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Does tax competition increase disparity among jurisdictions?

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Abstract

This paper investigates whether a less-developed economy can catch up with a more developed one when they compete for foreign direct investments. The main message of the paper is that jurisdictional competition can enable the lagging country to catch up if capital mobility is sufficiently high and the productivity gap is not too large. Further, we show that size asymmetry reinforces (weakens) the productivity catch-up resulting from interjurisdictional competition when the lagging economy is small (large). Finally, we demonstrate that the development gap widens when capital becomes less mobile, which is at odds with previous findings.

Keywords: *interjurisdictional competition; productivity catch-up; size asymmetry*

JEL classification: *H21; H73; C72*

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1 Introduction

The central message of the standard theory of tax competition (a survey is given in Wilson, 1999) is that the competing jurisdictions¹ will end up with inefficiently low levels of public goods and consequently with an under-provision of productivity enhancing public infrastructures. Moreover, if the competing jurisdictions are unevenly endowed with initial productive resources, the lagging countries will set the lowest equilibrium tax rate and get the lowest tax revenue. It follows that less endowed countries may suffer from infrastructure under-provision to a larger extent than more advanced jurisdictions and thus are unable to sustain development (e.g. Thomas, 2007). Consequently, economic divergence can be exacerbated by tax competition.

Many authors note that jurisdictions compete not only in taxes but also in infrastructure expenditures (for example, Hindriks et al., 2008; Zissimos and Wooders, 2008; Pieretti and Zanaj, 2011). This argument is empirically validated by recent research (Hauptmeier et al., 2012) which demonstrates that jurisdictions use independent and strategic business tax rates and public inputs to compete for capital.

The question that arises is the following. Does competition in taxes and productive government expenditures provide greater incentives to the competing jurisdictions for increasing their infrastructure provision and thus promote the development of their economies? In this context, are lagging countries able to catch up with more advanced jurisdictions?

These issues have received little attention in the theoretical literature. One exception is perhaps the paper of Cai and Treisman (2005) who study how infrastructure policies designed to promote growth are impacted when unevenly endowed jurisdictions in initial resources (e.g., natural resources, geographical advantages, inherited human capital) compete to attract capital. They argue that the less endowed jurisdictions will invest less in business services and loose capital that flows to the better

¹Jurisdictional competition can exist among subnational governments within decentralized states or among sovereign countries.

endowed rivals. Thus, capital mobility exacerbates the development gap among unevenly endowed economies.

Does the evidence demonstrate that fiscal competition between governments increases their disparity, in particular because lagging countries will have a strong incentive to restrict expenditures in productivity-enhancing public infrastructure by contrast to better endowed jurisdictions?

Cai and Treisman (2005) provide some tentative evidence² of increased divergence among Russian Federation's 89 regions induced by the liberation of private capital flows among the local governments following the collapse of communism. However, more elaborate empirical investigations yield opposite results. For example, Ezcurra and Pascual (2008) analyze the impact of fiscal decentralization on regional disparities in a set of European Union countries. They find that fiscal decentralization is correlated with reduced inequality in the considered sample. They conclude that the "processes of fiscal decentralization may contribute to a more balanced distribution of resources across space". In a recent empirical paper dealing with fiscal competition in China, Yu, Zhang, Li and Zheng (2011) find a catch-up effect in public infrastructure spending between coastal and non-coastal cities. Sorens (2014) uses a multilevel spatial regressions on primary sub-national jurisdictions in 25 OECD countries and shows that lower-income regions tend to catch up with higher-income regions if they enjoy substantial economic power. Consequently, "there is more convergence across member states of the European Union than across regions within almost any of the European Union member states".

Ambiguous results have also been highlighted in the empirical literature. Rodríguez-Pose and Ezcurra (2010) who analyze a panel of 26 countries for the period 1990-2006 find mixed results. They observe that FDIs increase inequality in developing economies, but decrease inequality in developed economies.

²They find, "that a region's initial endowments, as measured by this index, correlated positively with various indicators of regional government effort to build infrastructure or enact business-friendly policies in subsequent years" (see page 825).

The purpose of this paper is to develop a framework that is able to analyze under which parameter constellations fiscal competition can decrease or increase the gap between unevenly developed jurisdictions. The aim is thus to provide some insights regarding the contradictory effects of fiscal competition observed empirically.

The model developed in the paper has the following features. Two jurisdictions are supposed to compete for mobile businesses by using two independent policy instruments, namely taxes and public infrastructure expenditures. We introduce two types of asymmetries. First, the competing jurisdictions are unequally endowed in initial infrastructure, thus explaining that one of them is lagging behind its rival in terms of productivity. Second, we assume that the jurisdictions can be of unequal size, the size being reflected by the number of firms initially located in each economy. While small countries undercut larger ones in the standard tax competition literature³, small jurisdictions do not necessarily need to resort to tax dumping when they compete with taxes and infrastructure (see Pieretti and Zanaj, 2011). Small countries can also react by increasing their infrastructure provision relative to their larger rivals. As we argue in this paper, this effect impacts ambiguously on the economic discrepancies between the competing countries.

We further assume that the competing governments maximize social welfare (or tax revenue), as in Cai and Treisman (2005), when they strategically choose taxes and infrastructure services. Consequently, firms can decide to move according to combinations of taxes and infrastructure services provided by competing jurisdictions.

Our paper contributes to the literature in the following ways.

³Asymmetric tax competition among jurisdictions, where competing entities can be uneven in several respects, has been extensively treated in the literature. For example, Bucovetsky (1991) addresses tax competition when the competing countries are of different size. Wilson (1991) introduces asymmetries in the capital endowment in tax competition. Kanbur and Keen (1993) investigate tax competition and tax coordination when countries differ in population size. These models yield similar results. The larger country faces a lower elasticity of capital relative to the tax rate and hence a lower marginal cost of public funds. Consequently, it chooses a higher tax rate than the smaller country. The advantage of small jurisdictions translates into their ability to undercut tax rates of their large rivals.

We demonstrate that jurisdictional competition can enable lagging countries to catch up if capital mobility is sufficiently high and the initial productivity divergence not too large. If these conditions are not verified, interjurisdictional competition will result in increased divergence. The mixed results we obtain contrast with Cai and Treisman (2005) who conclude that international competition always increases the gap among unevenly developed jurisdictions. Further, we demonstrate that the development gap widens when capital becomes less mobile, which is at odds with Cai and Treisman (2005) who demonstrate that inequality increases when capital become perfectly mobile.

Moreover, our contribution highlights that size matters. We find that size asymmetry reinforces (weakens) the effect of inter-jurisdictional competition on productivity catch-up when the lagging jurisdiction is the small (large) economy.

Our approach differs from the existing literature in the following way. We do not consider, contrary to most contributions on tax competition, that public expenditures are passively determined after tax revenue is collected. We rather assume that both tax rates and public infrastructure are (independent) strategic variables⁴. This assumption, which is supported by evidence plays a crucial role for obtaining the main results of the paper. Cai and Treisman (2005) also consider taxation and infrastructure provision as two distinct policy variables. However, our paper differs in two respects from their contribution. First, they only focus on two polar cases, namely lack of capital mobility and perfect capital mobility⁵. More realistically, our paper considers intermediate degrees of capital mobility. Second, the technology they consider has decreasing returns

⁴Other authors (Keen and Marchand, 1997 and Fuest, 1995) analyze the effect of taxation and infrastructure on internationally mobile capital. However, these instruments are not independent. This results formally from the fact that taxes and infrastructure expenditures are linked through a balanced budget. According to Wildasin (1991), equilibria in fiscal competition games with two instruments related via a budget constraint crucially depend on which instrument is set strategically. Consequently, if countries interact through tax competition, expenditures are not necessarily a strategic variable.

⁵However, Cai and Treisman (2005) recognize that, reality lies somewhere in between capital immobility and perfect mobility.

to scale in public investment, whereas we assume constant returns to scale. Our paper can thus be viewed as complementary to Cai and Treisman (2005).

Our paper is organized as follows. In the next section, we set up the model. In section 3 the conditions on economic catch-up are investigated. We check the robustness of our results in section 4. Section 5 concludes.

2 Model set-up

Consider two jurisdictions denoted by h and f . In either country the population is evenly spread with a unit density on the interval $[0, 1]$. The size of country $i = h, f$ in terms of total population is denoted by S_i with $0 < S_i < 1$ and $S_h + S_f = 1$. Similar to Pieretti and Zanaj (2011), we consider that each individual owns one unit of capital and is at the same time an entrepreneur and a worker. In other words, to each member of the population corresponds a one-person company⁶. The entrepreneurs can move their activity abroad, but are supposed to be heterogeneous in their preference to leave the home location. The entrepreneurs are ranked according to their willingness to relocate abroad⁷. The closer an individual is to the border separating countries h and f , the easier she is able to relocate abroad. For example, an entrepreneur of type $\alpha \in [0, 1]$ who moves from h to f incurs a mobility cost equal to $k|\alpha - S_h|$, where $|\alpha - S_h|$ is the gap between the "border" S_h and the type α . The parameter k is the unit cost of relocation. It can also be viewed as a measure of the degree of international financial integration. In particular, the lower k , the higher international financial integration.

⁶It follows that the "world" population coincides with the population of firms. We could assume that each firm is run by more than one persons but this would unnecessarily complicate the model without further insights.

⁷As in Ogura (2006), we assume that the population of entrepreneurs is heterogeneous in the degree of their attachment to the home country. The sources of this home bias can be various. For example, transferring activities abroad requires a lot of information, which can be different for each entrepreneur. Another cause can be linked to material relocation costs that can be specific to each firm.

Firms

Using one unit of capital combined with her own labor input, each entrepreneur living in country i ($i = h, f$) is able to produce y_i units of one final good. We suppose that the final good is sold in a competitive market with a price normalized to one. Consider now that the productivity in the private sector has a firm-specific component q and a part that depends on the amount of infrastructure provided in country i ($i = 1, 2$). This assumption is in accordance with empirical evidence (see for example, Easterly and Rebelo, 1993; Fernald, 1999; Fedderke and Bogetic, 2009). Consequently, we write⁸ $y_i = q + \Theta_i$, where Θ_i is the private productivity level depending on the existing infrastructure in country i ($i = 1, 2$). It follows that, other things being equal, private capital is more productive in the country that is well-endowed in public infrastructure than in the poorly endowed locations (Cai and Treisman, 2005). In other words, the jurisdiction that is more endowed with infrastructure will also be the more developed one.

Consider now firms' relocation choices under international competition. The capital owner $x \in [0, S_h]$ living in country h is indifferent between producing at home and in the foreign country f if

$$\Theta_h - t_h = \Theta_f - t_f - k(S_h - x),$$

where t_h and t_f are source-based tax rates levied on capital in countries h and f , respectively.

Similarly, a firm of type $x \in [S_h, 1]$ located in country f is indifferent between investing at home and investing abroad if

$$\Theta_h - t_h - k(x - S_h) = \Theta_f - t_f.$$

⁸We use here a linear production function but a more general technology could also be conceivable. Because capital and labor are given at the firm level, we could assume a CES type production function, $y_i = (q + \Theta_i) [\gamma K^\rho + (1 - \gamma) L^\rho]^{\frac{1}{\rho}}$ with $\gamma \in (0, 1)$. Because labor and capital are given and uniform across firms and countries we can normalize L and K to one. Consequently, the production function reduces to $y_i = q + \Theta_i$, up to a multiplicative constant.

The two above conditions yield

$$x = \frac{1}{k} ((\Theta_h - \Theta_f) + (t_f - t_h)) + S_h. \quad (1)$$

Note that if $x > S_h$, firms move from f to h . If $x < S_h$, firms move from h to f .

Governments

We now consider that the countries try to attract companies by competing in taxes and providing attractive infrastructure. In other words, the jurisdictions are able to increase the productivity of all the firms located within their respective territories by furnishing additional infrastructure denoted by θ_i ($i = h, f$). The cost of providing the amount θ_i in country $i = h, f$ is given by the quadratic cost function $C(\theta_i) = \frac{g_i}{2}\theta_i^2$, where g_i is an (in)efficiency parameter that can be different across the competing jurisdictions.

As in Hindriks et al. (2008) and Pieretti and Zanaj (2011), we suppose that the provision of one additional unit of public infrastructure increases the private productivity by one unit. Consequently, a firm's production in country $i = h, f$ equals $y_i = q + \Theta_i^0 + \theta_i$, where Θ_i^0 is the initial level of private productivity depending on the initial level of infrastructure before new public investments are decided. Note that Θ_i^0 depends on historical and natural conditions and therefore reflects the level of economic development that has been reached so far in country i . For sake of simplicity, we set $\Theta_h^0 = 1$ and write $\Theta_f^0 = \beta\Theta_h^0 = \beta > 0$, where the ratio β reflects the difference in initial development between the two economies. Without loss of generality, we assume that country h lags behind country f in terms of initial productivity. Consequently, we have $\Theta_f^0 - \Theta_h^0 = \beta - 1 > 0$. Furthermore, we set $g_f = 1$ and $g_h = g$ with $g \geq 1$. In other words, we assume that the advanced country is at least as efficient as the lagging country in providing infrastructure. For simplification, we also write $S_h = S$ and $S_f = 1 - S$, since that $S_h + S_f = 1$. Note that the small (large) country is the lagging one if $0 < S < \frac{1}{2}$ ($1 > S > \frac{1}{2}$).

According to equation (1), we can write

$$x = \frac{1}{k} [(1 - \beta) + (\theta_h - \theta_f) + (t_f - t_h)] + S. \quad (2)$$

The jurisdictions h and f choose non-cooperatively the tax rates and infrastructure expenditures that maximize the following objective functions, respectively.⁹

$$V_h = x(y_h - t_h) + \lambda B_h \text{ and } V_f = (1 - x)(y_f - t_f) + \lambda B_f, \quad (3)$$

with $B_h = t_h x - \frac{g}{2}\theta_h^2$ and $B_f = t_f(1 - x) - \frac{1}{2}\theta_f^2$. To make calculations tractable and without changing the general messages of the present paper, we assume that $g_f = g_h$ or, $g = 1$. However, we shall briefly return to this assumption in section 4 when discussing the possible catching up of the lagging jurisdiction.

The first term in the objective function V_i ($i = h, f$) is the net national income generated in country i , which is supposed to be spent on private consumption in country i . The variable B_i ($i = h, f$) the tax revenue collected in country i net of infrastructure expenditures. If we consider that jurisdictions are not self-interested governments, we can assume that the collected taxes net of infrastructure expenditures are used to finance public consumption. The parameter $\lambda > 0$ measures the jurisdictions' preference for public relative to private consumption.

3 Inter-jurisdictional competition and catching up

To keep the analytics tractable, we first consider¹⁰ that the only goal of the governments is to maximize net public spending, which is equivalent to assuming¹¹ that $\lambda \rightarrow \infty$. In section 4, we demonstrate that the main conclusions of the paper are preserved for the

⁹The form of the above objective functions is a special case of a quasi-linear indirect utility function $V_i = x_i y_i + \lambda v(g_h)$, where $v'(g_h) > 0$ and $v''(g_h) = 0$. Note that we use the same specification as in Cai and Treisman (2005).

¹⁰For a similar assumption, see Kanbur and Keen (1993), Zissimos and Wooders (2008) and Pieretti and Zanaj (2011).

¹¹Indeed, we can write $V_i = a x_i (y_i - t_i) + b B_i$ with $x_h = x$ and $x_f = 1 - x$, where $a \geq 0$ and $b > 0$ measure respectively the preference of the governments for private and public spending. Because we can write $V_i = a [x_i (y_i - t_i) + \lambda B_i]$ where $\lambda = \frac{b}{a}$, it follows that $V_i \rightarrow B_i$ if $a \rightarrow 0$ ($\lambda \rightarrow \infty$).

general case with $\lambda > 1$. Consequently, the governments' objective functions are

$$B_h = t_h x - \frac{1}{2} \theta_h^2 \quad \text{and} \quad B_f = t_f (1 - x) - \frac{1}{2} \theta_f^2. \quad (4)$$

Hence, each jurisdiction i ($i = h, f$) is supposed to maximize its objective by choosing the appropriate tax rate t_i and infrastructure level θ_i .

3.1 Nash Equilibrium

We assume that the jurisdictions compete simultaneously in taxes and infrastructure expenditures. In the Appendix we present a sequential game in which jurisdictions compete first in infrastructure and then in taxes¹² and demonstrate that qualitatively equivalent results to the simultaneous case are derived.

The FOCs with respect to t_i and θ_i ($i = h, f$) yield a unique Nash equilibrium. The equilibrium infrastructure decisions are

$$\begin{aligned} \theta_h^* &= \frac{k(1+S) - \beta}{3k-2}, \\ \theta_f^* &= \frac{k(2-S) + \beta - 2}{3k-2}. \end{aligned} \quad (5)$$

The equilibrium tax rates are

$$\begin{aligned} t_h^* &= k\theta_h^*, \\ t_f^* &= k\theta_f^*. \end{aligned} \quad (6)$$

It is easy to check that the SOC's are satisfied if $k > \frac{1}{2}$. Hence, the above first order conditions are not only necessary, but also sufficient. The number of firms located in the country h equals $x^* = \frac{k(1+S) - \beta}{3k-2}$. It follows that firms move from the advanced country to the lagging one if $x^* - S > 0$, which occurs when $\frac{1}{2} < k < \frac{2}{3}$ and $k > \frac{\beta - 2S}{1 - 2S}$.

¹²The choice of this sequential order follows from the rule that the most irreversible decision must be made first.

Firms move from the lagging country to the more advanced if $x^* - S < 0$, which occurs when $\frac{2}{3} < k < \frac{\beta - 2S}{1 - 2S}$.

We impose $\theta_i^* > 0$, $t_i^* > 0$ and $0 < x^* < 1$. This requires that either $k > \bar{k}$, where $\bar{k} = \max \left\{ \frac{2}{3}, \frac{\beta}{1+S}, \frac{2-\beta}{2-S} \right\}$ or $\frac{1}{2} < k < \underline{k}$, where $\underline{k} = \min \left\{ \frac{2}{3}, \frac{\beta}{1+S}, \frac{2-\beta}{2-S} \right\}$ with $\beta > 1$. It is interesting to note that the tax and infrastructure differentials have the same sign ($\text{sign}(t_h^* - t_f^*) = \text{sign}(\theta_h^* - \theta_f^*)$). Finally, the net tax revenues are positive if the SOCs are verified. Indeed, it is easy to calculate that $B_h^* = \frac{1}{2}(\theta_h^*)^2(2k - 1) > 0$ and $B_f^* = \frac{1}{2}(\theta_f^*)^2(2k - 1) > 0$.

3.2 Catching up

Now, we analyze if tax and infrastructure competition can reduce the economic divergence between the competing countries. Two cases are considered. First, countries are supposed to be equally sized and second, they have a different size. Similar to the previous section, we assume that country h is the lagging country, or $\beta > 1$.

3.2.1 Equally sized countries

In this section, we assume that the competing countries don't differ in their population size. So we set $S = \frac{1}{2}$. To investigate whether tax and infrastructure competition can reduce the productivity gap between the advanced and the lagging countries, we have to consider the difference between the productivity gap after $(\Theta_f - \Theta_h)$ and before $(\Theta_f^0 - \Theta_h^0)$ tax cum infrastructure competition. In other words, we have to investigate the sign of $(\Theta_f - \Theta_h) - (\Theta_f^0 - \Theta_h^0) = \theta_f^* - \theta_h^*$. The productivity gap between the competing economies shrinks if $\theta_f^* - \theta_h^* < 0$. According to (5) we get $\theta_f^* - \theta_h^* = \frac{2(\beta-1)}{3k-2}$. Because $\beta > 1$, we have only to consider the value of k to determine the sign of $\theta_f^* - \theta_h^*$. If we take into account the above positivity conditions, it is easy to demonstrate that the productivity gap between the competing countries shrinks $(\Theta_f - \Theta_h < \Theta_f^0 - \Theta_h^0)$ when $\frac{1}{2} < k < \frac{2(2-\beta)}{3}$ and $1 < \beta < \frac{5}{4}$. In other words, jurisdictional competition can

contribute to a productivity catch-up¹³ between the competing jurisdictions if capital mobility is high enough and the productivity gap not too large. This contrasts with the results from traditional tax competition literature where tax competition exacerbates the productivity gap between equal-sized jurisdictions, as we argued at the beginning of the paper. Note that catching-up is consistent with capital inflow ($x^* - \frac{1}{2} > 0$) into the lagging country, whereas divergence is consistent with capital outflow ($x^* - \frac{1}{2} < 0$) from the lagging country.

The intuition underlying this result is based on the fact that the lagging jurisdiction can compete in two instruments that are chosen independently. This allows some flexibility in policy making. Because tax and infrastructure differentials have the same sign (according to equation (6)), the policy makers can choose among two different policy strategies to attract foreign firms. When the mobility cost is high ($k > \frac{2}{3}\beta$), it is more profitable for the the lagging jurisdiction to be tax attractive ($t_h^* < t_f^*$) and less attractive in terms of infrastructure ($\theta_h^* < \theta_f^*$). The reason is that low capital mobility encourages the more developed country to set high tax rates, which in turn creates an incentive for the lagging country to undercut the leading country. On the contrary, when capital is sufficiently mobile ($\frac{1}{2} < k < \frac{2(2-\beta)}{3}$), the lagging country prefers to be attractive in infrastructure ($\theta_h^* > \theta_f^*$) and not in taxes ($t_h^* > t_f^*$). In other words, the lagging country chooses to avoid fierce tax competition by switching to a different policy regime. Recognizing that engaging in a strategy of tax undercutting would eventually cause serious revenue problems, the lagging country decides to promote its attractiveness by augmenting its infrastructure provision relative to its rival. In short, the best policy choice is to be tax attractive when capital mobility is relatively low and to provide attractive infrastructure when capital mobility is relatively high.

In subsection 4.1., we show that our results are robust with respect to a more general objective function. Indeed, jurisdictional competition can also enable the lagging

¹³More precisely, it appears that the lagging country overtakes the more advanced one. However, if we assume, as may be expected, that the lagging country is relatively less efficient in providing public infrastructure, there is not necessarily surpassing. We discuss this aspect in the following section.

country to catch up when the governments' objective function (see (3)) accounts for private and public consumption.

We can now state the following proposition.

Proposition 1 *When the competing economies are identical in size, jurisdictional competition can induce the lagging country to catch up if capital mobility is sufficiently high and the initial productivity gap is not too large.*

This result contrasts with Cai and Treisman (2005) where tax competition *always* increases divergence between jurisdictions for any difference in initial endowments.

3.2.2 Unequally sized countries

Now, we consider two unequally sized countries. We still assume that h is the lagging country ($\beta > 1$), which can be small ($0 < S < \frac{1}{2}$) or large ($S > \frac{1}{2}$). The change in the productivity gap induced by tax cum infrastructure competition is given by $(\Theta_f - \Theta_h) - (\Theta_f^0 - \Theta_h^0) = \theta_f^* - \theta_h^*$. Consequently, we obtain

$$\theta_f^* - \theta_h^* = \frac{2(\beta - 1)}{3k - 2} + \frac{k(1 - 2S)}{3k - 2}. \quad (7)$$

The result shows that size asymmetry matters when we investigate the role of fiscal competition on the productivity gap across countries.

Firstly, we consider that the lagging is relatively small, $0 < S < \frac{1}{2}$. In this case, the impact of jurisdictional competition on economic catch-up is increased compared to size symmetry.

We observe that size asymmetry reinforces the impact of tax cum infrastructure competition on productivity catching-up if $\frac{1}{2} < k < \frac{2}{3}$ (the second term of (7) is negative), while it reinforces the impact on productivity divergence if $k > \frac{2}{3}$ (the second term of (7) is positive).

These effects can be explained as follows. In case of high capital mobility ($\frac{1}{2} < k < \frac{2}{3}$), the lagging country can avoid fierce tax competition by increasing its infrastructure provision. If the lagging country is small, this effect is even stronger. To understand why this is the case, assume for a moment a uniform level of productivity across the competing jurisdictions but unequal country sizes.

According to the standard tax competition literature small countries face more elastic tax bases than larger countries if tax rates are uniform. Consequently, small jurisdictions undercut larger rivals. However, if the small country provides sufficiently more infrastructure than its larger rival, the capital elasticity it faces will decrease to such an extent that tax dumping becomes needless (see Pieretti and Zanaj, 2011). Consequently, if capital mobility is high enough, a small lagging country will be attractive in infrastructure provision more than in case of size symmetry.

However, if capital mobility is relatively low ($k > \frac{2}{3}$), a small lagging country will favor tax competitiveness, but more intensively than in case of size symmetry. This follows again from the elasticity rule that was highlighted above.

Taking into account the positivity condition on θ_i and t_i ($i = h, f$), which implies $\frac{1}{2} < k < \underline{k}$, we conclude that tax cum infrastructure competition induces international productivity catch-up ($\theta_f^* - \theta_h^* < 0$) if capital mobility is high enough ($\frac{1}{2} < k < \frac{2-\beta}{2-S}$) and the productivity lag is not too high ($\beta < 1 + \frac{S}{2}$).

We can now state the following proposition

Proposition 2 *When the lagging country is small,*

- (a) *inter-jurisdictional competition can induce international productivity catch-up if capital mobility is sufficiently high and the productivity gap is not too large;*
- (b) *the smaller the lagging country the more inter-jurisdictional competition will promote catching up if capital mobility is high enough and the initial lag not too high.*

Consider now the case where the lagging country is large, $\frac{1}{2} < S < 1$. Then, the effect of jurisdictional competition on catch-up and divergence is weaker than in case of size symmetry. Indeed, in this case, the elasticity rule we just highlighted makes the lagging jurisdiction less responsive in infrastructure provision when capital mobility is high and less tax aggressive when capital mobility is low.

Taking into account the positivity condition on θ_i and t_i ($i = 1, 2$), which implies $\frac{1}{2} < k < \underline{k}$, we can conclude that there is catching up only if $\frac{1}{2} < k < \min \left\{ \underline{k}, \frac{2(\beta-1)}{2S-1} \right\}$. Particularly, if the initial gap is small enough, $\beta < \frac{2(1+S)}{3}$, the catch-up condition is $\frac{1}{2} < k < \frac{2(\beta-1)}{2S-1}$.

We can now state the following proposition

Proposition 3 *When the lagging country is large,*

- (a) *inter-jurisdictional competition can enable the lagging jurisdiction to catch up if capital mobility is sufficiently high and the productivity gap is not too large;*
- (b) *size asymmetry weakens the effect of inter-jurisdictional competition on productivity catch-up.*

The result indicates that size matters when we analyze whether inter-jurisdictional competition is able to promote economic catch-up. In particular, when the lagging economy is large, size asymmetry mitigates the effect of international competition on economic catch-up. This is at odds with the case when the lagging country is small.

Finally, contrary to Cai and Treisman (2005) who find that regional inequality increases when capital becomes highly mobile, we demonstrate the opposite, namely that the development gap widens when capital becomes less mobile.

4 Extensions and discussion

In this section, we discuss different assumptions we made until now. Firstly, let us now consider a more general governmental objective function by assuming $\lambda > 1$ instead of the special case $\lambda \rightarrow \infty$. Secondly, we now allow for efficiency heterogeneity in infrastructure provision across the competing jurisdictions.

4.1 Extended objective functions

Let us assess the robustness of the above results when the governments' objective function includes private and public consumption. Therefore, assume that the jurisdictions h and f choose tax rates and infrastructure expenditures that maximize the following objective functions

$$V_h = x(y_h - t_h) + \lambda B_h \text{ and } V_f = (1 - x)(y_f - t_f) + \lambda B_f \quad (8)$$

with $\lambda > 1$.

Next, we deduce conditions that enable the lagging country to catch up. First, we solve the game when the jurisdictions compete simultaneously in their strategic variables. In the Appendix, we address the case where the policy instruments are chosen sequentially.

Replacing B_i and y_i respectively by $B_i = t_i x_i - \frac{1}{2} \theta_i^2$ and $y_i = q + \Theta_i^0 + \theta_i$ ($i = h, f$, $x_h = x$ and $x_f = 1 - x$) in (8) and substituting (2) for x , it is convenient to demonstrate that the above objective functions are concave in t_i and θ_i if $k > \frac{\lambda}{2(\lambda-1)}$ with $\lambda > 1$. Solving the game, yields a unique Nash equilibrium in pure strategies characterized

by the following equilibrium values¹⁴

$$\begin{aligned}\theta_h^* &= \frac{k(1+S)(\lambda-1) - \lambda\beta}{3k(\lambda-1) - 2\lambda}, \\ \theta_f^* &= \frac{k(2-S)(\lambda-1) + \lambda(\beta-2)}{3k(\lambda-1) - 2\lambda}.\end{aligned}$$

The equilibrium number of moving firms is

$$x^* = \frac{k(1+S)(\lambda-1) - \lambda\beta}{3k(\lambda-1) - 2\lambda} = \theta_h^*.$$

Furthermore, it appears that

$$\theta_f^* - \theta_h^* = \frac{2(\beta-1)\lambda}{3k(\lambda-1) - 2\lambda} + \frac{k(1-2S)(\lambda-1)}{3k(\lambda-1) - 2\lambda}$$

and

$$t_h^* - t_f^* = k \frac{3\beta - 2(S+1)}{3k(\lambda-1) - 2\lambda} + k(\theta_h^* - \theta_f^*).$$

For simplicity and without loss of generality, we only consider the symmetric case, $S = \frac{1}{2}$. The productivity gap becomes

$$\theta_f^* - \theta_h^* = \frac{2\lambda(\beta-1)}{3k(\lambda-1) - 2\lambda}.$$

Taking account of the above concavity condition and the positiveness conditions on θ_h^* , θ_f^* , t_h^* and t_f^* , it is convenient to prove¹⁵ that the lagging country catches up ($\theta_f^* - \theta_h^* < 0$) iff $\frac{\lambda}{2(\lambda-1)} < k < \frac{2(2-\beta)}{3}$ when λ is sufficiently larger than 1 and $1 < \beta < \frac{5}{4}$. In other words we recover a result which is in line with Proposition 1.

Finally, we can write $t_h^* - t_f^* = \Psi + \frac{3k}{2}(\theta_h^* - \theta_f^*)$ with $\Psi = \frac{3k(\beta-1)}{3k(\lambda-1)-2\lambda}$, where $\Psi < 0$ when $\theta_h^* > \theta_f^*$. Consequently, $\theta_h^* > \theta_f^*$ does not necessarily imply $t_h^* > t_f^*$, which is the case when $\lambda \rightarrow \infty$.

¹⁴Note that at equilibrium, we have $B_i > 0$ ($i = h, f$) for sufficiently large λ .

¹⁵The proofs are provided on request.

4.2 Efficiency heterogeneity

Now we analyze how efficiency heterogeneity in public provision impacts the equilibrium values of the model. To this purpose, we assume that the lagging country is relatively less efficient in providing public infrastructure. Hence, the objective functions become $B_h = t_h x - \frac{g}{2} \theta_h^2$ and $B_f = t_f(1 - x) - \frac{1}{2} \theta_f^2$, with $g > 1$.

For sake of simplification we assume that $S = \frac{1}{2}$. Furthermore, we confine ourselves to the case where jurisdictions maximize net tax revenue (public consumption) and compete simultaneously in taxes and infrastructure. The following equilibrium values can be deduced

$$\begin{aligned}\theta_h^* &= \frac{\frac{3}{2}k - \beta}{3gk - (1 + g)}, \\ \theta_f^* &= \frac{g\left(\frac{3}{2}k + \beta - 1\right) - 1}{3gk - (1 + g)}.\end{aligned}$$

Hence, the difference in the amount of infrastructure provision is

$$\theta_f^* - \theta_h^* = \frac{(1 + g)(\beta - 1)}{(3gk - (1 + g))} + \frac{3k(g - 1)}{2(3gk - (1 + g))}.$$

Because $\theta_i^* > 0$, $t_i^* > 0$ and $0 < x^* < 1$, we require that, either $k > \bar{k}$, where $\bar{k} = \max\left\{\frac{1+g}{3g}, \frac{2\beta}{3}, \frac{2(1-g(\beta-1))}{3g}\right\}$ or $\frac{1}{2} < k < \underline{k}$, where $\underline{k} = \min\left\{\frac{1+g}{3g}, \frac{2\beta}{3}, \frac{2(1-g(\beta-1))}{3g}\right\}$ with $\beta > 1$.

It follows that $\Theta_f - \Theta_h = (\theta_f^* - \theta_h^*) - (\beta - 1) = -(\beta - 1) \frac{3gk - 2(1+g)}{3gk - (1+g)} + \frac{\frac{3}{2}k(g-1)}{3gk - (1+g)}$. Therefore, catching-up does not necessarily mean that the lagging jurisdiction will surpass its ($\Theta_f - \Theta_h < 0$) rival. Indeed, if $k < \frac{2[1-g(\beta-1)]}{3g}$, the difference $\Theta_f - \Theta_h$ can be positive if g is high enough.

5 Conclusions

In this paper, we investigate whether tax and infrastructure competition can induce less developed jurisdictions to catch up with more developed ones. To this aim, we employ a game-theoretical approach where jurisdictions, that are asymmetric in size and in initial infrastructure endowments, compete for international capital that is imperfectly mobile.

Our results suggest that tax cum infrastructure competition can enable a lagging jurisdiction to catch up if capital mobility is high enough and the initial productivity gap is not too large. This qualifies the main conclusion of Cai and Treisman (2005) who argue that inter-jurisdictional competition always widens the productivity gap if capital is perfectly mobile.

One key element of our model is the existence of flexibility in policy-making, which is enabled by the use of two independent competition instrument. When capital mobility is low the best policy of the lagging country is to favor tax under-cutting instead of infrastructure over-bidding. As a result, this widens the already existing productivity gap among the competing jurisdictions. When capital mobility is sufficiently high, the lagging country adopts a policy switch, which favors infrastructure over-bidding. The resulting effect is catching-up.

Our paper also demonstrates that size asymmetry among countries may reinforce or weaken the effect of inter-jurisdictional competition on the initial productivity gap.

In this paper we analyzed the effect of inter-jurisdictional competition on the productivity gap of competing economies within a static model. This is surely a limitation of the analysis because it provides little information about the time trajectories of the productivity asymmetry among countries. In particular, we did not answer important questions about long-run convergence or divergence and the existence of possible steady states and the way to reach them. In a future work these issues should be addressed within a dynamic extension of our model.

References

- [1] Bucovetsky S., 1991. Asymmetric Tax Competition. *Journal of Urban Economics* 30, 167–181.
- [2] Cai H.B. and D. Treisman, 2005. Does competition for capital discipline governments? Decentralization, globalization, and public policy. *American Economic Review* 95(3), 817-830.
- [3] Easterly W. and S. Rebelo, 1993. Fiscal policy and economic growth: an empirical investigation. *Journal of Monetary Economics* 32, 417-458.
- [4] Ezcurra R. and P. Pascual, 2008. Fiscal decentralization and regional disparities: evidence from several European Union countries. *Environment and Planning A* 40(5), 1185-1201.
- [5] Fuest C., 1995. Interjurisdictional competition and public expenditure: is tax coordination counterproductive? *Finanzarchiv* (52), 478-496.
- [6] Fernald J.G., 1999. Roads to prosperity? Assessing the link between public capital and productivity. *American Economic Review* 89(3), 619-638.
- [7] Fedderke J.W. and Z. Bogetic, 2009. Infrastructure and growth in south Africa: direct and indirect productivity impacts of 19 infrastructure measures. *World Development* 37(9), 1522-1539.
- [8] Hindriks J., S. Peralta and S. Weber, 2008. Competing in taxes and investment under fiscal equalization. *Journal of public economics* 92, 2392-2402.
- [9] Hauptmeier S., F. Mittermaier and J. Rincke, 2012. Fiscal competition over taxes and public inputs. *Regional science and urban economics* 42, 407-419.
- [10] Kanbur, R., and M. Keen, 1993. Jeux Sans Frontières: Tax competition and tax coordination when countries differ in size. *American Economic Review* 83, 877–893.

- [11] Keen M. and M. Marchand, 1997. Fiscal competition and pattern of public expenditure. *Journal of public economics* 66, 33-53.
- [12] Ogura L.M., 2006. A note on tax competition, attachment to home, and underprovision of public goods. *Journal of Urban Economics* 59, 252-258.
- [13] Pieretti P. and S. Zanaj, 2011. On tax competition, public goods provision and jurisdictions' size. *Journal of international economics* 84, 124-130.
- [14] Rodríguez-Pose A., and R. Ezcurra, 2010. Does decentralization matter for regional disparities? A cross-country analysis. *Journal of Economic Geography* 10(5), 619-644.
- [15] Sorens J., 2014. Does Fiscal Federalism Promote Regional Inequality? An Empirical Analysis of the OECD, 1980–2005. *Regional Studies* 48, 239-253.
- [16] Thomas K.P., 2007. Investment incentives: Growing use, uncertain benefits, uneven controls. The Global Subsidies Initiative (GSI) of the International Institute for Sustainable Development (IISD). Geneva, Switzerland
- [17] Wildasin D.E., 1991. Some rudimentary 'duopoly' theory. *Regional Science and Urban Economics* 21, 393-421.
- [18] Wilson J.D., 1991. Tax competition with interregional differences in factor endowments. *Regional Science and Urban Economics* 21, 423-451.
- [19] Wilson, J. D., 1999. Theories of tax competition. *National Tax Journal* 52, 269–304.
- [20] Yu Y.H., L. Zhang, F.H. Li and X.Y. Zheng, 2011. On the determinants of public infrastructure spending in Chinese cities: A spatial econometric perspective. *The Social Science Journal* 48, 458–467.
- [21] Zissimos B. and M. Wooders, 2008. Public good differentiation and the intensity of tax competition. *Journal of public economics* 92, 1105-1121.

A Sequential game in taxes and infrastructure

In section 3, we consider a *simultaneous game* when the governments maximize tax revenues. To check the robustness of our results, we now assume that the governments choose the level of public infrastructure and tax rates *sequentially*. This choice follows from the rule that the most irreversible decision must be made first. In other words, we assume that the jurisdictions set the level of infrastructure first and then the level of tax rates. Then, we solve the game by backward induction.

A.1 Subgame perfect Nash equilibrium

Starting from the second stage, each government maximizes its objective with respect to its tax rate assuming its rival's rate as given. The first order conditions yield the following unique equilibrium in tax rates

$$t_h^* = \frac{1 - \beta + k(1 + S_h) - \theta_f + \theta_h}{3}, \quad t_f^* = \frac{\beta - 1 + k(2 - S_h) + \theta_f - \theta_h}{3}. \quad (9)$$

The type of the firm that is indifferent in investing at home or abroad is

$$x^* = \frac{1 - \beta + k(1 + S_h) + \theta_h - \theta_f}{3k}.$$

After substituting the above tax rates into the jurisdictions' objective functions we can solve the game for stage 1, when the governments compete in public infrastructure. The first order conditions lead to the unique equilibrium in public inputs

$$\theta_h^* = \frac{2 \ 3k(1 + S) - (3\beta - 1)}{9k - 4}, \quad \theta_f^* = \frac{2 \ 3k(2 - S) + 3(\beta - 1) - 2}{9k - 4}. \quad (10)$$

Introducing (10) into (9) yields the equilibrium values

$$t_h^* = \frac{k[3k(1 + S_h) + 1 - 3\beta]}{9k - 4}, \quad t_f^* = \frac{k[3k(2 - S_h) - 5 + 3\beta]}{9k - 4}.$$

It is easy to see that

$$t_h^* = \frac{3k}{2}\theta_h^*, t_f^* = \frac{3k}{2}\theta_f^*. \quad (11)$$

The sub-game perfect Nash equilibrium is $((\theta_h^*, t_h^*), (\theta_f^*, t_f^*))$. The number of firms in country h is given by

$$x^* = \frac{3k(1 + S_h) + 1 - 3\beta}{9k - 4}.$$

Hence, the number of firms located in the country h equals $x^* = \frac{3}{2}\theta_h$. Moreover, when $k > \frac{2}{9}$, the budgets B_i ($i = h, f$) are strictly concave in θ_i ($i = h, f$). Consequently, the first order conditions are not only necessary, but also sufficient.

A.2 Non-negativity conditions

We now analyze under which conditions we can impose $\theta_i^* \geq 0, t_i^* \geq 0, (i = h, f)$ and $0 < x^* < 1$. From (10), it is easy to see that $\theta_h^* \geq 0$ and $\theta_f^* \geq 0$ if and only if one of the following conditions hold: either

$$k \geq \frac{3\beta - 1}{3(1 + S_h)} \quad \text{and} \quad k \geq \frac{5 - 3\beta}{3(2 - S_h)},$$

when the denominators are positive, i.e., $k > \frac{4}{9}$, the numerators are positive; or

$$k \leq \frac{3\beta - 1}{3(1 + S_h)} \quad \text{and} \quad k \leq \frac{5 - 3\beta}{3(2 - S_h)},$$

when the denominators are negative, i.e., $k < \frac{4}{9}$, the numerators are negative.

We can deduce the following conditions on the initial productivity gap β .

(a) when $k > \frac{4}{9}$, the condition on β is

$$\frac{5}{3} + k(S_h - 2) \leq \beta \leq k(1 + S_h) + \frac{1}{3};$$

(b) when $\frac{2}{9} < k < \frac{4}{9}$, the condition on β is

$$k(1 + S_h) + \frac{1}{3} \leq \beta \leq \frac{5}{3} + k(S_h - 2).$$

Notice that when the conditions (a) and (b) are verified, we have $x^* \in (0, 1)$.

In short, non-negativity of the policy instruments requires that $\frac{2}{9} < k < \underline{k}$, where $\underline{k} = \min \left\{ \frac{4}{9}, \frac{3\beta-1}{3(1+S)}, \frac{5-3\beta}{3(2-S)} \right\}$, or $k > \bar{k}$, where $\bar{k} = \max \left\{ \frac{4}{9}, \frac{3\beta-1}{3(1+S)}, \frac{5-3\beta}{3(2-S)} \right\}$.

A.3 Inter-jurisdictional competition and catching up

Now, we analyze under which conditions tax and infrastructure competition can reduce the productivity gap between unequally developed countries. According to the above results we readily get

$$\theta_f^* - \theta_h^* = \frac{4(\beta - 1)}{9k - 4} + 2\frac{k(1 - 2S)}{9k - 4}. \quad (12)$$

First, we consider that the competing countries are equally sized.

In this case, it is convenient to show that the productivity gap between the competing jurisdictions narrows ($\theta_f^* - \theta_h^* < 0$) when $k \in \left(\frac{2}{9}, \frac{2(5-3\beta)}{9} \right)$ and $1 < \beta < \frac{4}{3}$. However, if $k > \frac{2(3\beta-1)}{9}$ the productivity gap widens.

Let us then turn to the more general case where the competing countries can be uneven in their population size. We still assume that country h is lagging behind country f .

Similar to the case of simultaneous competition in taxes and infrastructure, we see that the impact of jurisdictional competition is magnified compared to the case of size equality if the lagging country is relatively small ($0 < S < \frac{1}{2}$). The effect of jurisdictional competition is however mitigated when the lagging country is the larger one ($1 > S > \frac{1}{2}$). The underlying intuition is similar to the case where jurisdictions compete simultaneously.

Taking into account expression (12) and the positivity conditions on taxes and infrastructure provisions we can state the following result. Tax and infrastructure competition helps the lagging country h to catch up in terms of productivity if capital mobility is high enough ($\frac{2}{9} < k < \underline{k}$) and the productivity gap not too large. If the lagging country is the smaller one, there is catching up if $\frac{2}{9} < k < \frac{5-3\beta}{3(2-S)}$ and $1 < \beta < \frac{11}{9} + \frac{2S}{9}$.

Finally, we briefly address the case where the lagging country is the larger one. There is catch-up if $k < \min\{\underline{k}, \frac{2(\beta-1)}{2S-1}\}$. Furthermore, if the initial gap is small enough, $\beta < \frac{2(S+1)}{3}$, the catch-up condition is $\frac{2}{9} < k < \frac{2(\beta-1)}{2S-1}$.

B Sequential game with extended objectives

In section 4, we assume that the governments maximize the following objectives

$$V_h = x(y_h - t_h) + \lambda B_h \text{ and } V_f = (1 - x)(y_f - t_f) + \lambda B_f,$$

while competing *simultaneously* in two instruments.

To check the robustness the results in section 4, we now analyze a *sequential game*. In a first stage, jurisdictions compete in infrastructure and then in tax rates. It is then convenient to demonstrate that the objective functions are concave in the two strategic variables if $k > \frac{2\lambda}{9(\lambda-1)}$ with $\lambda > 1$.

Solving the game yields a sub-game perfect equilibrium characterized by the following equilibrium values.

$$\begin{aligned} t_h^* &= \frac{2(5 + 3\beta)\lambda + 3k((\lambda - 1))(-11 - 2S + 3k(1 + S)(\lambda - 1) - \lambda(3\beta - 1))}{3(\lambda - 1)[9k(\lambda - 1) - 4\lambda]}, \\ t_f^* &= \frac{3k(-4 + 2S + 3\beta(\lambda - 3) - 5\lambda)(\lambda - 1) + 9k^2(2 - S)(\lambda - 1)^2 + 2(5 + 3\beta)\lambda}{3(\lambda - 1)[9k(\lambda - 1) - 4\lambda]}, \\ \theta_h^* &= \frac{2}{3} \frac{3k(1 + S)(\lambda - 1) - \lambda(3\beta - 1)}{9k(\lambda - 1) - 4\lambda}, \\ \theta_f^* &= \frac{2}{3} \frac{3k(2 - S)(\lambda - 1) + \lambda(3\beta - 5)}{9k(\lambda - 1) - 4\lambda}. \end{aligned}$$

The number firms that move equals

$$x^* = \frac{3k(1+S)(\lambda-1) - \lambda(3\beta-1)}{9k(\lambda-1) - 4\lambda} = \frac{3}{2}\theta_h^*.$$

Furthermore, we have

$$\theta_f^* - \theta_h^* = \frac{4(\beta-1)\lambda}{9k(\lambda-1) - 4\lambda} + \frac{2k(1-2S)(\lambda-1)}{9k(\lambda-1) - 4\lambda}$$

and

$$t_h^* - t_f^* = k \frac{-4S + 9\beta - 7}{9k(\lambda-1) - 4\lambda} + \frac{3k}{2} (\theta_h^* - \theta_f^*).$$

For simplicity and without loss of generality, we only consider the symmetric case $S = \frac{1}{2}$. The ex post productivity gap becomes

$$\theta_f^* - \theta_h^* = \frac{4(\beta-1)\lambda}{9k(\lambda-1) - 4\lambda}.$$

Together with the positiveness and concavity conditions, it is convenient to prove¹⁶ that there is catch-up ($\theta_f^* - \theta_h^* < 0$) if $\frac{2\lambda}{9(\lambda-1)} < k < \frac{2(5-3\beta)}{9}$, when λ is sufficiently larger than 1 and $1 < \beta < \frac{4\lambda-5}{3(\lambda-1)}$. It follows that this result is consistent with Proposition 1.

Finally, note that $t_h^* - t_f^* = \Omega + \frac{3k}{2} (\theta_h^* - \theta_f^*)$ with $\Omega = \frac{9k(\beta-1)}{9k(\lambda-1)-4\lambda}$ where $\Psi < 0$ when $\theta_h^* > \theta_f^*$. Consequently, $\theta_h^* > \theta_f^*$ does not necessarily imply $t_h^* > t_f^*$.

¹⁶The proofs are provided on request.