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Decentralized leadership in a federation and competition for mobile firms: Does economic integration matter?

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Decentralized leadership in a federation and competition for mobile firms: Does economic integration matter?

A note

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Abstract

Our paper presents a model of decentralized leadership with fiscal equalization and imperfect economic integration. The degree of trade integration (reflected by trade costs) turns out to have an effect on both the equilibrium tax rates across states and the ex-post vertical equalization transfers. Our main results are the following: Ex post vertical transfers are welfare deteriorating for low levels of trade integration while they are welfare improving compared to tax competition when trade integration is high enough. However, when public goods are highly valued by the citizens of the federation, ex post transfers are always welfare enhancing.

Keywords Tax competition, Trade Integration, Decentralized Leadership
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1 Introduction

There is a growing literature dealing with the effects of decentralized leadership on the efficiency of public good provision in federations (representative papers are those by Caplan et al. (2000), Köthenbürger (2004, 2007), Silva (2014, 2015) and Silva et al. (2016)). Decentralized leadership refers to a situation where self-interested regional (or state) governments act as first movers and anticipate how federal government will react to their fiscal policies.[1] The underlying assumption is that the state governments are able to pre-commit vis-à-vis the federal government.[2] All these papers focus on inter-jurisdictional spill-overs and fiscal externalities arising from factor mobility but abstract from the effects of trade integration on the efficiency of (ex-post) federal policies. This is all the more surprising given that the border literature shows that "borders still matter" not only across countries which are member of a highly integrated area such as the European Union (Millimet and Osang (2007)) but also within countries in both developed countries (Millimet and Osang (2007) for the US states) and emerging countries (Poncet (2005) for Chinese provinces). Our objective is to show that the level of economic integration has effects on both the intensity of tax competition among states and the amount of vertical equalization transfers granted by the federal government.

Our paper aims at filling this gap and analyses tax competition among a set of regions (countries) being part of an imperfectly integrated two-tier federation. Regional governments provide a public good in anticipating the ex-post fiscal equalization transfers that the federal government will grant to promote equal access to public services across the federation (Boadway (2004))[3]. As shown by Köthenbürger (2004), ex post transfers in a decentralized leadership setting lead to two effects which go in opposite direction: On the one hand, ex-post vertical transfers allow to internalize tax externalities arising from tax-induced capital mobility (Pigouvian effect), which is welfare improving compared to a situation of tax competition; on the other hand, ex-post transfers create a tax revenue sharing effect, which may be welfare deteriorating because the latter reduces the incentives for governments to tax capital. In Köthenbürger's model, the net effect on global welfare mostly depends on the size (market power) of the decentralized states.

Our paper departs from the standard decentralized literature in two main aspects: Most of the literature including (Köthenbürger, 2004, 2007) uses a standard model of tax competition à la Zodrow and Mieszkowski (1986) and Wildasin (1988) assuming that capital is perfectly mobile across regions and abstracting from both interregional trade and agglomeration effects. Instead, we set up a model of generalised oligopoly à la Haufler and Wooton (2010) where a set of N identical countries (and not only two) compete between each other over a corporate income tax to attract internationally mobile firms owned by residents of a third country. The model allows for rents that can be taxed away by governments to finance a regional public good which enters the utility function of the representative individual in each region. This is a main difference with Haufler and Wooton (2010), who assume that corporate tax incomes are evenly redistributed in a lump-sum way to the consumers in each region. We also depart from their paper since we account for a federal framework and assume that there are two layers of governments, with the federal government aiming at equalizing the provision of public good across the federation through ex-post vertical transfers.

Our model shows that the degree of trade integration (reflected by trade costs) has effects on

[1] Examples of decentralized leadership arrangements include the relationships between European member states and the European Union (Nitsch (2000)), the Russian Oblasts and the federal government of Russia and the Canadian provinces of British Columbia and Alberta vis-à-vis the Canadian federal government (see Köthenbürger (2007) for more details).

[2] The decentralized leadership assumption leads of course to a radical change of perspective with respect to the top-down literature (Dahlby (1996); Boadway and Keen (1996) and Boadway et al. (1998)) which implicitly assumes that the federal government can commit itself towards sub-national governments and that well-designed federal transfers are able to internalize inter-jurisdictional externalities, which is generally welfare-improving.

[3] Silva (2017) shows that if the federal government can implement both fiscal equalization and revenue equalization, the subgame perfect decentralized leadership equilibrium is socially optimal.

both the equilibrium tax rates across regions (countries) and the ex-post vertical equalization transfers. High trade costs insulate the domestic markets from competition of foreign firms while low trade cost intensifies price competition. In our framework, the intensity of price competition impacts the sensitivity of firms with respect to tax rates and, eventually, tax revenues accruing to state governments. This turns out to have effects on both the Pigouvian tax effect and the tax revenue sharing effect. More precisely, the strengths of either effect turns out to depend on the level of trade costs and the extent to which public goods are valued by the citizens of the federation. Our main result is the following: When public goods are highly valued by the citizens of the federation, ex post transfers are always welfare enhancing with respect to tax competition. However, ex post vertical transfers are welfare deteriorating for low levels of trade integration while they are welfare improving when trade integration is high enough.
Our paper develops as follows: Section 2 presents the set-up of the model. Section 3 deals with the central planner's solution. Section 4 presents Nash equilibrium tax rates when regions simultaneously compete over corporate tax rates. Section 5 is devoted to the decentralized leadership arrangement and Section 6 provides a comparison of welfare.

2 The Model

We consider a federation composed of N identical states (countries) and an overarching (federal) government. States compete over corporate taxes to attract mobile firms. State governments offer a residential public good to the representative household located within their country. The federal government uses vertical transfers in order to equalize the marginal benefit of the public good across countries. We first present the central planner solution. Then, we use the case where both layers of governments move simultaneously and play as Nash competitors as a benchmark. Finally, we assume that the two layers act sequentially with countries being leaders and the federal government being a follower. In the latter case the federal government reacts ex post to countries' decisions.

2.1 Consumers

The households consume two private goods and a public good. The first private good labeled x is produced and sold by the firms in an oligopolistic industry at price p. The numeraire commodity labeled z is produced and sold in a perfectly competitive market. Finally, g stands for a publicly-provided good which is financed out of corporate taxes paid by mobile firms operating in the oligopolistic industry. The public good is assumed to enter the utility function of the households in a log linear way with γ being a parameter that captures the (relative) preference of the consumers for the public good[4]. Consumers in each country have the same preference which is given by:

$$u_i = \alpha x_i - \frac{\beta}{2} x_i^2 + z_i + \gamma \ln g_i \quad \forall i = 1, ..., N \quad \text{and} \quad g_i > 0. \tag{1}$$

This utility function is similar to Haufler and Wooton (2010), except that it also includes the consumption of the public good. The budget constraint for the representative consumer in each country writes:

$$w = z_i + p_i x_i \quad \forall i = 1, ..., N \tag{2}$$

where p_i is the price of good x_i and w is the wage income determined in the numeraire industry and assumed to be the same across countries. The profit incomes are assumed to accrue to capital owners outside the federation and do not enter the budget constraint. The households

[4]Note that the logarithmic form of the public good implies that corporate taxes are always positive, which is not the case in the Haufler and Wooton's (2010) paper.

maximise their utility function (1) with respect to x_i taking into account their budget constraint (2), which leads to:

$$x_i = \frac{\alpha - p_i}{\beta} \quad \forall i. \tag{3}$$

2.2 Firms

There are k firms which operate in the oligopolistic industry with $k \geqslant N$. They are located inside the federation and can invest in either of the N states of the federation. Firms bear fixed costs that are assumed to be high enough to ensure that each firm can set up only one production plant in the Federation. Firms can serve both their domestic market and the $N-1$ foreign markets. Exporting firms bear trade costs labeled τ on each unit of exported output. Firms compete between each other in both their domestic and foreign markets. Labour is assumed to be the only variable input so that the cost of exporting the x good is equal to $\omega + \tau$ with $\omega = \lambda w$, with λ being the number of workers in the industry.

The total profit of a given firm in country i amounts to:

$$\pi_i = (p_i - \omega)x_{ii} + \sum_{j \neq i}(p_j - \omega - \tau)x_{ji} \tag{4}$$

where x_{ji} stands for sales in country j by a firm located in country i.

The aggregated demand in country i is given by

$$x_i = \sum k_j x_{ij} \tag{5}$$

where k_j is the number of firms located in j. Firms maximise their profit (4) taking into account (5) and that $\sum k_j = k$. This yields to the outpout levels per firm:

$$x_{ii} = \frac{\alpha - \omega + \tau \sum\limits_{j \neq i} k_j}{\beta(k+1)} \text{ and } x_{ji} = \frac{\alpha - \omega + \tau\,(1 + k_j)}{\beta(k+1)} \tag{6}$$

and the level of consumer price in each country i:

$$p_i = \frac{\alpha + k\omega + \tau \sum\limits_{j \neq i} k_j}{k+1}. \tag{7}$$

For symmetric countries, ensuring that $x_{ij} > 0$ and $x_{ji} > 0$ implies:

$$\alpha - \omega - \tau\left(1 + \frac{k}{N}\right) > 0 \Longleftrightarrow \tau < (\alpha - \omega)\,\frac{N}{N+k} = \overline{\tau}. \tag{8}$$

Plugging Equations (6) and (7) into (4) leads to:

$$\pi_i = \frac{\left(\alpha - \omega + \tau \sum\limits_{j \neq i} k_j\right)^2}{\beta\,(k+1)^2} + \sum_{j \neq i} \frac{(\alpha - \omega - (1 + k_j)\,\tau)^2}{\beta\,(k+1)^2} \tag{9}$$

Firms being mobile, the location equilibrium writes $\pi_i - t_i = \pi_j - t_j$ $\forall i, j$ and $i \neq j$, which determines the number of firms k_i in each country (see Appendix 1):

$$k_i = \frac{k}{N} - \frac{\beta\,(k+1)}{2\tau^2 N} \sum_{l \neq i} (t_i - t_l) = \frac{1}{N}\left(k - \frac{\beta\,(k+1)}{2\tau^2} \sum_{l \neq i} (t_i - t_l)\right)$$

and

$$\frac{\partial k_i}{\partial t_i} = -\frac{\beta}{2\tau^2}(k+1)\left(1-\frac{1}{N}\right) < 0 \text{ and } \frac{\partial k_j}{\partial t_i} = \frac{\beta(k+1)}{2\tau^2 N} > 0$$

Combining both we obtain:

$$\frac{\partial k_i}{\partial t_i} = -(N-1)\frac{\partial k_j}{\partial t_i} \tag{10}$$

An increase in t_i leads to an outflow of mobile firms which relocate to other countries $j \neq i$. Moreover, it is straightforward to check that:

$$\frac{\partial}{\partial N}\left(-\frac{\partial k_i}{\partial t_i}\right) > 0 \; ; \quad \frac{\partial}{\partial N}\left(\frac{\partial k_j}{\partial t_i}\right) < 0$$

and

$$\frac{\partial}{\partial \tau}\left(-\frac{\partial k_i}{\partial t_i}\right) < 0 \; ; \quad \frac{\partial}{\partial \tau}\left(\frac{\partial k_j}{\partial t_i}\right) < 0$$

The comparative statics show that the larger N, the larger the number of firms which relocate to foreign countries if t_i rises. In addition, a rise in the trade cost makes price competition less fierce on the domestic market and mitigates the magnitude of relocations of firms. Put differently, firms are less responsive to a shift in tax rate when trade costs are high. Indeed, the latter insulates the domestic market from competition of foreign firms.

2.3 Governments

As already mentioned, the federation is composed of two layers of benevolent governments. Each state government sets a source-based corporate tax t_i on each firm in a lump sum fashion in order to finance its local public good g_i. Moreover, the federal government aims at maximizing the agents' utility of the federation $\sum_{i=1}^{N} u_i(\cdot)$ and implements an horizontal equalization scheme which comes down to grant a positive or negative lump sum transfer to each country with $\sum_{i=1}^{N} s_i = 0$.

Each state i's budget constraint is given by $g_i = t_i k_i + s_i \; \forall i = 1, ..., N$ and policy makers in each country maximise the welfare of their representative households. By integrating the budget constraint (2) of the consumer into the utility function (1) and using the country aggregate demand (5), the output of the firms (6) and the expression for the price (7), we derive the country i representative agent's utility

$$u_i = S_i + w + \gamma \ln g_i \tag{11}$$

with country i's total consumer surplus in market x given by:

$$S_i = \frac{\left(k(\alpha-\omega) - \tau\sum_{j\neq i} k_j\right)^2}{2\beta(k+1)^2} = \frac{(k(\alpha-\omega-\tau)+\tau k_i)^2}{2\beta(k+1)^2}$$

We immediately deduce that

$$\frac{\partial S_i}{\partial t_i} = -\frac{N-1}{N}\frac{k(\alpha-\omega-\tau)+\tau k_i}{2\tau(k+1)} < 0$$

Any increase (resp. decrease) in the tax rate set by state i leads to an outflow (resp. inflow) of firms which in turn makes price competition on the domestic market less fierce (resp. fiercer). Note that governments are constrained in their ability to tax since the after tax profits have to be non negative ($\pi_i - t_i \geqslant 0$), such that $t^{\max} = \min\{\pi_1, ..., \pi_N\}$.

3 The central planner

The central planner chooses s_i and t_i in order to maximise the aggregated welfare

$$\max_{s_i,t_i} \sum_i u_i \equiv \sum_i S_i + Nw + \sum_i \gamma \ln g_i$$

taking into account

$$\sum_i s_i = 0 \tag{12}$$

$$\sum_i g_i = \sum_i t_i k_i + \sum_i s_i \tag{13}$$

$$k = \sum_i k_i \tag{14}$$

$$\sum_i z_i = Nw - \sum_i (\alpha - \beta x_i) x_i$$

and (5) $\forall i$.

Computing the first order conditions with respect to s_i and t_i leads to

$$t_i k_i + s_i = t_j k_j + s_j \quad \forall i, j \tag{15}$$

and

$$\frac{\partial \sum_l u_l}{\partial t_i} = \frac{\partial S_i}{\partial t_i} + \frac{\gamma}{t_i k_i}\left(k_i + t_i \frac{\partial k_i}{\partial t_i}\right) + \sum_{l \neq i} \frac{\partial S_l}{\partial t_l} + \sum_{l \neq i} \frac{\gamma}{t_l k_l}\left(t_l \frac{\partial k_l}{\partial t_i}\right) \tag{16}$$

For identical countries, $t_i = t_j$ and $k_i = k_j = \frac{k}{N}$, such that $s_i = s_j = 0$. Moreover, $\frac{\partial S_i}{\partial t_i} = -\sum_{l \neq i} \frac{\partial S_l}{\partial t_l}$ and $\frac{\partial k_i}{\partial t_i} = -\sum_{l \neq i} \frac{\partial k_l}{\partial t_i}$. Equation (16) reduces to $\frac{\partial \sum_l u_l}{\partial t_i} = \frac{\gamma}{t_i}$ and the optimal tax t^{SP} should be set at its maximum level[5] : $t^{SP} = t^{max}$. The latter result is explained by the fact that on the one hand, a higher t_i leads to a lower consumer surplus because less firms are located in i and then price competition is less intense. On the other hand, a higher tax rate leads to higher tax revenues and more public good provision. However, for identical countries, the effect of the tax rate on both the domestic consumer surplus and the number of firms is perfectly compensated by the opposite effect on both foreign consumer surpluses and firms. It results that the only effect that remains is the direct tax revenue effect which is positive.

4 Nash equilibrium

Both layers of government choose their fiscal instruments simultaneously and non cooperatively taking into account the effect on mobile firms' location. State governments maximise u_i s.t. $g_i = t_i k_i + s_i$. The first order condition writes:

$$\frac{\partial S_i}{\partial t_i} + \frac{\gamma}{t_i k_i + s_i}\left(k_i + t_i \frac{\partial k_i}{\partial t_i}\right) = 0$$

[5] The level of t^{max} is determined by the level of t that leaves the net of tax profit null.

An interior solution exists if the elasticity of capital is not too high in absolute value. From now, we assume that $\varepsilon_i = \left|\frac{t_i}{k_i}\frac{\partial k_i}{\partial t_i}\right| < 1$.
At the symmetric equilibrium there are no transfers ($s_i = s_j = 0$) and for positive net profits we have:

$$\widehat{t} = \frac{N}{N-1}\frac{\gamma 2\tau^2(k+1)k}{k^2(\alpha-\omega-\tau)\tau + \frac{k^2}{N}\tau^2 + \gamma\beta\,(k+1)^2\,N} \tag{17}$$

with

$$\frac{\partial \widehat{t}}{\partial \tau} = \frac{N}{N-1}\gamma 2(k+1)k\tau \frac{\left(k^2(\alpha-\omega)\tau + 2\gamma\beta\,(k+1)^2\,N\right)}{\left(k^2(\alpha-\omega-\tau)\tau + \frac{k^2}{N}\tau^2 + \gamma\beta\,(k+1)^2\,N\right)^2} > 0 \tag{18}$$

$$\frac{\partial \widehat{t}}{\partial N} = -\frac{N}{(N-1)^2}\gamma 2(k+1)k\tau^2 \frac{\left(k^2N(\alpha-\omega-2\tau)\tau + 2k^2\tau^2 + \gamma\beta\,(k+1)^2\,N^3\right)}{\left(Nk^2(\alpha-\omega-\tau)\tau + k^2\tau^2 + \gamma\beta\,(k+1)^2\,N^2\right)^2} < 0 \tag{19}$$

and

$$\frac{\partial \widehat{t}}{\partial \gamma} = \frac{N^2}{N-1}2(k+1)k^3\tau^3 \frac{(N(\alpha-\omega-\tau)\tau + \tau)}{\left(k^2N(\alpha-\omega-\tau)\tau + k^2\tau^2 + \gamma\beta\,(k+1)^2\,N^2\right)^2} > 0 \tag{20}$$

At the symmetric Nash equilibrium, the implemented tax rate is $t^N = \min\{\widehat{t}, t^{max}\}$. Note that $\hat{t}$ is always positive despite the two opposite effects identified by Haufler and Wooton (2010): A location rent effect which goes towards high tax rates in the presence of trade costs and a consumer price effect which goes towards a low tax rate. In contrast with Haufler and Wooton (2010), the first effect always outweighs the second one in our model because the public good enters directly into the utility function while, in their setting, corporate income tax revenue is redistributed in a lump sum way to the representative consumer in each country.

In our model, for a given number of firms k, a rise in the number of competitive regions makes the competition fiercer and drives down the Nash equilibrium tax rate. All things being equal an increase ij the preference for the public good γ unsurprisingly leads to a higher Nash equilibrium tax rate.

5 Decentralized Leadership

In the decentralized leadership setting, state governments behave as Stackelberg leaders vis à vis the federal government. In the first stage, state governments choose their local tax rates taking into account the reaction function of the federal government. They still play as Nash competitors towards each other. In the second stage, the federal government chooses the grants provided to state governments taking the local tax rates as given. We solve the program by backward induction in order to obtain the subgame perfect equilibrium.

The federal government maximises the aggregated welfare, which leads to expression (15). Summing this expression for all $j \neq i$ and compiling with (12) leads to

$$s_i = \frac{1}{N}\sum_{j\neq i}(t_j k_j - t_i k_i)$$

The program of each state government i becomes

$$\begin{aligned} &\max_{t_i} \quad u_i \\ \text{s.t.} \quad g_i &= t_i k_i + s_i \\ s_i &= \frac{1}{N}\sum_{j\neq i}(t_j k_j - t_i k_i) \end{aligned}$$

The first order condition for country i writes

$$\frac{\partial S_i}{\partial t_i} + \frac{\gamma}{t_i k_i + s_i}\left(k_i + t_i \frac{\partial k_i}{\partial t_i} + \frac{\partial s_i}{\partial t_i}\right) = 0$$

with

$$\frac{\partial s_i}{\partial t_i} = \overbrace{\frac{1}{N}\sum_{j\neq i} t_j \frac{\partial k_j}{\partial t_i}}^{\text{Pigouvian tax effect}} \overbrace{-\frac{(N-1)}{N}\left(k_i + t_i \frac{\partial k_i}{\partial t_i}\right)}^{\text{tax revenue sharing effect}}$$

The reaction of the federal transfer with respect to a change in t_i depends on two effects. On the one hand, a Pigouvian tax effect which reflects the internalization by the federal government of the horizontal tax externalities arising from tax competition. On the other hand, a tax revenue sharing effect whereby any change in the tax revenue of state i will be pooled and redistributed among the other states $j \neq i$ through the equalization scheme. The first effect is always positive while the second one is negative since we assumed that $\varepsilon_i = \left|\frac{t_i}{k_i}\frac{\partial k_i}{\partial t_i}\right| < 1$.

$$\frac{\partial s_i}{\partial t_k} = \frac{\left(k_k + t_k \frac{\partial k_k}{\partial t_k}\right) + \sum_{j\neq k} t_j \frac{\partial k_j}{\partial t_k} - N t_i \frac{\partial k_i}{\partial t_k}}{N}$$

At the symmetric equilibrium we obtain

$$\tilde{t} = \frac{\gamma 2\tau(k+1)}{(N-1)\,k\left((\alpha - \omega - \tau) + \frac{\tau}{N}\right)}$$

with

$$\frac{\partial \tilde{t}}{\partial \tau} = \frac{\gamma 2(k+1)}{(N-1)} \frac{\alpha - \omega}{k\left((\alpha - \omega - \tau) + \tau\frac{k}{N}\right)^2} > 0$$

$$\frac{\partial \tilde{t}}{\partial N} = -\frac{\gamma 2(k+1)\tau}{(N-1)^2} \frac{(\alpha - \omega - \tau)N^2 + \tau}{k\left((\alpha - \omega - \tau)N + \tau k\right)^2} < 0$$

and

$$\frac{\partial \tilde{t}}{\partial \gamma} = \frac{2(k+1)N\tau}{k(N-1)\left((\alpha - \omega - \tau)N + \tau\right)^2} > 0$$

At the decentralized leadership equilibrium, the implemented tax rate is $t^{DL} = \min\{\tilde{t}, t^{max}\}$

6 Comparisons of the equilibrium tax rates and levels of welfare

Note that the consumer surplus (S_i) does not depend on the tax rates at the symmetric equilibrium. As a result, the comparison of the welfare defined by Equation (11) reduces to the comparison of the tax rates. The comparison between the Nash setting (tax competition) and the decentralized leadership comes down to a trade-off between a pure tax competition effect which drives the tax rate down at Nash equilibrium and a tax revenue sharing effect that dilutes the ability of the state governments to increase their tax rates at decentralized leadership equilibrium.

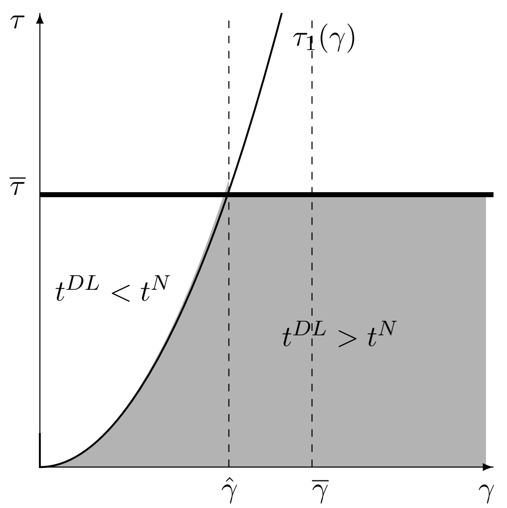


Figure 1: Case for N finite and $N < k$

Proposition 1 *Let* $\hat{\gamma} = \frac{(N-1)(\alpha-\omega)^2 k^2}{(N+k)^2 \beta (k+1)}$,

i) if $\gamma > \hat{\gamma}$, *then* $\left.\frac{\partial s_i}{\partial t_i}\right|_{t^{NS}} > 0$ *and* $t^{DL} > t^N \ \forall \tau$

$$ii) \text{ if } \gamma < \hat{\gamma}, \quad \begin{array}{lllll} then & \left.\frac{\partial s_i}{\partial t_i}\right|_{t^{NS}} \geqslant 0 & and & t^{DL} > t^N & for \quad \tau \in [0, \tau_1] \\ then & \left.\frac{\partial s_i}{\partial t_i}\right|_{t^{NS}} < 0 & and & t^{DL} < t^N & for \quad \tau \in]\tau_1, \overline{\tau}], \end{array}$$

with $\frac{\partial \tau_1}{\partial \gamma} > 0$ *and* $\frac{\partial \tau_1}{\partial k} < 0$.

Proof. see Appendix 2. ■

Proposition 1 states that a high level of preference for the public good (γ) implies that the tax rate at the decentralized leadership equilibrium is always higher than the tax rate set at the Nash equilibrium (see Figure 1). In other words, ex post vertical transfers are always welfare improving with respect to tax competition. This is true regardless the degree of economic integration (i.e whatever the level of trade cost τ). The reason is that the Pigouvian tax effect always dominates the tax revenue sharing effect when the public good is highly valued by individuals. A high level of γ drives both the Nash and the decentralized leadership equilibrium tax rates upward. At the symmetric equilibrium, this results in strengthening the Pigouvian tax effect and mitigating the tax revenue sharing effect as shown by Equation (5). The former effect arises directly because the equilibrium tax rate in any region $j \neq i$ is higher and so are tax revenues which accrue to those states. The latter effect is explained by the fact that, for a high equilibrium tax rate, the sensitivity of firms location to tax rate (ε_i) is higher. As a result, both effects go towards higher vertical transfers granted by the central government ($\frac{\partial s_i}{\partial t_i} > 0$).

For lower level of preference for the public good ($\gamma < \hat{\gamma}$), whether the tax revenue sharing effect dominates the Pigouvian tax effect ultimately depends of the level of trade costs. When $\gamma > \hat{\gamma}$, the threshold trade cost is higher than the maximum level of trade cost $\overline{\tau}$ and the decentralized leadership tax rate is still higher than the Nash tax rate. When $\gamma < \hat{\gamma}$, the tax rate at the decentralized leadership equilibrium will be higher than the tax set at the Nash equilibrium if trade costs are not too high. High trade costs make firms less sensitive to tax rates resulting in less intense tax competition. As a result, tax rates are higher at Nash equilibrium. At the decentralized equilibrium, high trade costs imply, on the one hand, a low Pigouvian tax

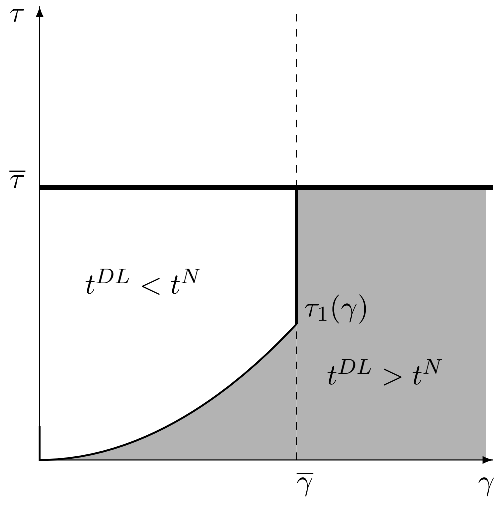


Figure 2: Case for $N \longrightarrow \infty$

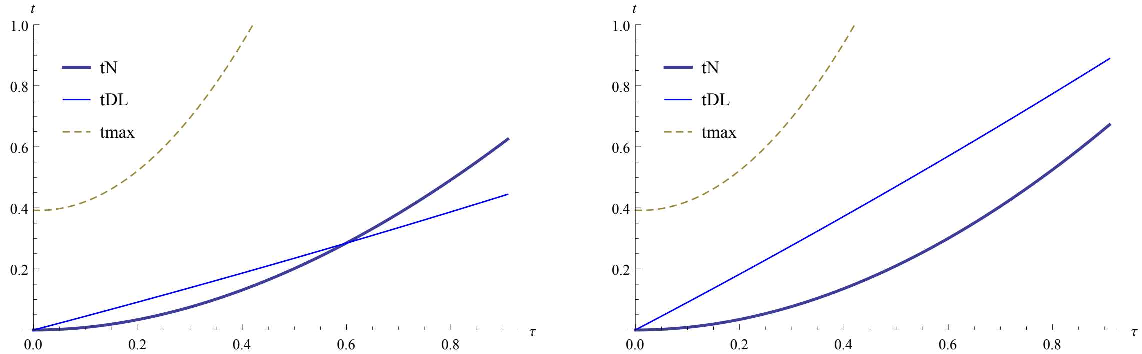
effect because tax externalities are less severe. On the other hand, high trade costs imply a larger tax revenue sharing effect since a low mobility of firms leads to a higher share of tax revenue that is captured by the federal government to be redistributed to the other states. As a result, the tax revenue sharing effect dominates the Pigouvian tax effect and the Nash equilibrium tax rate is higher than the decentralized leadership one.

Corollary 2 *Let* $\overline{\gamma} = \frac{(\alpha-\omega)^2 k^2}{4\beta(k+1)^2}$*,*
For $N \to \infty$ *then* $t^N > t^{DL}$ *if* $\gamma < \overline{\gamma}$ *and* $\tau \in [\tau_1, \overline{\tau}]$.

Proof. We have $\underset{N \longrightarrow \infty}{lim} \overline{\tau} = (\alpha - \omega)$ and $\underset{N \longrightarrow \infty}{lim} \tau_1 = \frac{1}{2}(\alpha - \omega) - \sqrt{(\alpha-\omega)^2 - 4\beta\gamma\left(\frac{k+1}{k}\right)^2}$ which implies $\tau_1 < \overline{\tau}$ for any $\gamma < \overline{\gamma}$ with $\overline{\gamma} > \hat{\gamma}$. ■

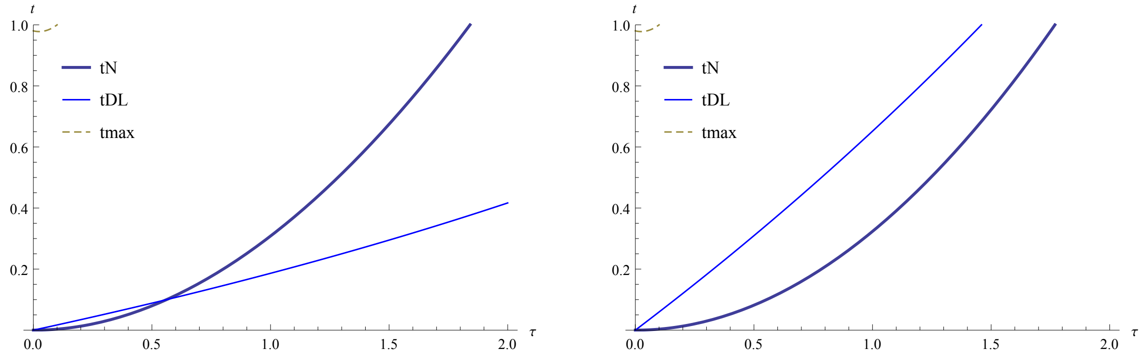
Corollary 2 shows that when N tends to infinity, the level of trade costs and then the intensity of tax competition still matter. This is not the case in the standard tax competition framework used by Köthenbürger (2004). In his model, when the number of competing states is very high, tax competition intensity does not have any effect on the relative tax rates: The Nash equilibrium tax rate always dominates the decentralized leadership tax rate. The main reason is that each household is endowed with one unit of capital so that the total capital supply in the federation increases proportionally to the number of states. This implies that the tax competition intensity based on the production technology does not change. In contrast, in our setting, the total number of firms is given and does not increase with the number of states which is in line with Haufler and Wooton (2010) among others. As a result, the Nash equilibrium tax rate is much less (negatively) affected than the decentralized tax rate equilibrium by the number of competing states. The increase in the number of states mitigates both the Pigouvian tax effect and the revenue tax sharing effect. Whether either of the two effects dominates ultimately depends on trade costs (for $\gamma < \overline{\gamma}$).

We calibrate the model to display our results. Figure 3 stands for 10 states while Figure 4 illustrates the case of 25 states (as in the European Union for instance). For the calibration, we use $k = 100$, $\alpha - \omega = 10$ and $\beta = 1/4$. Figures 3 (a) and 4 (a) present the case ii) of Proposition 1: When $\tau < \tau_1$, we observe that $t^{DL} > t^N$ while $t^{DL} < t^N$ for $\tau \in [\tau_1, \overline{\tau}]$. Figures 3(b) and 4(b) illustrate case i) i.e. $t^{DL} > t^N \quad \forall \tau$ because of a high preference for public goods ($\gamma > \hat{\gamma}$).



(a)$\gamma < \hat{\gamma}$ ($\gamma = 20$ and $\tau_1 = 0.599016$) (b)$\gamma > \hat{\gamma}$ ($\gamma = 40$)

Figure 3: For $N = 10$, $\overline{\tau} = 0.909$, $\hat{\gamma} = 29.45$



(a)$\gamma < \hat{\gamma}$ ($\gamma = 20$ and $\tau_1 = 0.5615$) (b)$\gamma > \hat{\gamma}$ ($\gamma = 70$)

Figure 4: For $N = 25$, $\overline{\tau} = 2$, $\hat{\gamma} = 60.83$

7 Conclusion

Decentralized leadership in federations has been extensively studied within the framework of the standard tax competition model characterized by perfect competition on markets of goods. Alternatively, we have argued that product markets are segmented and economic integration may have effects on the propensity of countries (or subnational governments) to extract vertical transfers from the federal government when the institutional context gives them an advantage of first mover. Furthermore, vertical transfers have mixed effects on welfare depending on the level of economic integration. These results are obtained assuming that countries are identical. An interesting extension would be to suppose asymmetry of countries and different kinds of equalization schemes.

8 Appendix

8.1 Appendix 1: Determination of k_i

The level of k_i solves $\pi_i - t_i = \pi_j - t_j = \pi_l - t_l = ...$
Replacing the profit by its expression (9) for i and j and manipulating the resulting expression we obtain :

$$\frac{2\tau^2}{\beta(k+1)}(k_l - k_i) = (t_i - t_l) \tag{21}$$

The sum of this expression for any $l \neq i$ gives

$$\begin{aligned}
\sum_{l\neq i} \frac{2\tau^2}{\beta(k+1)}(k_l - k_i) &= \sum_{l\neq i}(t_i - t_l) \\
2\tau^2 \sum_{l\neq i}(k_l - k_i) &= \beta(k+1)\sum_{l\neq i}(t_i - t_l) \\
2\tau^2(k - Nk_i) &= \beta(k+1)\left((N-1)t_i - \sum_{l\neq i} t_l\right)
\end{aligned}$$

and we obtain

$$k_i = \frac{k}{N} - \frac{\beta(k+1)}{2\tau^2 N}\left((N-1)t_i - \sum_{l\neq i} t_l\right)$$

8.2 Appendix 2: Comparison of t^{NS} and t^{DL}

The FOC from the decentralized solution writes

$$\frac{\partial S_i}{\partial t_i} + \frac{\gamma}{t_i k_i + s_i}\left(k_i + t_i \frac{\partial k_i}{\partial t_i} + \frac{\partial s_i}{\partial t_i}\right) = 0$$

while for the Nash equilibrium,

$$\frac{\partial S_i}{\partial t_i} + \frac{\gamma}{t_i k_i + s_i}\left(k_i + t_i \frac{\partial k_i}{\partial t_i}\right) = 0$$

Evaluated at the Nash equilibrium, the FOC of the decentralized leadership writes

$$\begin{aligned}
\frac{\gamma}{t_i k_i + s_i}\left.\frac{\partial s_i}{\partial t_i}\right|_{\widehat{t}} &> 0 \Longleftrightarrow \left.\frac{\partial s_i}{\partial t_i}\right|_{\widehat{t}} > 0 \text{ (cf. lemma 3 Kothenburger)} \\
\text{and } \widehat{t} &< \widetilde{t} \Longleftrightarrow \left.\frac{\partial s_i}{\partial t_i}\right|_{\widehat{t}} > 0
\end{aligned}$$

which rewrites

$$\begin{aligned}
\left.\frac{\partial s_i}{\partial t_i}\right|_{\widehat{t}} = \frac{(N-1)}{N}\left(-\frac{k}{N} + \widehat{t}\frac{\beta(k+1)}{2\tau^2 N}(N-1)\right) &+ \left(\frac{N-1}{N}\right)\widehat{t}\frac{\beta(k+1)}{2\tau^2 N} > 0 \\
&\Longleftrightarrow \\
\widehat{t} &> \frac{k2\tau^2}{N\beta(k+1)}
\end{aligned}$$

Replacing $\hat{t}$ by its expression (17) gives after manipulations:

$$N\beta\gamma\left(\frac{k+1}{k}\right)^2 \quad > \quad \tau(\alpha-\omega)(N-1)-\tau^2\frac{(N-1)^2}{N}$$

Let us define $F(\tau)=\tau^2\frac{(N-1)^2}{N}-\tau(\alpha-\omega)(N-1)+N\beta\gamma(\frac{k+1}{k})^2$

$\Delta=(N-1)^2\left((\alpha-\omega)\right)^2-4\beta\gamma(\frac{k+1}{k})^2>0 \Longleftrightarrow \gamma<\frac{(\alpha-\omega)^2}{4\beta(\frac{k+1}{k})^2}=\overline{\gamma}$
For $\Delta>0$ we have two roots

$$\tau_1=N\frac{(\alpha-\omega)-\sqrt{(\alpha-\omega)^2-4\beta\gamma\left(\frac{k+1}{k}\right)^2}}{2(N-1)};$$
$$\tau_2=N\frac{(\alpha-\omega)+\sqrt{(\alpha-\omega)^2-4\beta\gamma(\frac{k+1}{k})^2}}{2(N-1)}$$

$$\begin{aligned}\tau_1 \quad &= \quad N\frac{(\alpha-\omega)-\sqrt{(\alpha-\omega)^2-4\beta\gamma(\frac{k+1}{k})^2}}{2(N-1)}<\overline{\tau}\\ \Longleftrightarrow \quad &\gamma<\frac{(N-1)\left(\alpha-\omega\right)^2k^2}{(N+k)^2\beta(k+1)}=\hat{\gamma}\end{aligned}$$

We can check that

$$\hat{\gamma}-\overline{\gamma}<0 \Longleftrightarrow (k+N)^2-4(1+k)(N-1)>0$$

Which is always true for $N\in[2,k[$. Then when $\gamma>\hat{\gamma}$, $\tau_1>\overline{\tau}$ and $F(\tau)>0 \quad \forall\tau$. Furthermore,

$$\tau_2=N\frac{(\alpha-\omega)+\sqrt{(\alpha-\omega)^2-4\beta\gamma(\frac{k+1}{k})^2}}{2(N-1)}>\frac{N(\alpha-\omega)}{2N}>\overline{\tau}=(\alpha-\omega)\,\frac{N}{N+k}$$

because $k\geqslant N$. We obviously have

$$\frac{\partial\tau_1}{\partial N}>0, \quad \frac{\partial\tau_1}{\partial\gamma}>0 \quad \text{and} \quad \frac{\partial\tau_1}{\partial k}<0$$

Finally, $t^N=\min\{\widehat{t},t^{\max}\}$ and $t^{DL}=\min\{\widetilde{t},t^{\max}\}$ complement the proof.

References

Boadway, R. (2004). The theory and practice of equalization. *CESifo Economic Studies*, 50(1):211–254.

Boadway, R. and Keen, M. (1996). Efficiency and the optimal direction of federal-state transfers. *International Tax and Public Finance*, 3(2):137–155.

Boadway, R., Marchand, M., and Vigneault, M. (1998). The consequences of overlapping tax bases for redistribution and public spending in a federation. *Journal of Public Economics*, 68(3):453–478.

Caplan, A. J., Cornes, R. C., and Silva, E. C. (2000). Pure public goods and income redistribution in a federation with decentralized leadership and imperfect labor mobility. *Journal of Public Economics*, 77(2):265–284.

Dahlby, B. (1996). Fiscal externalities and the design of intergovernmental grants. *International Tax and Public Finance*, 3(3):397–412.

Haufler, A. and Wooton, I. (2010). Competition for firms in an oligopolistic industry: The impact of economic integration. *Journal of International Economics*, 80(2):239–248.

Köthenbürger, M. (2004). Tax competition in a fiscal union with decentralized leadership. *Journal of Urban Economics*, 55(3):498–513.

Köthenbürger, M. (2007). Ex-post redistribution in a federation: Implications for corrective policy. *Journal of Public Economics*, 91(3):481–496.

Millimet, D. L. and Osang, T. (2007). Do state borders matter for us intranational trade? the role of history and internal migration. *Canadian Journal of Economics/Revue canadienne d'économique*, 40(1):93–126.

Nitsch, V. (2000). National borders and international trade: evidence from the european union. *Canadian Journal of Economics/Revue canadienne d'économique*, 33(4):1091–1105.

Poncet, S. (2005). A fragmented china: measure and determinants of chinese domestic market disintegration. *Review of International Economics*, 13(3):409–430.

Silva, E. C. D. (2014). Selective decentralized leadership. *Journal of Urban Economics*, 83:1–5.

Silva, E. C. D. (2015). Efficient earmarking under decentralized fiscal commitments. *International Tax and Public Finance*, 22(4):683–701.

Silva, E. C. D. et al. (2016). Common labor market, attachment and spillovers in a large metropolis. *International Tax and Public Finance*, 23(4):693–715.

Wildasin, D. E. (1988). Nash equilibria in models of fiscal competition. *Journal of Public Economics*, 35(2):229–240.

Zodrow, G. R. and Mieszkowski, P. (1986). Pigou, tiebout, property taxation, and the under-provision of local public goods. *Journal of Urban Economics*, 19(3):356–370.