FACULTY OF LAW, ECONOMICS AND FINANCE

CREA Discussion Paper

2018-10

Economics

Center for Research in Economics and Management
University of Luxembourg

Tax Competition – An intertemporal perspective

available online : http://wwwfr.uni.lu/recherche/fdef/crea/publications2/discussion_papers

Nora Paulus, CREA, University of Luxembourg
Patrice Pieretti, CREA, University of Luxembourg
Benteng Zou CREA, University of Luxembourg

April, 2018

For editorial correspondence, please contact: crea@uni.lu
University of Luxembourg
Faculty of Law, Economics and Finance
162A, avenue de la Faïencerie

UNIVERSITÉ DU LUXEMBOURG

Tax Competition - An intertemporal perspective

Nora Paulus, Patrice Pieretti, Benteng Zou
CREA, University of Luxembourg

162A, avenue de la Faïencerie, Luxembourg, L-1511

Abstract

The paper focuses on intertemporal tax competition between jurisdictions that differ in size. Given that the existing literature is mainly based on static models, it is interesting to investigate which new insights tax competition in an intertemporal setting may provide. In this respect, how does the fact that agents anticipate possible future changes, once they moved capital abroad, modify their behavior and the tax policy of the competing jurisdictions? Does tax competition become more intense? Are capital outflows and tax losses incurred by high tax jurisdictions exacerbated ?

To answer these questions, we assume that a small and a large country compete for internationally mobile capital within a two-period model. We demonstrate that tax competition is less fierce in an intertemporal setting relative to a static one. It also appears that the tax loss of the large country induced by tax competition is higher relative to a static model. This means that tax competition becomes more deleterious for the country that suffers from capital outflows.

Keywords: Intertemporal tax competition, Mobile capital, Home attachment, Country size asymmetry

JEL classification: F21, H21, H73

1 Introduction

The existing literature on tax competition among jurisdictions of uneven size is mainly based on static models (see for example Bucovetsky, 1991; Kanbur and Keen, 1993 and Trandel, 1994). Does tax competition within an intertemporal setting provide new insights relative to atemporal models? In this respect, several questions arise. Does the fact that agents anticipate possible future changes once they moved capital abroad modify their behavior and the tax policy of the competing jurisdictions? Does tax competition become more intense? Are capital outflows and tax losses incurred by high tax jurisdictions exacerbated ? To answer these questions, we add a temporal dimension to the analysis of tax competition among jurisdictions.

The intertemporal aspect of tax competition has already been addressed in different publications. Wildasin (2003, 2011) analyses competition for capital in a dynamic framework and highlights the importance of endogenously determined adjustment costs. However, in his model agents don't have to anticipate future tax changes because competition unfolds under a tax-invariant framework that is exogenously given. Han et al. (2013, 2014) analyze dynamic tax competition within a differential-game setting. The mobile firms are assumed to be heterogenous in their attachment to home and these preferences are updated after each period. This helps to understand why tax rates change over time but the investors and the governments are myopic and thus don't care about possible future changes induced by preference updates. Ferret et al. (2016) examine the effects of government policies on the relocation of foreign direct investment from one period to the next, given that the "geography" (for example market size, population growth and improvements in local infrastructure) of one jurisdiction changes over time. By adding a second period to their model, they give the firms the possibility to relocate and the governments the possibility to change their offers to the firms after the first period. Although the aim of this contribution is close to ours, there are major differences. First, contrary to Ferret et al. (2016) in which all firms are identical, we introduce heterogeneity among the agents by assuming different preferences for investing abroad. This is justified by the fact that the investors don't have the same access to information specific to the foreign destination of their capital movements. Second, in Ferret et al. (2016) the tax rates don't result from a strategic game between two neighboring jurisdictions. The authors determine the tax rates set by one country in order to attract or to retain firms, but they don't model the reaction of the other country. Between the two neighboring jurisdictions, no interaction regarding their tax policies takes place. In our model, the tax rates are endogenously determined. Each government maximizes its tax revenues given that firms' location decisions depend on the chosen tax rates of both countries.

The model we develop has the following features. Two jurisdictions of unequal size attempt to attract firms by competing in taxes. The size is determined by the number of capital owners initially located in each jurisdiction. The governments of the competing jurisdictions maximize their tax revenues relative to their respective tax rates.

We introduce heterogeneity among the capital owners by assuming that they are different in their reluctance to invest in a foreign country. This last assumption is empirically validated by recent research dealing with the home bias in investment decisions (see, for example, Feldstein and Horioka, 1980; French and Poterba, 1991; Tesar and Werner, 1995). Levis et ali. (2016) provide evidence that the "home bias" exists not only in equity markets but also in foreign investment decisions of domestic investors. Important sources of investors' reluctance to invest abroad are informational asymmetries (Ahearne et al., 2004) regarding the investment destination. According to Levis et ali. (2015), "investors might find it more difficult to gather information on more 'distant' investment possibilities". Consequently, transferring activities abroad requires a lot of information that increases transaction costs.

As in Ferret et al. (2016), the world in our model lasts for two periods. Moreover, we assume that the investors' home preference decreases in the second period if they already invested abroad in the first period. In the first period, the capital owners who want to transfer activities abroad have to gather information about the destination country. This in turn increases transaction costs, as well as the time needed to set up a firm. After the first period, the investors who moved capital in a foreign location where they set up a firm acquire more country-specific information about economic conditions such as laws and regulations, local culture and institutional arrangements. Consequently, their initial information disadvantage can diminish or even disappear over the years. This is consistent with Van Nieuwerburgh and Veldkamp (2009) who use a similar assumption and criticize the information-based theory of the home bias, which assumes that investors are unable to learn about foreign firms.

The main results of the paper can be summarized as follows. First, we show that forward-looking governments facing forward-looking investors have no incentive to change their taxation policy from one period to the next. In other words, the governments' taxation policies remain stable trough time. This results from rational decisions and is not an assumption. Moreover, we demonstrate that the capital owners have no incentive to relocate their capital from one country to the other between the two periods. If an investor invests his capital in his home country in the first period, he will do the same in the second period. The same scenario holds for an investor who invests his capital abroad. A second message is that interjurisdictional tax competition is less intense in a multi-period approach. Despite this, the impact of tax competition on capital relocation is more important in an intertemporal setting relative to a static one. The reason can be explained as follows. Since forward-looking agents expect to gain in information about a foreign destination when they move capital abroad (for example, they become more accustomed to new institutional environments), the value of their future attachment to home decreases. Consequently, more capital owners will find it advantageous to invest capital in the low tax country. Finally, we note that the tax loss of the high tax country induced by tax competition is more important within a temporal setting with forward-looking agents. Consequently, tax competition is more deleterious for the large country in an intertemporal setting.

Our paper is organized as follows. The next section models intertemporal tax competition between two countries of asymmetric size. Section 3 characterizes as a benchmark the case of a one-shot game between competing governments for internationally mobile capital. In Section 4 we solve a two-period tax game with forward-looking agents. Section 5 concludes.

2 The model setting

Suppose that the world is composed of two jurisdictions of uneven size, denoted by h (home) and f (foreign). The two jurisdictions are defined on an interval $[0,1]$. There are two types of agents living in both jurisdictions, workers and capital owners. Labour is internationally immobile while capital is imperfectly mobile. Contrary to the workers, the capital owners are endowed with an initial quantity of capital they can invest in their home-country or abroad. Let us denote by $k^{i,j}$ the amount of capital owned by an individual in country $i = h, f$ who invests in country $j = h, f$ and l^j the labour supply of one worker in country $j = h, f$. We assume that the labour supplied by one worker is given and the same across the jurisdictions. This means that $l^j = l$. Given the fact that every individual is endowed with the same quantity of capital, we can write $k^{i,j} = k$. One homogenous good is produced that is sold in a competitive market at a given price normalized to one. Each firm of country $j = h, f$ produces q^j units of this good according to a Leontief production function $q^j = f(k, l) = \min\{ak, bl\}$ with k units of capital and l units of labour. The technological coefficients a and b are positive with $a > 1$. Throughout the paper we assume that capital is the limiting factor, which means that $ak < bl$. It follows that labour is provided in excess of demand and the wage rate tends to the lowest bound that equals the level required for subsistence or the legal minimum. In other words, we can write, $q^j = ak$. Production in excess of capital replacement and tax payments is consumed by the capitalists and the workers.

The capital owners are evenly distributed with unit density on a segment $[0, 1]$. The mass of capital owners in country h is s and and $1 - s$ in country f. We shall refer to s and $1 - s$ as being the size of the countries h and f. In the sequel we set $s < \frac{1}{2}$, which means that the home country is small relative to the foreign country. More precisely, the small country extends from 0 to s and the larger from s to 1. It follows that the geometric border is given at s on the interval of unit length. The capital owners are supposed to be heterogenous in the degree of their reluctance to invest in a foreign country. In other words, we assume that the investors have different preferences for investing abroad. The "closer" the investors are to the border separating the countries h and f, the less reluctant to invest abroad they are. More precisely, a capitalist of type $x \in [0, 1]$ who invests one unit of capital abroad incurs a "moving" cost (disutility) $|x - s|$. The difference $|x - s|$ is the “distance” between the border s and the individual of type x.

The world lasts for two periods, labelled 1 and 2. The two competing jurisdictions maximize the present value of their respective tax revenues and the capital owners maximize the present value of their after tax profits. The discount factor $\rho\,(1 > \rho > 0)$ is supposed to be the same for the competing governments and all the investors.

As we highlight above, we assume that the capital owners' reluctance to keep on investing abroad weakens in the second period if they invested abroad in the first period. In the second period, the disutility of these agents will thus be lower relative to the first period. More precisely, all capital owners of type x who continue investing abroad in the second period incur a disutility of $|x - s| - \beta$ in the second period with $0 < \beta \leqslant |x - s|$. The disutility to continue investing abroad in the second period decreases with β. The parameter β captures the investors' ability to adapt to a new institutional environment.

The government of country $j = h, f$ levies a tax τ^j that is proportional to the profits generated within its jurisdiction. Consequently, the net income per capita earned in country j by a capital owner of type x equals $(1-\tau^j)a\ k$.

3 The benchmark case: the one-shot tax game.

Before analyzing how time impacts tax competition relative to a static model, we develop a one-shot game as a benchmark case. We thus assume that the world lasts for only one period and the investors characterized above decide where to set up a firm by investing their capital. It follows that an investor, who lives, for example, in country h earns $(1-\tau^h)a\ k$ if she invests k units of capital at home and $(1-\tau^f)a\ k-(s-x)\,k$ if capital is invested in country f, given that $(s-x)$ is the disutility incurred by investing abroad. For sake of simplicity, we normalize k to 1. The investor is indifferent between investing in h or f if

$$(1-\tau^h)a = \left(1-\tau^f\right)a-(s-x)\,.$$

An investor living in the large country f is indifferent between investing at home and investing abroad if

$$\left(1-\tau^f\right)a = \left(1-\tau^h\right)a-(x-s)\,.$$

The above two conditions yield the same value

$$x = a\left(\tau^f-\tau^h\right)+s. \tag{1}$$

It follows that capital can move from country h to f $(s>x)$ or from f to h $(s<x)$, depending on the value of both countries' tax rates τ^h,τ^f. In other words, the number of firms (capital) moving from country h to f equals $(s-x)$ and $(x-s)$ if firms (capital) move from f to h.

We now assume that the jurisdictions attempt to attract firms by competing in taxes. The policymakers of the two competing jurisdictions h and f choose noncooperatively the tax rates that maximize their total tax revenue T^j.The assumption that the governments maximize their tax revenue can also be found in Kanbur and Keen (1993), Trandel (1994), and Pieretti and Zanaj (2011). This is consistent with a welfarist view in which individuals put a very high marginal valuation on public goods which are financed by tax revenue (see Kanbur and Keen, 1993). It follows that :

$$\underset{\tau^j}{Max} T^j = \tau^j \cdot Q^j, \tag{2}$$

where $Q^h = xa$ and $Q^f = (1-x)a$ represent the total amount of output produced in jurisdiction h and f, respectively. Because the objective functions are concave in their own tax rates, the first order conditions yield the following equilibrium rates.

$$\tau^h = \frac{1+s}{3a}, \tag{3}$$

$$\tau^f = \frac{2-s}{3a}. \tag{4}$$

Let us denote by ϕ the difference between the tax rates set by both governments. It is straightforward to show that $\phi = \tau^f - \tau^h = \frac{1-2s}{3a} > 0$ for $s < \frac{1}{2}$. In other words, the small country undercuts the tax rate of the large country. This is in line with standard findings (see Bucovetsky, 1991, Kanbur and Keen, 1993, and Trandel, 1994). Futhermore, if the size asymmetry between the competing countries increases (lower s), the tax rate will increase in the large jurisdiction and decrease in the small jurisdiction. Consequently, a higher size asymmetry intensifies tax competition. The reason is that the tax elasticity of the tax base decreases in the large country and increases in the small country[1].

By plugging (3) and (4) in (1), we obtain the marginal investor who is indifferent between investing in h or in f:

$$x = \frac{1+s}{3}. \tag{5}$$

This is at the same time the number of firms producing in country h. It is straightforward to show that $x > s$ for any $s < \frac{1}{2}$. Consequently, there are $x - s = \frac{1-2s}{3}$ investors of the large country f who set up a firm in the small country h. Note that capital outflows increase when the size of the small jurisdiction is decreased.

The equilibrium tax revenues in countries h and f are $T^h = \frac{(1+s)^2}{9}$ and $T^f = \frac{(2-s)^2}{9}$, respectively. The joint tax revenue becomes

$$T = \frac{5-2s(1-s)}{9}. \tag{6}$$

It follows that if the size asymmetry (lower s) between the competing jurisdictions

[1] If $\epsilon^h_{\tau^h}$ and $\epsilon^f_{\tau^f}$ are the tax elasticities in countries h and f respectively, it is convenient to show that for given tax rates, $\frac{d\left|\epsilon^h_{\tau^h}\right|}{ds} < 0$ and $\frac{d\left|\epsilon^f_{\tau^f}\right|}{ds} > 0$ with $\left|\epsilon^h_{\tau^h}\right| = \frac{a\tau^h}{a(\tau^f-\tau^h)+s}$ and $\left|\epsilon^f_{\tau^f}\right| = \frac{a\tau^f}{-a(\tau^f-\tau^h)+1-s}$.

increases, there will be higher tax revenues in the large country and lower revenues in the small country. The reason is that the tax base x and the tax rate τ^h decrease in country h , while the tax base $1-x$ and the tax rate τ^f increase in country f. Moreover, higher revenues in the large country overcompensate the revenue decrease in the small country. In other words, the size effect (tax base increase in country f) induced by reducing s dominates the competition effect (increase of the tax gap $\tau^f - \tau^h$).

4 Two-period tax competition.

4.1 Spatial pattern of dynamic investment decisions

Now, we extend the above analysis by assuming that the world lasts for two periods labelled 1 and 2. The policy makers and the capital owners are assumed to be forward-looking and thus maximize the discounted value of tax revenues and after tax profits, respectively. We assume that the investors' attachment to their home-country weakens in the second period for those who already moved capital abroad in the first period. As explained above, this is due to the fact that investors gain experience in the foreign country after having moved abroad. Formally, all investors of type x who continue investing abroad in the second period incur in the second period a reduced disutility of $|x-s|-\beta$, with $0<\beta\leqslant|x-s|$. Moreover, the capital fully depreciates at the end of each period.

An individual of type x who is located in country $j=h,f$ can invest her capital in country $j'=h,f$, namely at home or abroad. At the beginning of the first period, she thus faces four possible cases. When she invests in j in period 1 and 2, the corresponding discounted profit stream equals Π_I. The discounted profit is Π_{II} when she invests in j in period 1 and in $j'\neq j$ in period 2 and Π_{III} when she invests in j' in period 1 and in $j\neq j'$ in period 2. Finally, the discounted profit is Π_{IV} when she invests j' in period 1 and 2. The different cases are summarized as follows.

$$\Pi=\begin{cases}\Pi_I=a\left(1-\tau_1^j\right)+\rho a\left(1-\tau_2^j\right),\\ \Pi_{II}=a\left(1-\tau_1^j\right)+\rho\left[a\left(1-\tau_2^{j'}\right)-|x-s|\right],\\ \Pi_{III}=a\left(1-\tau_1^{j'}\right)-|x-s|+\rho a\left(1-\tau_2^j\right),\\ \Pi_{IV}=a\left(1-\tau_1^{j'}\right)-|x-s|+\rho\left[a\left(1-\tau_2^{j'}\right)-(|x-s|-\beta)\right].\end{cases}$$

We now consider the following question. If an investor living in country $j = h, f$ decides to invest in country h or f during period 1, does she have an incentive to change the location of her investment during period 2 ? Assume that x_t is the marginal investor who is indifferent between investing at home or abroad in period t $(t = 1, 2)$.

Two cases are considered. First capital owners can invest abroad in period 1 and then repatriate their capital in period 2. The difference $|x_1 - x_2|$ is the number of capital owners that repatriate their capital in period 2. Second, capital owners can invest in their home country in period 1 and move capital abroad in period 2. In that case, the difference $|x_1 - x_2|$ is the additional number of individuals who invest abroad in period 2.

In the Appendix, we demonstrate two results. First, the small country h attracts capital from the large country f, which implies that x_1 and x_2 are larger than s. Second, no investor decides to relocate his capital in period 2, which implies that $|x_1 - x_2| = 0$.

The following lemma states these results.

Lemma 1 *(1) Capital flows from the large to the small country. (2) No forward-looking investor has an incentive to change the location of its capital in a future period.*

4.2 Equilibrium

The above lemma simplifies the resolution of the tax competition game by focusing on only two different decisional time patterns. Either investors decide to invest in their home country in the first and the second period, or they decide to invest abroad in both periods. Consequently, we only consider the profits streams Π_I and Π_{IV}. Moreover, capital flows from the large country (f) to the small (h) one. Because no investor relocates his capital in the second period, we can state that $x_1 = x_2 = x$, which results from the following arbitrage equation

$$a\left(1-\tau_1^f\right)+\rho a\left(1-\tau_2^f\right)=a\left(1-\tau_1^h\right)-(x-s)+\rho\left[a\left(1-\tau_2^h\right)-(x-s-\beta)\right].$$

This yields

$$x = \frac{1}{1+\rho}\left[s(1+\rho) + \beta\rho + a\left(\tau_1^f - \tau_1^h\right) + a\rho\left(\tau_2^f - \tau_2^h\right)\right]. \tag{7}$$

At the beginning of the first period both jurisdictions maximize the present discounted value of the total tax revenue $T^j = \tau_1^j \cdot Q_1^j + \rho \cdot \tau_2^j \cdot Q_2^j$ with respect to their own tax rates τ_1^j and τ_2^j and commit to the resulting rates. It follows that

$$\underset{\tau_1^j,\tau_2^j}{Max} T^j = \tau_1^j \cdot Q_1^j + \rho \cdot \tau_2^j \cdot Q_2^j, \qquad j = h, f, \tag{8}$$

The objective functions are concave in their own tax rates ($\frac{\partial^2 T^j}{\partial \tau_1^{j2}} = -\frac{2a^2}{1+\rho} < 0$ and $\frac{\partial^2 T^j}{\partial \tau_2^{j2}} = -\frac{2a^2\rho^2}{1+\rho} < 0$). The mark ($\hat{}$) stands for two period equilibrium values. The first order conditions yield the equilibrium tax rates for the first and the second period.

$$\widehat{\tau}_1^h = \widehat{\tau}_2^h = \frac{1 + s(1+\rho) + \rho\,(1+\beta)}{3a(1+\rho)}, \tag{9}$$

$$\widehat{\tau}_1^f = \widehat{\tau}_2^f = \frac{2 - s(1+\rho) + \rho\,(2-\beta)}{3a(1+\rho)}. \tag{10}$$

We can easily verify that an intertemporal approach with short-sighted agents (i.e. $\rho = 0$) is equivalent to the benchmark case. By plugging (9) and (10) in (7), we obtain the marginal investor who is indifferent between investing in h or in f

$$\widehat{x} = \frac{1+s}{3} + \frac{\rho\beta}{3\,(1+\rho)}. \tag{11}$$

It follows that there are $\widehat{x} - s = \frac{1-2s}{3} + \frac{\rho\beta}{3(1+\rho)}$ investors of the large country who set up a firm in the small country. As in the benchmark case, capital outflows increase when the size of the small country is reduced. But, reducing the size parameter s causes a decrease of the tax base $\widehat{x}$ in the small country and an increase of the tax base $1 - \widehat{x}$ in the large country.

Note that $\widehat{x} - x = \frac{\rho\beta}{3(1+\rho)} > 0$, which means that capital outflows are higher than in the one-shot game. It also appears that capital outflows increase if investors care more about the future (higher ρ) and if their reluctance to continue investing abroad decreases (higher β).

The intuition underlying this result can be explained as follows. If $\beta > 0$, we know that the initial information disadvantage of foreign investors diminishes or even disappears over the years. It follows that investors anticipate that once they move capital abroad they will gain experience in the foreign location and become more accustomed to the new institutional environment. Consequently, the anticipated value of future attachment to home is lowered by $\rho\beta$, which makes it more attractive to invest capital abroad.

It follows that the number of agents who live in the high-tax country and invest in the low-tax country is higher in an intertemporal setting relative to a one-shot game. This highlights that static models underestimate the impact of tax competition on capital relocation.

We conclude with the following proposition.

Proposition 2 *Tax competition exacerbates capital outflows in an intertemporal setting relative to a static one.*

The equilibrium tax rates, which are given by (9) and (10), do not change across different periods. In other words, the governments' taxation policy remains stable trough time.[2]

Let us denote by $\widehat{\phi}$ the difference between the equilibrium tax rates of the competing jurisdictions in an intertemporal world. We verify that $\widehat{\phi} = \widehat{\tau}^f - \widehat{\tau}^h = \frac{1-2s(1+\rho)+\rho(1-2\beta)}{3a(1+\rho)} > 0$ for $s < \frac{1}{2}$ and $\beta < \widehat{x} - s$. Moreover, the tax differential decreases with β. In other words, a decrease in the investors' attachment to home in period 2 lowers the difference between interjurisdictional tax rates.

We now analyze how intertemporal tax competition impacts the tax rate differential relative to the one-shot tax game. To this purpose, we calculate $\phi - \hat{\phi}$, that is the difference between the tax gap in the intertemporal and static cases. It follows that $\hat{\phi} - \phi = \frac{-2\rho\beta}{3a(1+\rho)} < 0$. Given that the tax gap decreases in the intertemporal setting, we conclude that tax competition is less fierce in an intertemporal setting. More precisely, the large jurisdiction sets a lower tax rate in a two-period world compared to a timeless world (i.e., $\widehat{\tau}^f < \tau^f$), whereas the small country sets a higher rate (i.e., $\widehat{\tau}^h > \tau^h$). The small country is thus less aggressive in a two-period setting and the large country less inclined to raise its tax rate. This is due to the fact that investors expect to become more accustomed to a new institutional environment, once they move capital abroad. Therefore, the value of their future attachment to home is lowered by $\rho\beta$, which makes

[2] In Wildasin (2003, 2011), the tax rates do not change across different periods, but this happens by assumption. However, in our model, tax rates can a priori evolve over time and tax invariance results from endogeneous choices.

it more attractive to invest in the small country. Consequently, the tax rate resulting from the game will be higher (lower) in the small (large) country relative to a static world. More technically, the tax elasticity of the tax base increases (decreases) in the small (large) country relative to static tax competition.[3]

As in the one-shot game, a higher size asymmetry (lower s) between the competing jurisdictions increases the equilibrium tax rate in the large country and decreases the tax rate in the small country. In other words, inter-tempopral tax competition becomes more intense with increasing size asymmetry.

The following proposition concludes.

Proposition 3 *The intensity of tax competition is lower in an intertemporal setting relative to a static one and increases with the size asymmetry between the competing countries. The tax differential between the competing jurisdictions increases if investors care more about the future (higher ρ) and if the anticipated value of their future attachment to home decreases (higher β) after having moved capital abroad.*

We now investigate how intertemporal tax competition impacts the competing jurisdictions' tax revenues.

The equilibrium tax revenues of countries h and f resulting from the two-period game are $\widehat{T}^h = \frac{(1+s(1+\rho)+\rho(1+\beta))^2}{9(1+\rho)^2}$ and $\widehat{T}^f = \frac{(2-s(1+\rho)+\rho(2-\beta))^2}{9(1+\rho)^2}$, respectively. Note that for $s < \frac{1}{2}$ and $\beta \leq \widehat{x} - s$, we have $\widehat{T}^f > \widehat{T}^h$. The joint tax revenue becomes

$$\widehat{T} = \frac{(1+\rho)^2(5-2s) + 2s^2(1+\rho)^2 - 2\rho\beta(1-2s(1+\rho)+\rho(1-\beta))}{9(1+\rho)^2}, \tag{12}$$

where $\widehat{T}$ is positive for $s < \frac{1}{2}$ and $\beta \leq \widehat{x} - s$. As we noted above, if the agents are short-sighted (i.e. $\rho = 0$), the intertemporal approach is equivalent to the static case. This allows us to compare the joint tax revenue per period that results from the two-period game with a one-shot game, by subtracting (12) from (6).

[3] If we use the symbol ($\hat{}$) to designate the intertemporal case, it is easy to demonstrate that for given tax rates, the tax elasticities meet the following conditions:

$\left|\widehat{\epsilon}^f_{\tau^f}\right| > \left|\epsilon^f_{\tau^f}\right|$ and $\left|\widehat{\epsilon}^h_{\tau^f}\right| < \left|\epsilon^h_{\tau^f}\right|$, with $\left|\widehat{\epsilon}^f_{\tau^f}\right| = \frac{a\tau^f}{-a(\tau^f-\tau^h)-\frac{\beta\rho}{1+\rho}+(1-s)}$, $\left|\widehat{\epsilon}^h_{\tau^h}\right| = \frac{a\tau^h}{a(\tau^f-\tau^h)+\frac{\beta\rho}{1+\rho}+s}$ and $\left|\epsilon^f_{\tau^f}\right| = \frac{a\tau^f}{-a(\tau^f-\tau^h)+1-s}$, $\left|\epsilon^h_{\tau^h}\right| = \frac{a\tau^h}{a(\tau^f-\tau^h)+s}$.

$$T-\widehat{T}=\frac{2\beta\rho\left(1-2s(1+\rho)+\rho(1-\beta)\right)}{9\left(1+\rho\right)^{2}}>0. \tag{13}$$

It is straightforward to show that the global tax revenue differential $T-\widehat{T}$ is always positive for $s<\frac{1}{2}$ and $\beta\leq\widehat{x}-s$. The global tax revenue of countries h and f is thus lower in an intertemporal setting. More precisely, the difference $\left|T^{f}-\widehat{T}^{f}\right|$ in the large country's total tax revenue is higher than the difference $\left|T^{h}-\widehat{T}^{h}\right|$ in the small country (i.e. $\left|T^{f}-\widehat{T}^{f}\right|>\left|T^{h}-\widehat{T}^{h}\right|$). Hence, despite the fact that interjurisdictional competition is less intense in a multi-period approach, the tax loss of the high tax country is more important. This is due to the fact that capital outflows are higher in an intertemporal setting than in a timeless world. Actually, the negative effect of capital outflows on the large jurisdiction's total tax revenue dominates the positive effect of less intense competition between the jurisdictions. Consequently, tax competition is more deleterious for the large country in an intertemporal setting.

The following proposition summarizes the previous results.

Proposition 4 *(1) The global tax revenue of the competing jurisdictions is lower in an intertemporal setting than in a static world. (2) The tax loss of the large country is higher in an intertemporal setting.*

5 Conclusion

In this paper, we argue that static models are not accurate enough to analyze the consequences of tax competition. For this reason, we propose a framework which allows to analyze tax competition in a temporal setting. We then investigate whether intertemporal tax competition provides new insights relative to atemporal models. We thus develop a two-period model, in which policy makers and capital owners are forward-looking agents. We assume that investors are heterogenous in their degree of reluctance to invest in a foreign country. One key element of the model is to assume that capital owners who set up a firm in a foreign location improve their future knowledge about the destination country. It follows that their reluctance to keep on investing abroad decreases in the future.

The model shows that capital always flows from the large to the small country and that forward-looking investors have no incentive to change the location of their capital in the second period. If capital owners invest in the home country in the first period, they will do the same in the second period. If investors shift capital abroad in the first period, they continue investing abroad in the second period. Moreover, the equilibrium tax rates do not change across time. In other words, the governments' taxation policies remain stable trough time. However, this results from rational decisions and is not an assumption.

In order to highlight the relevance of a dynamic perspective, we use static tax competition as a benchmark. First, we demonstrate that the intensity of interjurisdictional tax competition is lower in a multi-period game. Despite this fact, the impact of tax competition on the extent of capital outflows increases in a dynamic setting. The reason is explained as follows. Since forward-looking agents expect to gain in information about a foreign destination when they move capital abroad, the value of their future attachment to home weakens. Consequently, more capital owners will find it advantageous to invest capital in the small country. Second, we show that tax losses in the large country that result from capital outflows, are higher in a intertemporal setting.

This paper can be extended in the following way. In the present study, production in excess of capital replacement and tax payments is entirely consumed. In a future paper, it would be interesting to assume that investors save and thus decide to increase their capital endowments. This would allow to analyze how tax competition can impact economic growth.

References

[1] Ahearne A., Griever W., Warnock F., 2004. Information costs and home bias: An analysis of U.S. holdings of foreign equities. Journal of International Economics 62, 313-36.

[2] Bucovetsky S., 1991. Asymmetric Tax Competition. Journal of Urban Economics 30, 167-181.

[3] Feldstein, S., Horioka, C., 1980. Domestic saving and international capital flow. The Economic Journal 90, 314-329.

[4] Ferrett B., Hoefele A., Wooton I., 2016. Does tax competition make mobile firms more footloose? CEPR Discussion Papers 11325

[5] French, K., Poterba, J., 1991. Investor diversification and international equity markets. American Economic Review 81(2), 222-226.

[6] Han Y., Pieretti P., Zanaj S., Zou B., 2014. Asymmetric Competition among Nation States: A Differential Game Approach. Journal of Public Economics 119, 71-79.

[7] Han Y., Pieretti P., Zou B., 2013. An extension of the home-attachment criteria under dynamic tax competition. Economics Letters 121, 508-510.

[8] Kanbur, R., Keen, M., 1993. Jeux Sans Frontières: Tax competition and tax coordination when countries differ in size. American Economic Review 83(4), 877-893.

[9] Levis, M., Muradoglu, Y. G., Vasileva, K., 2015. Home bias persistence in foreign direct investments. European Journal of Finance 4364, 1-21.

[10] Pieretti, P., Zanaj, S., 2011. On tax competition, public goods provision and jurisdictions' size. Journal of International Economics 84(1), 124-130.

[11] Tesar, L., Werner, I., 1995. Home bias and high turnover. Journal of International Money and Finance 14(4), 467-492.

[12] Trandel, G., 1994. Interstate commodity tax differentials and the distribution of residents. Journal of Public Economics 53, 435-457.

[13] Van Nieuwerburgh S., Veldkamp L., 2009. Information Immobility and the Home Bias Puzzle. The Journal of Finance 64(3), 1187-1215.

[14] Wildasin D.E., 2003. Fiscal competition in space and time. Journal of Public Economics 87, 2571-2588.

[15] Wildasin D.E., 2011. Fiscal competition for imperfectly-mobile labor and capital: a comparative dynamic analysis. Journal of Public Economics 95, 1312-1321.

[16] Wilson, J.D., 1991. Tax competition with interregional differences in factor endowments. Regional Science and Urban Economics 92, 1105-1121.

A. Appendix : Investors' relocation decisions in period 2

A.1. Case 1: Repatriation of capital in period 2

The aim is to demonstrate that investors who shift capital abroad in the first period keep on investing abroad in the following period. For the purpose of the proof we assume that there are capital owners of country $j = h, f$ who invested abroad (in country $j\prime = h, f$ with $j \neq j\prime$) in period 1 and repatriate their capital in period 2. It follows that the marginal investor x_1, who is indifferent between investing her capital at home (j) or abroad ($j\prime$) in period 1 (conditional upon the assumption that she invests at home in the second period), is given by

$$a\left(1-\tau_1^j\right)+\rho a\left(1-\tau_2^j\right)=a\left(1-\tau_1^{j\prime}\right)-|x_1-s|+\rho a\left(1-\tau_2^j\right).$$

Considering that j can be either h or f , which involves that $j\prime$ equals f and h respectively, it follows that

$$x_1=s+a\left(\tau_1^f-\tau_1^h\right). \tag{14}$$

In order to determine the number of investors who repatriate their capital, we have to consider the marginal investor x_2 in the second period. By assumption capital owners of country $j = h, f$ transfer capital back to their home country. This involves that the investor of type x_1 will repatriate its capital at period 2. The marginal investor who is indifferent between investing at home or abroad in period 2 should be of type $x_2 \neq x_1$. Because the disutility of investing abroad equals now $|x - s| - \beta$ for those capital owners who decide to continue investing in the foreign country in the second period, the individual of type x_2 verifies the following indifference condition in the first period. This condition states that the investor of type x_2 is indifferent between repatriating (first member) his capital in period 2 and keeping on investing abroad (second member).

$$a\left(1-\tau_1^{j\prime}\right)-|x_2-s|+\rho a\left(1-\tau_2^j\right)=a\left(1-\tau_1^{j\prime}\right)-|x_2-s|+\rho\left[a\left(1-\tau_2^{j\prime}\right)-\left(|x_2-s|-\beta\right)\right]. \tag{15}$$

Considering that j can be either h or f, which involves that $j\prime$ equals f and h respectively, it follows that

$$x_2 = \begin{cases} s + \beta + a\left(\tau_2^f - \tau_2^h\right) & \text{for } j = f \text{ and } j' = h, \\ s - \beta + a\left(\tau_2^f - \tau_2^h\right) & \text{for } j = h \text{ and } j' = f. \end{cases} \tag{16}$$

We now assume that the jurisdictions attempt to attract firms by competing in taxes. The policymakers of the two competing jurisdictions h and f are forward-looking and choose noncooperatively the tax rates that maximize their respective objective functions. It follows that

$$\underset{\tau_1^j, \tau_2^j}{Max} T^j = \tau_1^j \cdot Q_1^j + \rho \cdot \tau_2^j \cdot Q_2^j, \qquad j = h, f. \tag{17}$$

It is convenient to show that the objective functions are concave in their own tax rates ($\frac{\partial^2 T^j}{\partial \tau_1^{j2}} = -2a^2 < 0$ and $\frac{\partial^2 T^j}{\partial \tau_2^{j2}} = -2\rho a^2 < 0$). The first order conditions yield the equilibrium tax rates for the first and the second period.

In the first period, the tax rates set by both governments are, respectively

$$\tau_1^h = \frac{1+s}{3a}, \tag{18}$$

$$\tau_1^f = \frac{2-s}{3a}. \tag{19}$$

It is straightforward to show that $\tau_1^f - \tau_1^h = \frac{1-2s}{3a} > 0$ for $s < \frac{1}{2}$. In other words, the small country (h) undercuts the tax rate of the large country (f) in the first period. In the second period, the tax rates set by both governments are, respectively

$$\tau_2^h = \begin{cases} \frac{1+s+\beta}{3a} & \text{for } j = f \text{ and } j' = h, \\ \frac{1+s-\beta}{3a} & \text{for } j = h \text{ and } j' = f. \end{cases} \tag{20}$$

$$\tau_2^f = \begin{cases} \frac{2-s-\beta}{3a} & \text{for } j = f \text{ and } j' = h, \\ \frac{2-s+\beta}{3a} & \text{for } j = h \text{ and } j' = f. \end{cases} \tag{21}$$

Hence, the marginal investor who is indifferent between investing in h or in f in the first period is

$$x_1 = \frac{1+s}{3}. \tag{22}$$

The marginal investor who is indifferent between investing in h or in f in the second period is defined by

$$x_2 = \begin{cases} \frac{1+s+\beta}{3} & \text{for } j = f \text{ and } j' = h, \\ \frac{1+s-\beta}{3} & \text{for } j = h \text{ and } j' = f. \end{cases} \tag{23}$$

Given the restriction that $\beta \leq |x_2 - s|$, it is straightforward to show that x_2 is always larger than s, for $j = h$ and $j' = f$. This means that there is no capital flow from the small country to the large country. It follows that the small country attracts capital from the large country, given that x_1 and x_2 are larger than s for $j = f$ and $j' = h$. Moreover, it appears that $x_2 \geq x_1$ for $j = f$ and $j' = h$. In other words, the number of foreign investors does not decrease, which contradicts the initial assumption of capital repatriation. Consequently, once capital is invested abroad in the first period it remains invested abroad in the following period.

A.2. Case 2: Additional outflow of capital in period 2

The purpose is now to prove that capital owners who invest in their home country in period 1 keep on investing at home in period 2.

As a first step, we assume that the number of capital owners of country $j = h, f$ who invest abroad (in country $j\prime = h, f$ with $j \neq j\prime$) increases in the second period. The marginal investor x_1, who is indifferent between investing her capital at home (j) or abroad $(j\prime)$ in period 1 (conditional upon the assumption that she invests abroad in the second period), is given by the following condition

$$a\left(1-\tau_1^j\right)+\rho\left[a\left(1-\tau_2^{j'}\right)-|x_1-s|\right] = a\left(1-\tau_1^{j'}\right)-|x_1-s|+\rho\left[a\left(1-\tau_2^{j'}\right)-\left(|x_1-s|-\beta\right)\right]. \tag{24}$$

Considering that j can be either h or f, which involves that $j\prime$ equals f and h respectively, it follows that

$$x_1 = \begin{cases} s+\rho\beta+a\left(\tau_1^f-\tau_1^h\right) & \text{for } j = f \text{ and } j' = h, \\ s-\rho\beta+a\left(\tau_1^f-\tau_1^h\right) & \text{for } j = h \text{ and } j' = f. \end{cases} \tag{25}$$

Consider now the marginal investor in the second period. In period 2, the marginal investor who is indifferent between investing at home or abroad is now of type $x_2 \neq x_1$ and verifies the following indifference condition in the first period. This condition states that the investor of type x_2 is indifferent between investing (first member) his capital at home in period 2 and investing abroad (second member) in period 2.

$$a\left(1-\tau_1^j\right)+\rho a\left(1-\tau_2^j\right)=a\left(1-\tau_1^j\right)+\rho\left[a\left(1-\tau_2^{j'}\right)-(x_2-s)\right]. \tag{26}$$

Considering that j can be either h or f, which involves that $j\prime$ equals f and h respectively, it follows that

$$x_2=s+a\left(\tau_2^f-\tau_2^h\right). \tag{27}$$

We now assume that the jurisdictions attempt to attract firms by competing in taxes. Each jurisdiction j is assumed to be forward-looking and to maximize its total tax revenue $T^j=\tau_1^j\cdot Q_1^j+\rho\cdot\tau_2^j\cdot Q_2^j$ with respect to its own tax rates, namely τ_1^j and τ_2^j .

$$\underset{\tau_1^j,\tau_2^j}{Max}T^j=\tau_1^j\cdot Q_1^j+\rho\cdot\tau_2^j\cdot Q_2^j, \qquad j=h,f. \tag{28}$$

The objective functions are concave in their own tax rates ($\frac{\partial^2T^j}{\partial\tau_1^{j2}}=-2a^2<0$ and $\frac{\partial^2T^j}{\partial\tau_2^{j2}}=-2\rho a^2<0$). The first order condition yields the equilibrium tax rates for the first and the second period.

In the first period, the tax rates set by both governments are, respectively

$$\tau_1^h=\begin{cases}\frac{1+s+\rho\beta}{3a} & \text{for } j=f \text{ and } j'=h,\\ \frac{1+s-\rho\beta}{3a} & \text{for } j=h \text{ and } j'=f.\end{cases} \tag{29}$$

$$\tau_1^f=\begin{cases}\frac{2-s-\rho\beta}{3a} & \text{for } j=f \text{ and } j'=h,\\ \frac{2-s+\rho\beta}{3a} & \text{for } j=h \text{ and } j'=f.\end{cases} \tag{30}$$

In the second period, the tax rates set by both governments are, respectively

$$\tau_2^h = \frac{1+s}{3a}, \tag{31}$$
$$\tau_2^f = \frac{2-s}{3a}. \tag{32}$$

Hence, the marginal investor who is indifferent between investing in h or in f in the first period, is of type x_1 :

$$x_1 = \begin{cases} \frac{1+s+\rho\beta}{3} & \text{for } j = f \text{ and } j' = h, \\ \frac{1+s-\rho\beta}{3} & \text{for } j = h \text{ and } j' = f. \end{cases} \tag{33}$$

The marginal investor, who is indifferent between investing in h or in f in the second period is defined by

$$x_2 = \frac{1+s}{3}.$$

Remembering the condition $\beta < |x_1 - s|$, it is straightforward to show that x_1 is always larger than s, if $j = h$ and $j' = f$. In that case, there is no capital flow from the small country to the large country.

It follows that the small country attracts capital from the large country given that x_1 and x_2 are larger than s for $j = f$ and $j' = h$. Moreover it appears that $x_1 \geq x_2$ for $j = f$ and $j' = h$. In other words, the number of foreign investors does not increase, which contradicts the initial assumption that the number of capital owners who invest abroad increases between the two periods.

It results from the above analysis in cases 1 and 2 that $x_1 = x_2$. In other words, the capital owners keep on investing at home (abroad) in period 2 if they invest at home (abroad) in period 1.