, represented by the term $-\omega c/2$ in her reaction function, causes a downward pressure on t_2. In turn, this induces the federal government to increase its tax rate T; but this in turn induces the policy maker in state 1 to decrease her tax rate t_1, thus reinforcing the incentive for the federal policy maker to increase her tax rate T. The deviation from Leviathan behavior of state 2 policy maker bears therefore an impact on state 1 tax policy that is channeled through the reaction of the federal policy maker.

Let us now formally compare, in the following proposition, the total tax rates in the Nash equilibrium with those obtained in Proposition 1 for the social optimum.

Proposition 3 *The comparison between total tax rates in the Nash Equilibrium without lobbying and the corresponding total tax rates in the social optimum is as follows:*

$$\tilde{T} + \tilde{t}_1 - (\hat{T} + \hat{t}_1) = \frac{1}{6}\alpha + \left(\frac{n_2}{6} + \frac{1}{2}\right)\omega c > 0 \tag{23}$$

$$\tilde{T} + \tilde{t}_2 - (\hat{T} + \hat{t}_2) = \frac{1}{6}\alpha + \frac{n_2}{6}\omega c > 0 \tag{24}$$

Proof. By simple subtraction of the tax rates in (14) from the corresponding tax rates in (18)–(19). ∎

This proposition makes it clear that, because of vertical tax externalities, independent tax setting determines over-taxation with respect to the social optimum. As expected, for $\omega > 0$ the upward bias in total taxation is more severe in state 1 than in state 2. Somewhat surprisingly, the concern for workers' welfare reinforces overtaxation also in state 2, as shown by the second term in expression (24); this result can be explained by observing that lower taxation at the state level is more than compensated by higher taxation at the federal level.

4 Lobbying for tax rates cuts

We are now ready to address the central issue of the paper, by examining what happens when the producers exert pressure on policy makers in order to obtain a more favorable taxation of their sales. Concerning lobbying behavior, the first assumption we make is that of full cooperation among firms: while competing in their product market, firms act as a single body when making pressure on policy makers for tax rates cuts.[8] This is likely to be the case, for instance, when producers deal with other economic institutions (e.g. trade unions, consumers' organizations) by means of an association representing their interests. The second assumption we make is that the lobbying activity takes a 'legal' and 'public' form, in which the producers' association makes monetary offers to policy makers (in the form of campaign contributions, for instance) conditional on tax rates cuts. This 'buying influence' approach for modelling lobbying behavior has been popularized in the context of 'common agency' games by Dixit *et al.* (1997) and Grossman and Helpman (1994, 2001), building on previous work by Bernheim and Whinston (1986a,b). However, their common agency framework — in which there are many principals, the lobbying groups, and one agent, the policy maker— does not fit into our setting, starring one principal (the producers association) and many agents (the policy makers). We therefore appeal to the model in Segal (1999) that, although not focusing explicitly on lobbying activities, is cast in terms of a single principal contracting with many agents.[9]

Formally, the objective function of the federal policy maker is now given by:

$$V(T, t_1, t_2, Z) = R(T, t_1, t_2) + \lambda Z, \tag{25}$$

where $Z \geq 0$ represents the contribution offered by firms, whereas λ, $0 \leq \lambda \leq 1$, is a 'taste' parameter representing the importance that the policy maker attaches to one dollar of contributions relative one dollar of tax revenue.[10] The objective function of

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[8] Clearly, there is no need to justify the presence of a single lobby when the market is monopolized.

[9] The more general class of many-principals many-agents models, known as 'games played through agents', has been analyzed by Prat and Rustichini (2003).

[10] Most of the literature on lobbying focuses on the case in which utility is transferable between the principal(s) and the agent(s), by assuming $\lambda = 1$. The taste parameter λ was first introduced by Persson (1998).

the state policy makers is amended in a similar way:

$$v_1(T, t_1, z_1) = r_1(T, t_1) + \lambda z_1, \tag{26}$$

$$v_2(T, t_1, t_2, z_2) = r_2(T, t_2) + \omega C(T, t_1, t_2) + \lambda z_2, \tag{27}$$

where $z_i \geq 0$, $i = 1, 2$, is the contribution paid to state i policy maker. Notice that we are assuming that policy makers have identical preferences for the lobbyist's contributions, since the parameter λ is uniform.

Net of contributions to policy makers, firms aggregate profits are equal to:

$$\pi(T, t_1, t_2, Z, z_1, z_2) = \Pi(T, t_1, t_2) - (Z + z_1 + z_2), \tag{28}$$

where aggregate gross profits, $\Pi(T, t_1, t_2)$, are defined in (8). Since firms are identical, it is assumed that the monetary contributions are equally shared among them.

Following Segal (1999), we set up a two-stage game. In the first stage, the firms association (the *principal*) credibly sends a triplet of 'offers', (T^*, Z^*), (t_1^*, z_1^*) and (t_2^*, z_2^*), to the federal, state 1 and state 2 policy makers (the *agents*), respectively. We assume, as in Segal (1999, Section III), that these offers are publicly observed.[11] In the second stage, the policy makers simultaneously decide whether to accept or reject their respective offers. A policy maker accepting her offer would cash the contribution and implement the tax rate 'attached' to the offer. A policy maker not accepting the offer would instead cash no contribution and would be free to set the tax rate that maximizes her own objective function. Within this kind of game, we now characterize the Subgame-Perfect Nash Equilibria that maximize the producers aggregate net profits.[12]

Formally, the producers association select the offers (T^*, Z^*), (t_1^*, z_1^*) and (t_2^*, z_2^*) that maximize its net profits (28) subject to the policy makers' participation con-

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[11]Like in the literature quoted above, we assume that information is complete. Concerning her offers to the agents, however, the principal can make either *public* offers (Segal, Section III) or *private* offers (Segal, Section IV). For simplicity, we focus on public offers, although we recognize that also the case of private offers could be of interest.

[12]In general, this kind of games admit a multiplicity of equilibria. Following Segal (1999), we thus focus on the Subgame-Perfect Nash Equilibria (SPNE) that are preferred by the principal. Moreover, given the specific functional forms we adopted for tax revenues and firms' profits, the principal's preferred SPNE is unique.

straints:

$$R(T, t_1, t_2) + \lambda Z \geq R\left[T(t_1, t_2), t_1, t_2\right], \tag{29}$$

$$r_1(T, t_1) + \lambda z_1 \geq r_1\left[T, t_1(T)\right], \tag{30}$$

$$r_2(T, t_2) + \omega C(T, t_1, t_2) + \lambda z_2 \geq r_2\left[T, t_2(T)\right] + \omega C\left[T, t_1, t_2(T)\right], \tag{31}$$

where $T(t_1, t_2)$, $t_1(T)$ and $t_2(T)$ are the best response functions defined in (20)–(22).

The left-hand sides of these inequalities contain the objective functions, defined in (25)–(27), of the corresponding policy maker. The key point is the characterization, in the right-hand sides of the inequalities, of the *outside options* of the policy makers. To illustrate, consider the participation constraint (29) of the federal policy maker (a similar interpretation can be given for the other participation constraints). Were this agent to reject the offer made by the principal, his payoff would include only the federal tax revenue, that in turn depends on the tax rates, t_1 and t_2, set by the state policy makers, as well as on his own best response, $T(t_1, t_2)$, to these tax rates. The outside option of the federal policy maker is therefore endogenous to the tax rates set by the other policy makers. In this respect, our framework is more complex than the one considered in Segal (1999), in which the agents' outside options (or *non trade* options, in his terminology) are instead exogenously given.

Notice that the association of producers can always make a 'trivial' set of offers to policy makers, formally $(\tilde{T}, 0)$, $(\tilde{t}_1, 0)$ and $(\tilde{t}_2, 0)$, in which no contributions are offered in exchange for the tax rates (15)–(17) that would be set in the Nash equilibrium in the absence of lobbying (Proposition 2). We can thus focus, without loss of generality, only on the triplets of offers satisfying the participation constraints (29)–(31) and such that each policy maker accepts the offer made by the principal. Moreover, it is also immediate to see that a profit maximizing principal will make only offers such that all participation constraints are binding: if a participation constraint does not hold as an equality, the principal can always reduce the contribution to the agent without inducing her to reject the offer.[13] These remarks allow us to use the participation constraints (29)–(31), holding as equality, to define the monetary contribution as a function of the

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[13] In equilibrium, all policy makers are therefore indifferent between accepting and rejecting the offer presented to them by the firms association. Being indifferent, we then make the standard assumption that the agents accept the offers, since this is the outcome preferred by the principal.

relevant tax rates:

$$Z(T, t_1, t_2) = \lambda^{-1} \left\{ R\left[T(t_1, t_2), t_1, t_2\right] - R(T, t_1, t_2) \right\}, \tag{32}$$

$$z_1(T, t_1) = \lambda^{-1} \left\{ r_1\left[T, t_1(T)\right] - r_1(T, t_1) \right\}, \tag{33}$$

$$z_2(T, t_1, t_2) = \lambda^{-1} \left\{ r_2\left[T, t_2(T)\right] + \omega C\left[T, t_1, t_2(T)\right] - r_2(T, t_2) - \omega C(T, t_1, t_2) \right\}. \tag{34}$$

These contributions satisfying the policy makers participation constraints are then plugged into the expression (28) for firms aggregate net profits, to get:

$$\pi(T, t_1, t_2) = \Pi(T, t_1, t_2) + \lambda^{-1} W(T, t_1, t_2) +$$
$$- \lambda^{-1} \left\{ R\left[T(t_1, t_2), t_1, t_2\right] + \sum_{i=1}^{2} r_i\left[T, t_i(T)\right] + \omega C\left[T, t_1, t_2(T)\right] \right\}, \tag{35}$$

where $W(T, t_1, t_2)$ is the sum of the policy makers objective functions defined in (13). Notice that, for $\lambda = 1$, the sum of the first two terms in the expression (35), $\Pi(.) + W(.)$, is equal to the joint surplus of the principal and the agents. Were the third term in curly brackets absent, the maximization of net profits $\pi(T, t_1, t_2)$ would thus lead to an efficient outcome for the principal and the agents (Segal, 1999, proposition 1). This latter term, that accounts for the externalities that each agent causes on the other agents' reservation utilities, causes the chosen policy by the principal to fall short of the efficient outcome.[14]

The firms' association selects the tax rates to be included in the offers made to policy makers by maximizing its net profits (35). Denote the solution to this problem with T^*, t_1^* and t_2^*. By substituting these optimal tax rates into eqs. (32)–(34) we then find the optimal monetary contributions, $Z^* = Z(T^*, t_1^*, t_2^*)$, $z_1^* = z_1(T^*, t_1^*)$ and $z_2^* = z_2(T^*, t_1^*, t_2^*)$. Finally, the equilibrium net profits are determined by substituting the optimal tax rates and contributions into eq. (28). The equilibrium tax rates are presented in the following:

Proposition 4 *Suppose that the association of producers lobbies the policy makers for tax rates reductions. Let:*

$$\phi = \frac{\lambda}{1+m}, \quad \Phi = \frac{9 - 12\phi}{9 - 8\phi}, \quad \Phi_{12} = \frac{(19 - 16\phi)\phi}{(9 - 8\phi)(1 - \phi)}, \quad \Phi_2 = \frac{1}{1 - \phi}.$$

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[14]We do not formally make the comparison between the equilibrium outcome and the efficient outcome that maximizes the joint surplus of the principal and the agents, since our interest is on the comparison between tax policy under lobbying and the socially optimal policy.

In the unique Subgame-Perfect Nash Equilibrium of the lobbying game, tax rates are:

$$T^* = \Phi\left(\frac{1}{3}\alpha\right) + \Phi\left(\frac{n_2}{3}\omega c\right), \tag{36}$$

$$t_1^* = \Phi\left(\frac{1}{3}\alpha\right) + (1 - \Phi_{12})\left(-\frac{n_2}{6}\omega c\right), \tag{37}$$

$$t_2^* = \Phi\left(\frac{1}{3}\alpha\right) + (1 - \Phi_{12})\left(-\frac{n_2}{6}\omega c\right) + \Phi_2\left(-\frac{1}{2}\omega c\right), \tag{38}$$

while total tax rates are:

$$T^* + t_1^* = \Phi\left(\frac{2}{3}\alpha\right) + (2\Phi - 1 + \Phi_{12})\left(\frac{n_2}{6}\omega c\right), \tag{39}$$

$$T^* + t_2^* = \Phi\left(\frac{2}{3}\alpha\right) + (2\Phi - 1 + \Phi_{12})\left(\frac{n_2}{6}\omega c\right) + \Phi_2\left(-\frac{1}{2}\omega c\right), \tag{40}$$

where

$$2\Phi - 1 + \Phi_{12} = \frac{3(3 - 2\phi)}{(9 - 8\phi)(1 - \phi)}.$$

Proof. By differentiating the net profits function (35) with respect to the tax rates, we get the first order conditions:

$$\lambda\frac{\partial\Pi}{\partial T} + \frac{\partial W}{\partial T} - \sum_{i=1}^{2}\left(\frac{\partial r_i}{\partial T} + \frac{\partial r_i}{\partial t_i}\frac{\partial t_i(.)}{\partial T}\right) - \omega\left(\frac{\partial C}{\partial T} + \frac{\partial C}{\partial t_2}\frac{\partial t_2(.)}{\partial T}\right) = 0, \tag{41}$$

$$\lambda\frac{\partial\Pi}{\partial t_1} + \frac{\partial W}{\partial t_1} - \left(\frac{\partial R}{\partial T}\frac{\partial T(.)}{\partial t_1} + \frac{\partial R}{\partial t_1}\right) - \omega\frac{\partial C}{\partial t_1} = 0, \tag{42}$$

$$\lambda\frac{\partial\Pi}{\partial t_2} + \frac{\partial W}{\partial t_2} - \left(\frac{\partial R}{\partial T}\frac{\partial T(.)}{\partial t_2} + \frac{\partial R}{\partial t_2}\right) = 0, \tag{43}$$

where

$$\frac{\partial W}{\partial T} = \frac{\partial R}{\partial T} + \sum_{i=1}^{2}\frac{\partial r_i}{\partial T} + \omega\frac{\partial C}{\partial T},$$

$$\frac{\partial W}{\partial t_i} = \frac{\partial R}{\partial t_i} + \frac{\partial r_i}{\partial t_i} + \omega\frac{\partial C}{\partial t_i}, \quad i = 1, 2.$$

Using eqs. (8), (9), (10) and (11) to compute the partial derivatives with respect to Π, R, r_i and C, respectively; using eqs. (20)–(22) to compute the partial derivatives of the reaction functions $T(.)$, $t_1(.)$ and $t_2(.)$, and then solving the linear equation system (41)–(43), we get the equilibrium tax rates (36)–(38). ∎

Expressions (36)–(40) for the tax rates under lobbying can be easily compared with the corresponding expressions (15)–(19) in Proposition 2 for the tax rates in the absence of lobbying. Formally, the impact of lobbying on tax policy is fully captured by the

coefficients Φ, Φ_{12} and Φ_2. If $\lambda = 0$ (lobbying is not effective, because policy makers do not care about campaign contributions) and/or if $m \to \infty$ (the market approaches perfect competition, so that profits tend to zero and firms have no incentive to lobby), then $\Phi = 1$, $\Phi_{12} = 0$ and $\Phi_2 = 1$, and therefore the tax rates in (36)–(40) are equal to the corresponding tax rates in (15)–(19).

Consider the first (common) terms in tax rates (36)–(40), those reflecting the Leviathan objectives of the policy makers. It is straightforward to see that:

$$\text{for given } m, \, \Phi(\lambda) > 0, \, \Phi'(\lambda) < 0, \, \Phi(0) = 1, \, \Phi(1) = \frac{9m - 3}{9m + 1} < 1.$$
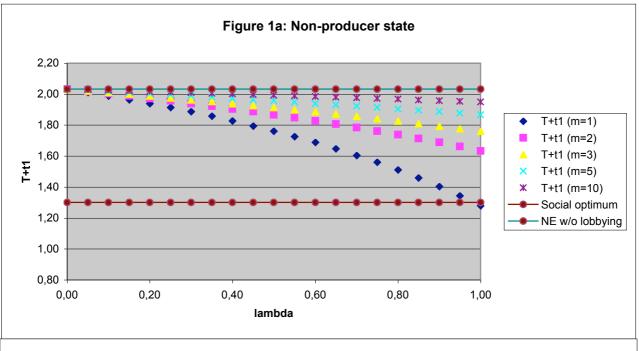
Therefore, in the absence of concern for workers' welfare ($\omega = 0$), lobbying reduces all tax rates to the same extent ($\Phi < 1$), and the more so the larger is λ. Moreover, the higher the number of firms, the lower the impact of lobbying in reducing the tax rates. For instance, if the market is monopolized ($m = 1$) and $\lambda = 1$, then $\Phi = \frac{3}{5}$, so that lobbying reduces the Leviathan component of tax rates by 40%; if, instead, $m = 11$ and $\lambda = 1$, then $\Phi = .96$, so that the impact of lobbying is to reduce this component of the tax rates by only 4%.
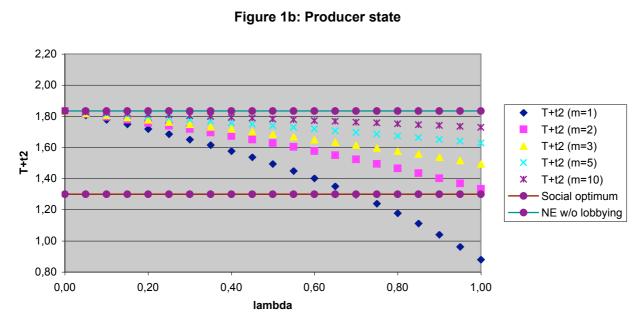
Consider now the terms in the tax rates (36)–(38) that depend on the parameter ω, reflecting the interest of the state 2 policy maker about workers' welfare in the taxed industry. We can show that:
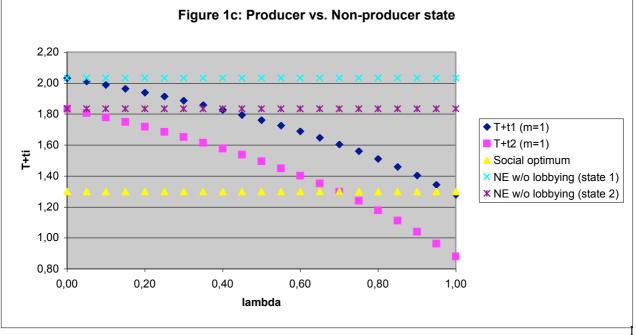
$$\text{for given } m, \, \Phi_{12}(\lambda) > 0, \, \Phi'_{12}(\lambda) > 0, \, \Phi_{12}(0) = 0, \, \Phi_{12}(1) = \frac{19m + 3}{(9m + 1)m},$$

$$\text{for given } m, \, \Phi_2(\lambda) > 0, \, \Phi'_2(\lambda) > 0, \, \Phi_2(0) = 1, \, \Phi_2(1) = \frac{1 + m}{m}.$$

Hence, for $\omega > 0$ and $\lambda > 0$, lobbying tends (a) to reduce the federal tax rate, T^*, since the second term in (36) is multiplied by $\Phi < 1$; (b) to *increase* (somewhat surprisingly) the state 1 tax rate, t_1^*, since the second term in (37) is multiplied by $(1 - \Phi_{12}) < 1$; and (c) both to increase and to decrease the state 2 tax rate, t_2^*, since the second and the third terms in (38) are multiplied by $(1 - \Phi_{12}) < 1$ and $\Phi_2 > 0$, respectively (it is likely, however, that the third term prevails over the second one).

As for the total tax rates (39)–(40), it is immediate to see that $(2\Phi - 1 + \Phi_{12}) > 1$ for $\lambda > 0$. Therefore, lobbying: (a) reduces the first term in (39)–(40); (b) increases the second term in (39)–(40); (c) increases, in absolute value, the third term in (40). To illustrate the impact of the parameters λ and m on the total tax rates, it is useful to look, in Figure 1, at the results of a numerical simulation (the other parameters are set at $n_1 = n_2 = .5$, $\omega = .8$, $\alpha = 3$). Figure 1a shows the total tax rate $T^* + t_1^*$ in the

Figure 1a: Non-producer state

Legend:
- ◆ T+t1 (m=1)
- ■ T+t1 (m=2)
- ▲ T+t1 (m=3)
- ✕ T+t1 (m=5)
- ✻ T+t1 (m=10)
- Social optimum
- NE w/o lobbying

Figure 1b: Producer state

Legend:
- ◆ T+t2 (m=1)
- ■ T+t2 (m=2)
- ▲ T+t2 (m=3)
- ✕ T+t2 (m=5)
- ✻ T+t2 (m=10)
- Social optimum
- NE w/o lobbying

Figure 1c: Producer vs. Non-producer state

Legend:
- ◆ T+t1 (m=1)
- ■ T+t2 (m=1)
- ▲ Social optimum
- ✕ NE w/o lobbying (state 1)
- ✻ NE w/o lobbying (state 2)

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non-producer state as a function of λ, for different levels of m. As expected, a more effective lobbying (a higher λ), causes a higher reduction in the total tax rate, and the more so the smaller is the number of producers, m. Total tax rates in the producer state, $T^* + t_2^*$, see Figure 1b, show a qualitative similar pattern, although, as shown in Figure 1c for $m = 1$, they are always below those set in the non-producer state.

5 Tax assignment with Leviathan policy makers

We now examine the tax assignment problem. In order to get clear-cut results, we focus on the special case in which all policy makers are revenue maximizers. In this setting, it is immediate to show that:

Lemma 1 *If all policy makers are pure Leviathans (i.e. $\omega = 0$), it is then equivalent to assign the power to tax either to the federal government or to the state governments, whether firms lobby the policy makers or not.*

Proof. Suppose that only the federal government can levy the excise tax at rate $\tau = T$, with $t_i = 0$, $i = 1, 2$. From eq. (9), aggregate tax revenue is then equal to $R(\tau, 0, 0) = \sum_{i=1}^{2} \mu b(\alpha - \tau) n_i \tau$, $\mu = m(1 + m)^{-1}$, while from eq. (8) aggregate profits are $\Pi(\tau, 0, 0) = \sum_{i=1}^{2} \mu(1 + m)^{-1} b(\alpha - \tau)^2 n_i$. Soppose now that only the state governments can levy the tax, at rates $\tau_i = t_i$, $T = 0$. From eqs. (10) and (8), aggregate tax revenue and gross profits are then equal to $\sum_{i=1}^{2} r_i(0, \tau_i) = \mu b(\alpha - \tau_i) n_i \tau_i$, $\Pi(0, \tau_1, \tau_2) = \sum_{i=1}^{2} \mu(1 + m)^{-1} b(\alpha - \tau_i)^2 n_i$, respectively. By symmetry, and since there are no horizontal tax externalities between the state governments, in equilibrium (with, or without, lobbying) $\tau_1 = \tau_2$. Therefore, $R(\tau, 0, 0) = \sum_{i=1}^{2} r_i(0, \tau_i)$ and $\Pi(\tau, 0, 0) = \Pi(0, \tau_1, \tau_2)$, that gives the equivalence result. ∎

Since (a) policy makers are assumed to have the same policy objective (tax revenue maximization), (b) policy makers are assumed to show the same interest for campaign contributions (i.e. uniform λ), and (c) there are no horizontal tax externalities between the state governments, then centralized tax setting turns out to be equivalent to decentralized tax setting. For the tax assignment problem, the relevant comparison is therefore between taxation by both layers of government and taxation by anyone of the two layers, using the social optimum as a normative benchmark. In this respect, the following proposition focuses on the equilibrium tax rates.

Proposition 5 *Let $\phi = \lambda(1+m)^{-1}$. Suppose that all policy makers are pure Leviathans (i.e. $\omega = 0$). Then:*

- *The socially optimal tax rates are (Proposition 1):*

$$\hat{T} + \hat{t}_i = \frac{1}{2}\alpha, \quad i = 1, 2.$$

- *If both layers of government have the power to tax, and if firms lobby the policy makers, the equilibrium total tax rates are (Proposition 4):*

$$T^* + t_i^* = \left(\frac{9 - 12\phi}{9 - 8\phi}\right)\left(\frac{2}{3}\alpha\right), \quad i = 1, 2.$$

If $m = 1$, then $T^* + t_i^* \gtreqless \hat{T} + \hat{t}_i$ for $\lambda \lesseqgtr \frac{3}{4}$. If $m \geq 2$, m integer, then $T^* + t_i^* > \hat{T} + \hat{t}_i$ for all $\lambda \in [0, 1]$.

- *If only one layer of government has the power to tax, at rate τ_i, and if firms lobby the policy makers, the equilibrium (total) tax rates are:*

$$\tau_i^* = \left(\frac{1 - 2\phi}{1 - \phi}\right)\left(\frac{1}{2}\alpha\right), \quad i = 1, 2,$$

where $\tau_i^* \leq \hat{T} + \hat{t}_i$ for all $m \geq 1$, m integer, $\lambda \in [0, 1]$.

Proof. The socially optimal tax rates come trivially from setting $\omega = 0$ in eq. (14). Similarly, from eqs. (39)–(40), for the tax rates under tax base overlapping. It is then immediate to see that $T^* + t_i^* \gtreqless \hat{T} + \hat{t}_i$ for $\phi \lesseqgtr 3/8$; thus, from the definition of ϕ, $T^* + t_i^* \gtreqless \hat{T} + \hat{t}_i$ for $\lambda \lesseqgtr 3/4$ if $m = 1$ and $T^* + t_i^* > \hat{T} + \hat{t}_i$ for all $\lambda \in [0, 1]$ if $m \geq 2$. As for the tax rates τ_i^*, suppose, using Lemma 1, that taxation is centralized. Then, the association of firms makes an offer (τ^*, Z^*) to the federal policy maker with the property that $(\tau^*, Z^*) = \arg\max \Pi(\tau, 0, 0) - Z$, subject to the participation constraint $R(\tau, 0, 0) + \lambda Z = R(\tilde{\tau}, 0, 0)$, where $\Pi(\tau, 0, 0) = \sum_{i=1}^{2} \mu(1+m)^{-1}b(\alpha - \tau)^2 n_i$, $R(\tau, 0, 0) = \sum_{i=1}^{2} \mu b(\alpha - \tau)n_i\tau$, $\tilde{\tau} = \arg\max R(\tau, 0, 0)$, $\mu = m(1+m)^{-1}$. The solution to this constrained maximization problem gives the uniform tax rates τ_i^*. Given that $m \geq 1$ and $\lambda \in [0, 1]$, then $\phi \in [0, 1/2]$; therefore $\tau_i^* \leq \hat{T} + \hat{t}_i$. ∎

To interpret these results, one has to bear in mind that while tax bases overlapping leads to excessive taxation, lobbying by firms leads to less than optimal taxation. The final outcome depends therefore on the balance between these two forces. If lobbying is not effective (i.e. if $\lambda = 0$), or if the market approaches perfect competition (i.e. if

$m \to \infty$), then $\phi = 0$, and therefore taxation is excessive under tax base overlapping $(T^* + t_i^* > \hat{T} + \hat{t}_i)$ whereas it is socially optimal in the absence of tax base overlapping $(\tau_i^* = \hat{T} + \hat{t}_i)$.

For $\lambda > 0$, the equilibrium tax rates are a decreasing function of λ, for given m. Taxation by both layers of government implements the social optimum in the special case in which the market is monopolized ($m = 1$) and lobbying is highly influential ($\lambda = 3/4$). With two, or more, firms, tax base overlapping leads to excessive taxation even if lobbying exerts its maximal influence on tax policy ($\lambda = 1$). Instead, taxation by one layer of government always falls short of the social optimum.[15]

By comparing the equilibrium tax rates in the presence of lobbying, with and without tax bases overlapping, with the tax rates in the social optimum, we can state our final result in the following:

Proposition 6 *Suppose that all policy makers are pure Leviathans ($\omega = 0$) and that firms lobby the policy makers for tax cuts. Let $\phi^* = (5 - \sqrt{13})/8 \approx .174$. Then:*

- *If $1 \leq m \leq 4$, m integer, and $0 \leq \lambda \leq \phi^*(1 + m)$, then $T^* + t_i^* - (\hat{T} + \hat{t}_i) \geq \hat{T} + \hat{t}_i - \tau_i^* > 0$. It is therefore optimal to assign the power to tax only to one layer of government.*

- *If $1 \leq m \leq 4$, m integer, and $\phi^*(1 + m) < \lambda \leq 1$, then $\hat{T} + \hat{t}_i - \tau_i^* > \left| T^* + t_i^* - (\hat{T} + \hat{t}_i) \right| > 0$. It is therefore optimal to assign the power to tax to both layers of government.*

- *If $m \geq 5$, m integer, then $T^* + t_i^* - (\hat{T} + \hat{t}_i) \geq \hat{T} + \hat{t}_i - \tau_i^* > 0$ for all $0 \leq \lambda \leq 1$. It is therefore optimal to assign the power to tax only to one layer of government.*

Proof. We know, from Proposition 5, that $\hat{T} + \hat{t}_i - \tau_i^* \geq 0$ for $\phi \in [0, 1/2]$, with equality for $\phi = 0$, increasing in ϕ. From the same proposition we know that $T^* + t_i^* - (\hat{T} + \hat{t}_i) \geq 0$ for $\phi \in [0, 3/8]$, with equality for $\phi = 3/8$, decreasing in ϕ. Therefore, there exists a unique threshold $\phi^* < 3/8$ such that $\hat{T} + \hat{t}_i - \tau_i^* = T^* + t_i^* - (\hat{T} + \hat{t}_i)$; by solving the latter equation one finds that $\phi^* = (5 - \sqrt{13})/8$. Hence $T^* + t_i^* - (\hat{T} + \hat{t}_i) \gtreqqless \hat{T} + \hat{t}_i - \tau_i^*$ for $\phi \lesseqqgtr \phi^*$. Recalling that $\phi = \lambda/(1 + m)$, and noting that $1/\phi^* \approx 5.737$, it follows that if $m \leq 4$ there exists a $\lambda^* = \phi^*(1 + m) < 1$,

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[15] In the special case in which $\lambda = 1$, taxation by one layer of government implements the *efficient* policy for the principal and the agent(s), i.e. the policy that maximizes their joint surplus (tax revenue plus gross profits).

such that $T^* + t_i^* - (\hat{T} + \hat{t}_i) \gtreqqless \hat{T} + \hat{t}_i - \tau_i^*$ for $\lambda \lesseqqgtr \lambda^*$; if $m \geq 5$, then $\phi^*(1 + m) > 1$ and therefore $T^* + t_i^* - (\hat{T} + \hat{t}_i) \geq \hat{T} + \hat{t}_i - \tau_i^*$ for all $\lambda \in [0, 1]$. In order to identify the optimal tax regime, i.e. the one that maximizes tax revenue, it is then sufficient to see which tax rates are closer to the socially optimal tax rates, since the revenue functions are quadratic (therefore single peaked and symmetric) in the tax rates. $\blacksquare$

If the market is 'highly' concentrated, in particular with no more than four firms, and if policy makers attach a 'high' value to campaign contributions, in particular $\lambda > \phi^*(1 + m)$, so that lobbying is 'highly' influential, then the total tax rates in the presence of tax base overlapping are closer to the socially optimal tax rates than those in the absence of tax base overlapping. Hence total tax revenue is closer to the social optimum under the former tax regime than under the latter. On the contrary, if the market is 'highly' concentrated ($m \leq 4$), but lobbying is not very influential ($\lambda < \phi^*(1 + m)$), or if the market is composed of at least five firms, whatever their lobbying influence, then the optimal tax regime is the one assigning the power to tax to only one layer of government, because its tax rates and revenue are closer to the socially optimal values than those prevailing when both layers of government are entitled to tax.

The intuition for this result is the following. In the absence of lobbying, tax base overlapping leads to excessive taxation because of the vertical tax externalities between the two layers of government, whereas the one-layer tax regime implements the social optimum. For tax base overlapping to become the optimal regime, it is therefore necessary that lobbying causes a large downward distortion on tax rates, so that those under tax base overlapping get close to the social optimum, while those under no tax base overlapping fall well below the social optimum. But for lobbying to be highly effective, it is necessary that influence (λ) is high and that profits are high (small number of firms, m). Notice also that, although lobbying by firms tends to reduce the equilibrium tax rates in both regimes, its impact is more relevant, for given 'influence' (λ) and market structure (m), when taxation is assigned to one layer of government than to both of them. In fact, in the latter case it is more difficult to 'buy' influence, since the externalities between the two levels of government call for compensating a policy maker not only for the distortions of her own tax rate but also for those on the tax rates of the other policy makers.

6   Conclusions

In this paper we have examined how tax setting in a federation with two layers of government is influenced by the lobbying activity of a special interest group. Concerning the tax assignment problem, our model highlights the antagonistic roles of vertical tax externalities and of lobbying pressure, with the former pushing tax rates above, and the latter below, their socially optimal level. In terms of tax revenue collected, the optimal tax regime was shown to depend on market structure and on the ability of the lobby to influence the policy makers. Therefore, our main conclusion is that the issue of tax assignment should not be dealt with without taking political institutions into account, in particular the role that special interest groups might play.

Among the possible extensions of our model, an important one concerns the introduction of the possibility of cross border shopping by consumers, induced by differentials in local tax rates. An additional factor, namely horizontal tax externalities among state governments, would come into play to define the optimal tax regime. Another possible extension is to consider a more general class of objective functions for the policy makers, including measures of consumers' surplus and, depending on the type of commodity taxed, paternalistic concerns (for limiting consumption, e.g. cigarettes) or the internalization of external effects (e.g. the consumption of pollution generating goods).

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