Tax Enforcement Policy and the Provision of Public Goods with the Presence of Tax Havens

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Abstract

A tax competition model is presented to investigate the effects of tax havens on the public good provision. We show that when countries facing a rise in tax havens change their tax enforcement strategies in response, the existence of tax havens may result in a higher level of equilibrium public good provision as compared to the case with no tax havens. Accordingly, tax havens could be welfare-enhancing for non-haven countries. This result offers a possible explanation for the recent empirical evidence that the corporate tax revenues in high-tax countries have actually increased with the growth in the flow of FDI to tax havens.

Keywords: tax havens; enforcement policy; tax competition
JEL classification: F23; H41; H73

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1. Introduction

The impact of tax havens on high-tax countries has attracted much attention and debate in recent years. It is often argued that tax havens erode the tax base of high-tax countries by providing opportunities for tax avoidance (OECD, 1998, 2000). The standard tax competition model essentially predicts that tax havens intensify tax competition among jurisdictions and reduce the public good provision (Slemrod and Wilson, 2009). The empirical evidence, by contrast, seems to suggest that the concern about the harmful effects of tax havens may be overstated. For example, based on US data, Dharmapala (2008) shows that despite increasing foreign direct investment (FDI) flows to tax havens, the US corporate tax revenues have actually increased, instead of having fallen. In Europe, the share of corporate income taxes in total revenues of OECD countries has been rising as well over the 1975-2005 period (OECD, 2008).

To explain the above phenomenon, we present a tax competition model in which countries facing the rise of tax havens choose a tax enforcement policy in response. As pointed out by Wilson (1999), there are many ways in which the governments can compete for mobile factors. One of the policy instruments that are recognized to play an important role in tax competition is the tax enforcement policy.[1] When dealing with the issue of tax havens, the tax enforcement policy is particularly relevant since the use of tax havens is essentially a tax avoidance activity. Hence, we extend the literature on the welfare effect of tax havens by considering a tax enforcement competition game between non-haven countries.

More specifically, we assume that in the initial equilibrium the governments

[1] There are a number of studies analyzing the role of tax enforcement policy in a tax competition model. For example, Cremer and Gahvari (1997, 2000) consider two countries that compete with each other by using tax rate and audit probabilities. Peralta et al. (2006) analyze a tax competition game in which countries compete for the profit by means of a corporate tax rate and a tax enforcement variable. Haufler and Schjelderup (2000) and Bucovetsky and Haufler (2008) study the optimal regulation of multinational firms when governments can choose both the tax rate and the tax base (or the degree of tax discrimination). These papers do not, however, deal with the issue of tax havens.

choose a capital income tax rate to finance the public good and to compete for mobile capital, as in standard tax competition models. Then, tax havens arise. With the existence of tax havens, the firms in non-haven countries can set up affiliates in tax havens, and direct interest payments to these affiliates to reduce their tax burden. In response to the rise of tax havens, two scenarios may emerge. The first scenario is that non-haven governments adjust their capital tax rate (i.e., engage in a tax rate competition game, TRC), and the second scenario is that they vary the tax enforcement policy (i.e., turn it into a tax enforcement competition game, TEC).

In our theoretical model, tax enforcement policies can specifically refer to any multinational tax regulations such as, for instance, the thin capitalization rules, the transfer-pricing rules, or controlled foreign corporation rules. These regulations are mostly imposed to counter the use of tax havens and are changed more frequently than the statutory tax rate. In the US, for example, the present corporate income tax rate was adopted in the Tax Reform Act of 1986, while the thin capitalization rule was added to the Code by the Omnibus Budget Reconciliation Act of 1989. Since then, the thin capitalization rule was adjusted more or less in 1991, 1993, 2002 and 2004, respectively, while the statutory corporate tax rate remains unchanged. Based on this observation, we assume that the tax rate is fixed when countries choose a tax enforcement policy to compete for mobile factors. Doing so could also help us to examine the pure effect of the tax enforcement policy competition, and to compare our results with previous studies.

A well-known conclusion is that tax competition will lead to the suboptimal under-provision of public goods. Our analysis shows that tax havens may either intensify or mitigate this inefficiency, depending on which policy instruments are used when facing the rise of tax havens. In the case of TRC, providing the public good (by increasing the tax rate) becomes more undesirable for the local policymakers because

it not only drives out the capital, but also spurs tax avoidance activities. Therefore the existence of tax havens intensifies tax competition and reduces efficiency. However, the story changes sharply in the case of TEC. When tax havens are present, the public good can also be financed by implementing a stricter enforcement policy. Doing so drives out capital in the same way as raising the tax rate, but it weakens the incentives to use tax havens. It turns out that in our model the latter effect outweighs the former, which leads to the undervaluation of the marginal cost of the public good. Under such a situation, the rise of tax havens results in a higher level of the public good.[2]

Our results are related to the growing strand of the literature that supports the positive view of tax havens. As an example, Desai et al. (2006a) empirically show that the presence of tax havens enables tax planning that lowers the cost of investing in non-haven countries, and thus stimulates investment.[3] Two studies are closely related to the present paper. The first is Hong and Smart (2010), who set up a general equilibrium model to evaluate the effect of international tax planning. The main idea of their paper is that governments in a small open economy would ideally like to impose a positive tax rate on immobile (domestic) firms and a zero tax rate on perfectly mobile (multinational) firms, whereas for some practical reasons the governments are unable to discriminate against them. Therefore, the existence of tax havens potentially improves welfare by giving rise to the desired differential tax treatment of the two kinds of firms. The major difference between our paper and theirs is that they study the tax planning effect in a "single high-tax country" rather

[2] Two points are worth-noting here. First, we show that tax havens increase public good provision to the level above the one without tax havens, but it is not clear whether the level is above the one without tax competition. Second, our result is based on the assumption that governments are not allowed to change the tax rates. The case in which tax rates and enforcement policies are both at the discretion of governments will be considered in Section 4.2.

[3] Other studies on the positive view of tax havens include Desai et al. (2006b) and Hines (2006). See Dharmapala (2008) for a survey of this literature.

than in a tax competition game among countries.[4] Therefore their analysis essentially goes beyond the issue of the under-provision of the public good in tax competing countries, which is our focus in this paper.

The second paper is Johannesen (2010) who uses a tax competition model to show that the presence of tax havens in some cases increases the tax revenues. Although the present paper obtains a similar result, it departs from his paper in several ways. First, the intuition in Johannesen (2010) is that tax havens make it less attractive for countries to set a low tax rate and thus have the effect of mitigating the problem of tax competition, whereas the beneficial effect in our model comes from another form of tax competition. Second, in his paper tax havens can only improve high-tax countries in an asymmetric equilibrium, while our analysis shows that even in a symmetric equilibrium, non-haven countries may also benefit from the rise of tax havens. Moreover, his paper does not take into consideration the facet of an endogenous tax enforcement policy.

The remainder of this paper is organized as follows. Section 2 describes the tax competition model with parasitic tax havens. Section 3 introduces two different forms of tax competition and shows how they result in diverse tax haven effects. Section 4 considers some possible extensions of the basic model. Section 5 concludes the paper.

2. The model

We consider a small open economy that consists of many identical non-haven countries (tax haven jurisdictions will be introduced later). Each country contains a constant number of homogeneous residents, which is normalized to unity. Given the symmetry, subscripts denoting countries are omitted to simplify the notation. Each resident is endowed with 1 unit of labor and $\bar{k}$ units of capital. The labor input is

[4] See Hong and Smart (2010), footnote 7.

internationally immobile while the capital input is internationally mobile. The wage income is w and the capital return is r. Accordingly, the private consumption, denoted by x, of a representative resident can be written as $x = w + r\bar{k}$. In addition, the utility function of the representative resident is assumed to be of the form:

$$u = x + Z(g), \qquad (1)^5$$

where g denotes the supply of a public good, which is financed by a tax on mobile capital. The function $Z(\cdot)$ measures the residents' preference for the public good and is assumed to have the properties that $Z_g > 0$ and $Z_{gg} < 0$ for all $g \geq 0$ and also $\lim_{g \to 0} Z_g = \infty$ (where a subscript denotes the partial differential).

Each country contains a large number of perfectly competitive firms, which use a constant returns-to-scale technology to produce a single output. Firms are identical so that we normalize the number of firms to unity. In particular, we assume the owners of capital (investors) create firms, and then hire labor and decide whether to shift income to tax havens.[6] The production function is $f(k)$ and satisfies the standard properties $f_k > 0$ and $f_{kk} < 0$ where k is the amount of capital used for production.[7]

We now turn to formulate how the firms utilize tax havens to avoid taxation. Our formulations of tax havens are mostly close to those in Slemrod and Wilson (2009) and Haufler and Runkel (2012). We assume that, besides the non-haven countries, there may exist a number of jurisdictions referred to as tax havens, which offer the firms in non-haven countries the opportunities for international tax planning. To be more specific, the firms in non-haven countries can set up an affiliate that is located in a tax haven jurisdiction. This subsidiary in a tax haven can make an intra-company loan to the producing parent in the non-haven country. The interest paid for this loan

[5] Lockwood and Makris (2006) and Lai (2010) use a similar specification.
[6] The purpose of this assumption is to model tax avoidance behavior at the firm level. A similar setting could be found in Slemrod and Wilson (2009) and Haufler and Runkel (2012).
[7] For simplicity, the fixed labor input is omitted in the production function.

is deductible from the tax base in the host country. We assume that tax havens impose no taxes, and thus the interest income in tax havens is entirely untaxed. Hence by directing interest payments to tax havens, the firms are capable of lowering their tax burden (known as "interest stripping").[8] In addition, to simplify the analysis we assume the tax havens are *small* in the sense that any net flows of capital between tax havens and non-haven countries are relatively minor and thus would not affect the capital and labor employed in the system of non-haven countries as a whole.[9] Moreover, the populations and any productive activities in tax havens are neglected in the model.

The governments of non-haven countries levy an ad valorem tax t on capital to finance the public good.[10] Hence, the profit function of the representative firm is written as:

$$\pi = f(k) - [1 + (1-s)t]rk - w - P(s, rk, \alpha, v), \qquad (2)$$

$$P_s > 0, \quad P_{rk} > 0, \quad P_\alpha > 0.$$

In (2), s denotes the firm's interest stripping behavior, and thus the amount of srk is deductible from the tax base. The function $P(\cdot)$ denotes the total cost associated with the tax avoidance activities, and can be interpreted as the total agency cost, the accounting fee required to research the tax codes, or the setup cost needed to establish an affiliate in a tax haven. As stated in (2), the cost function is directly increasing in the interest stripping behavior s and the amount of interest payment rk. The parameter α is a policy variable that describes the strictness of the tax enforcement policy implemented by the government to regulate the use of tax havens. A larger α

[8] Strictly speaking, interest stripping is a tax avoidance activity, and not tax planning. For the major difference between tax planning and tax avoidance, interested readers could consult Ulph (2009).

[9] This treatment is based on the observations that tax havens tend to be very small jurisdictions (see, e.g., Hines and Rice, 1994; Dharmapala and Hines, 2009). See also Slemrod and Wilson (2009) for a more detailed discussion of this specification.

[10] As in most of the tax competition literature, it is assumed that the capital tax follows the "source principle". That is, the government taxes only the capital income earned within its borders.

represents a stricter enforcement policy (the government allows for less use of tax havens). Accordingly, the relationship $P_\alpha > 0$ is warranted to capture the effect that a stricter enforcement policy results in more cost required to engage in tax avoidance activities and thus depress the incentives to avoid the tax.[11] Finally, $v \geq 0$ is an exogenous parameter that denotes the number (or scale) of available tax havens. To make our analysis tractable, we specify $P(\cdot)$ as taking a simple form that satisfies all the properties discussed above, given by:

$$P(s, rk, \alpha, v) = \begin{cases} \dfrac{1}{2\varphi(\alpha, v)} s^2 rk & if\ \varphi(\cdot) \neq 0 \\ 0 & if\ \varphi(\cdot) = 0 \end{cases}, \qquad (3)^{12}$$

where the function $\varphi(\cdot)$ satisfies the following properties.

Assumption 1. $\varphi(\alpha, 0) = 0$, $\varphi_\alpha(\alpha, 0) = 0$, $\varphi_\alpha < 0$ for all $v \neq 0$, and $\varphi(\cdot) \leq t^{-1}$ for any (α, v).

As we will see later in (5), the last inequality guarantees that the proportion of the interest payment shielded cannot be greater than unity. The first-order condition of the representative firm is:

$$f_k(k) = r[1 + (1-s)t + \frac{1}{2\varphi(\alpha, v)} s^2], \qquad (4)$$

$$s = \varphi(\alpha, v) t\,. \qquad (5)$$

To simplify the subsequent notation and for future use, we define ρ as the gross user cost of capital and thus we have $\rho = r[1 + t - \varphi t^2 / 2]$.

We see clearly in (5) that the firm's choice of interest stripping is positively related to t: a higher capital tax rate increases the firm's incentive to avoid taxation;

[11] One example of α is the thin capitalization rule. However, it should be noted that Hong and Smart (2010) and Haufler and Runkel (2012) model the thin capitalization rule as a direct (binding) upper bound for the firm's debt limit. Alternatively, in this paper we model the policy effect of enforcement policy as indirectly affecting the cost associated with tax avoidance activities. In fact, there is evidence suggesting that the effect of the thin capitalization rule is limited in magnitude due to the availability to the firm of other tax planning strategies (Weichenrieder and Windischbauer, 2008).

[12] The assumption that the total costs of tax avoidance activities are linear in the tax base simplifies the analysis considerably. See Stöwhase (2005) and Stöwhase and Traxler (2005) for this point.

while it is negatively related to α: a stricter enforcement policy increases the operating cost and reduces tax avoidance activities. It can also be seen that $s \to 0$ if v approaches zero. This result is obvious because with the absence of tax havens, the firm simply cannot engage in any tax avoidance activities by making use of tax havens.

With perfectly mobile capital and the assumption of a small open economy, the rate of return on capital must be the same across countries and determined in the worldwide capital market. Accordingly, the rate of return on capital is regarded as fixed by an individual country.

Then we derive the policy effects of t and α on the amount of capital employed, which follow from (4) and (5):

$$\frac{\partial k}{\partial t} = \frac{(1-\varphi(\cdot)t)r}{f_{kk}} < 0, \tag{6}$$

$$\frac{\partial k}{\partial \alpha} = \frac{-r\,t^2 \varphi_\alpha}{2\,f_{kk}} \le 0. \tag{7}$$

A higher tax rate or a stricter enforcement policy lowers the capital returns and thus drives out capital. Note that $\partial k / \partial \alpha = 0$ if there are no available tax havens.

In addition, the equilibrium wage must adjust to the point where it is optimal for the firm to hire one unit of labor, that is:

$$w = f(k) - k\,f_k(k). \tag{8}$$[13]

Finally, the government uses the capital tax revenue to finance the public good. The government budget constraint is thus:

$$g = (1-s)rtk. \tag{9}$$

It should be noted that our basic model assumes that implementing a stricter enforcement policy is costless (see, e.g., Peralta et al. 2006; Hansen et al. 2006). In

[13] The wage equation (8) can be obtained by substituting (3), (4), and (5) into (2) and imposing the zero-profit condition. The same specification may be found in, e.g., Brueckner (2000), Lockwood and Makris (2006), and Lai (2010).

Section 4.1 we will introduce enforcement costs.

3. Tax haven effects on public good provision

This section examines the effect of tax havens on the public good provision and welfare. In the initial equilibrium, there are no tax havens in the economy. Each country chooses the capital tax rate to finance the public good and compete for mobile capital. Specifically, an individual country chooses t to maximize the social welfare (1) under the condition $\varphi(\alpha,0)=0$. The first-order condition is thus $\partial x/\partial t + Z_g \cdot \partial g/\partial t = 0$, and rearranging yields the familiar equation:

$$Z_g^N = \left[1 - \frac{\varepsilon t}{1+t}\right]^{-1}, \tag{10}$$

where $\varepsilon = -(\partial k/\partial \rho)(\rho/k) > 0$ is the elasticity of capital demand, and Z_g^N denotes the marginal utility of the public good under the initial (no-haven) equilibrium condition. Equation (10) implicitly defines the equilibrium public good in the absence of tax havens, which is denoted by g^N. Moreover, we impose the following assumption to ensure that the marginal utility of the public good is positive.

Assumption 2. $\varepsilon < \frac{(1+t)}{t}$.

Then, tax havens arise. We consider two distinct scenarios. The first scenario is that governments confronting the rise of tax havens change the tax rate in response (TRC), and the second scenario is that they shift to vary their enforcement policies in response (TEC).

3.1. Capital tax rate competition (TRC)

In the case of TRC, an individual country chooses t to maximize (1) as in the initial equilibrium except that φ is no longer zero with the existence of tax havens.

The optimization condition requires:

$$Z_g^R = \left[1 - \frac{\varphi t}{1-\varphi t} - \frac{\varepsilon t(1-\varphi t)}{1+t-\varphi t^2/2}\right]^{-1}, \tag{11}$$

where Z_g^R denotes the marginal utility of the public good under the TRC equilibrium condition. The tax rate and the provision of the public good are defined simultaneously from the system of (9) and (11). To obtain a tractable result, we impose:

Assumption 3. $1 - 2\varphi t - \frac{\varphi t^2}{2} > 0$.

This assumption enables us to focus on the case in which the interest stripping behavior $s(=\varphi t)$ is not too pronounced.[14] Moreover, it also ensures that, given k and ρ, a higher tax rate increases the tax revenues and thus the provision of the public good. Accordingly, we can establish the following proposition:

Proposition 1. *Supposing that Assumptions 1-3 hold, then in an economy where each country uses the capital tax rate to compete for mobile capital, the rise of tax havens results in a lower equilibrium level of the public good.*

Proof: See Appendix A.

Proposition 1 reports the same conclusion as that in Slemrod and Wilson (2009). The intuition can be briefly explained as follows. It is well known that, in a tax competition model, inefficiency emerges because the marginal benefit (MB) of the public good exceeds the marginal resource cost (MC) to offset the negative impact of the capital outflow induced by a higher tax rate. This outflow is regarded as a positive

[14] Supposing that t=0.5, Assumption 3 means that s cannot be larger than 0.44, which is a quite loose assumption. For example, in the numerical analysis by Haufler and Runkel (2012), s is smaller than 0.34.

externality for other countries (as a form of capital inflow) and thus indicates that the public good provision is inefficiently low. When tax havens are introduced, this inefficiency is aggravated because the MB needs to exceed the MC by even more to further compensate for the *tax-induced tax avoidance* (note that tax avoidance activities increase with the capital tax rate). Hence the problem of under-provision of the public good is worsened in the presence of tax havens if countries use the capital tax rate as a policy instrument to attract capital.

3.2. Tax enforcement policy competition (TEC)

Now we turn to investigate the public good effect of tax havens if the countries compete for capital by choosing an enforcement policy. In the case of TEC, an individual country chooses α to maximize its social welfare, which gives:

$$\frac{\partial x}{\partial \alpha} + Z_g^E \frac{\partial g}{\partial \alpha} = 0, \tag{12}$$

where Z_g^E denotes the marginal utility of the public good in the case of TEC. Rewriting (12) yields:

$$Z_g^E = \left[2 - \frac{\varepsilon t(1-\varphi t)}{1+t-\varphi t^2/2} \right]^{-1}. \tag{13}$$

Given t, (13) implicitly defines the equilibrium public good in the presence of tax havens in the case of TEC, which is denoted by g^E.

We now compare g^E with g^N by comparing the magnitudes of Z_g^E and Z_g^N. Note that, in the TEC case, the tax rate is the same as that before the rise of tax havens. In the Appendix we will demonstrate that $Z_g^E - Z_g^N < 0$. The property $Z_{gg} < 0$ and $Z_g^E < Z_g^N$ indicates that $g^E > g^N$. Hence we have the following proposition:

Proposition 2. *Supposing that Assumptions 1-2 hold, then in an economy where each country confronting the rise of tax havens uses the tax enforcement policy in response, the rise of tax havens results in a higher equilibrium level of the public good.*

Proof: See Appendix B.

The result that different forms of tax competition lead to distinct tax haven effects on the public good is somewhat surprising and thus needs detailed discussion. The main reason lies in the diverse policy impacts on tax avoidance activities. To be more specific, to finance a unit rise in the public good, the government can either raise the capital tax rate or implement a stricter enforcement policy. A key difference between the impacts of the two policy instruments is that a higher tax rate increases the incentive to avoid the tax, whereas a stricter enforcement policy reduces such an incentive. In the case of TRC, as discussed previously, the existence of tax havens results in a higher MC of the public good (from the individual country's viewpoint) because the local policymaker takes into account the negative impact of capital tax on tax avoidance. Hence tax havens lead to a deterioration of the problem associated with the under-provision of public goods in a standard tax competition model.

The story, however, changes dramatically when countries engage in TEC. When tax havens exist, enforcement policies become valid to finance the public good. As in the case of TRC, a stricter enforcement policy causes capital to flow out so that the MC of the public good is overrated from the local policymaker's viewpoint. However, a stricter enforcement policy differs from a higher capital tax rate in that it can have an additional impact to depress tax avoidance activities, which leads to a *lower* MC of the public good for the local policymaker. It turns out that in our model the latter effect outweighs the former effect so that the MC is underrated as a whole. Therefore, the existence of tax havens leads to a positive effect on the public good provision and

thus mitigates the under-provision of the public good in tax competition models.

Proposition 2 implies that in an economy where each country, in confronting the rise of tax havens, adjusts the tax enforcement policy in response, the rise of tax havens is not necessarily welfare-reducing since it may mitigate the under-provision of the public good. If the weight of the public good in the utility function is sufficiently large, the rise of tax havens could improve social welfare. Our result thus supports the recent view of a beneficial tax haven.

4. Extensions and discussions

4.1. Enforcement costs

Thus far we have assumed that implementing an enforcement policy does not require any resource costs. In this subsection we relax this assumption and extend the basic model to incorporate an enforcement cost. Let $e(\alpha)$ denote the cost associated with the enforcement policy ($e_\alpha > 0$). The government budget constraint is rewritten as:

$$g + e(\alpha) = (1-s)rtk\,. \tag{14}$$

Utilizing (14) and (12), the marginal utility of the public good in the case of TEC with a positive enforcement cost, denoted by $\hat{Z}_g^E$, becomes:

$$\hat{Z}_g^E = \left[2 - \frac{\varepsilon t(1-\varphi t)}{1+t-\varphi t^2/2} + \frac{2e_\alpha}{rt^2\bar{k}\varphi_\alpha} \right]^{-1}. \tag{15}$$

Making an comparison between (15) and (13) yields $Z_g^E < \hat{Z}_g^E$. This indicates that, not surprisingly, introducing a positive cost of enforcement policy reduces the equilibrium public good provision. However, what concerns us is whether the existence of tax havens could increase the public good when the enforcement cost is taken into consideration. To examine this question, we can compare the values of $\hat{Z}_g^E$

with Z_g^N, which gives:

$$\hat{Z}_g^E - Z_g^N = \hat{Z}_g^E Z_g^N \left[-1 - \frac{\varepsilon\varphi t^2 (1+t/2)}{(1+t)(1+t-\varphi t^2/2)} - \frac{2e_\alpha}{rt^2 \bar{k} \varphi_\alpha} \right]. \tag{16}$$

The sign of (16) is uncertain, indicating an ambiguous effect of tax havens on the public good provision. We do not try to derive a parameter condition to determine the sign of (16) since we have not assumed the explicit functional form of $e(\cdot)$ and $\varphi(\cdot)$. Some remarks, however, could be made on the implications revealed from (16). First, a higher marginal enforcement cost ($e_\alpha \uparrow$) makes a stricter enforcement policy more undesirable and thus leans more toward a negative tax haven effect on the public good. Second, a stricter enforcement policy can restore more tax revenues if the capital endowment is large ($\bar{k} \uparrow$); hence a larger capital endowment is associated with a positive tax haven effect on the public good. Third, if the enforcement policy is more effective ($|\varphi_\alpha| \uparrow$, i.e., a stricter enforcement policy can reduce more tax avoidance activities), the MC of the public good is lower for the local jurisdiction. Under such a situation, tax havens are more likely to increase the public good provision. We summarize the above discussion by establishing the following proposition:

Proposition 3. *In the case of TEC with a positive enforcement cost, the rise of tax havens can either result in a higher or lower level of the public good in equilibrium. In particular, tax havens are more likely to increase the level of the public good if (i) the marginal enforcement cost is lower; (ii) the initial capital endowment is larger; or (iii) the enforcement policy is more effective.*

4.1.1. A simple numerical example

This subsection presents a simple numerical simulation to illustrate the results in

a model with an enforcement cost. In doing so we need to assign specific functional forms of the utility, production and cost functions. We first assume a simple preference for the public good, $Z(g)=\eta\log(g)$, $\eta>0$. The production function is specified to be of the form $f(k)=ak-bk^2$, which is in line with the numerical analysis in Haufler and Runkel (2012). Moreover, the function associated with the costs for tax avoidance $\varphi(v,\alpha)$ is assumed to be $\varphi=v/(c+\alpha)$ where the parameter c captures the cost of interest stripping without any policy intervention. The cost function associated with the enforcement policy is assumed to be $e(\alpha)=\chi\alpha^2$. For the parameterization we consider the following values: $a=3$, $b=0.25$, $c=5$, $\chi=0.001$, $\eta=1$, $\bar{k}=1$, and $v=0$ is used to represent the case of no tax havens while $v=1$ represents the cases of TRC and TEC.[15] We examine how the public good provision and welfare level will react following a rise in tax havens under different types of tax competition.[16] The numerical results are reported in Table 1. Under the chosen parameter values, we can see that with the presence of the enforcement cost, TEC performs better than TRC in terms of the levels of the public good and welfare, but performs worse than for the case where there are no tax havens.

Table 1.

	No tax havens	TRC with tax havens	TEC with tax havens
Public good	0.7576	0.7117	0.7132
Welfare	1.7148	1.6706	1.6711

4.2. A two-stage competition game

Our basic model assumes that tax rates are set not only prior to enforcement policies, but also before the rise of tax havens. In reality, after the rise of tax havens,

[15] We set a=3 and b=0.25 following Haufler and Runkel (2012), which implies that the elasticity of capital demand $\varepsilon=-(\partial k/\partial\rho)(\rho/k)$ can be calculated as 0.8.

[16] The details of the numerical process are provided in Appendix C.

countries may first adjust the tax rate and then adjust the enforcement policies. If this is the case, a more appropriate approach would involve the study of a two-stage competition game, in which the governments, as they face the rise of tax havens, set tax rates in the first stage and set the enforcement policies in the second stage. In this subsection we will discuss whether our results are tenable under the two-stage competition game.

The two-stage model can be solved by backward induction. First, let us define t_0 as the initial tax rate (without the presence of tax havens). Tax havens arise in stage 0.5. In stage 1 governments adjust the tax rate and t_1 is the tax rate determined in this stage. Lastly, in stage 2 governments choose enforcement policies to maximize country welfare taking as given the previously determined tax rate t_1. The optimal condition would be:

$$\tilde{Z}_g = \left[2 - \frac{\varepsilon t_1 (1 - \varphi t_1)}{1 + t_1 - \varphi {t_1}^2 / 2} \right]^{-1}, \tag{17}$$

where a tilde hereafter refers to the solutions to the two-stage game.

Our main focus is to examine the impact of tax havens on the public good provision. Hence we need to compare (17) with the optimal condition of the provision of public goods without tax havens, i.e., $\tilde{Z}_g^N = \left[1 - \varepsilon t_0 / (1 + t_0) \right]^{-1}$. Accordingly we have:

$$\tilde{Z}_g - \tilde{Z}_g^N = -\tilde{Z}_g \tilde{Z}_g^N \Upsilon \left[(1 + t_1 - \frac{\varphi t_1^2}{2})(1 + t_0) + \frac{\varphi t_1^2 \varepsilon}{2}(2 + t_0) + \varepsilon (t_0 - t_1) \right], \tag{18}$$

where $\Upsilon = [(1 + t_0)(1 + t_1 - \varphi {t_1}^2 / 2)]^{-1} > 0$.

The uncertain sign of (18) means that under a two-stage competition game, we cannot be sure whether tax havens result in a higher or lower level of public good provision. However, we also notice that $\tilde{Z}_g - \tilde{Z}_g^N < 0$ if $t_0 > t_1$. In words, if the tax

rate determined in stage 1 is lower than the initial tax rate, the rise of tax haven increases the equilibrium public good provision. We argue that $t_0 > t_1$ is quite likely to be the case because under the traditional TRC game (stage 1), tax havens intensify tax competition and thus countries will tend to set a lower tax rate. In a nutshell, although we need further specific functional forms to obtain the mathematical conditions, the basic logic that TEC implies the possibility for the positive effect of tax havens on public good provision remains the same.

4.3. Information sharing

In reality the implementation of many enforcement policies requires information sharing between national tax authorities and, in particular, tax havens.[17] This means that information sharing could be highly relevant, especially in a TEC game with tax havens. It is worthwhile, therefore, discussing the possible implications of this facet. To put it plainly, the issue on information sharing is beyond the scope of the present framework because our model ignores any decision-making in tax havens. For the issue to be properly addressed, we shall resort to a model that considers tax competition between a large country and a tax haven (see, for example, Krautheim and Schmidt-Eisenlohr, 2011), in which each government first decides the level of information provided to the other government and then decides the level of taxation or the enforcement policies (see, for example, Bacchetta and Espinosa, 1995; Makris, 2003).[18]

With the exchange of information as a choice variable for tax authorities and tax havens, several interesting debates can be studied. First, one could use the model to

[17] See Keen and Ligthart (2006) for a primary understanding of the interaction between information sharing and tax competition.

[18] The previous literature on information sharing and tax competition generally adopts a two-stage game because the decisions regarding the exchange of information often require specific mechanisms, which are long-run in nature, be set up.

interpret the observation that large countries tend to exchange more information while tax havens prefer not to do so. Second, as tax havens share less information, the implementation of enforcement policies in high-tax countries would be more difficult compared to the case with full information. The difficulty in exchanging information can also be thought of as one kind of enforcement cost. In view of this, the possibility for the stimulating effect of tax havens on public goods in the TEC game is expected to decline (see the discussion in Section 4.1). Lastly, under the framework one can also investigate whether cooperation in information sharing improves the global welfare.[19] If the answer is yes, some mechanisms are required to achieve such a cooperation because essentially tax havens have little incentive to volunteer the information. We shall leave these interesting topics to future research.

5. Conclusion

In this paper, we present a tax competition model in which governments can choose the tax enforcement policy as competing for mobile capital, and use it to examine the impacts of tax havens on the public good and social welfare. The main finding is that tax havens may possibly increase the equilibrium public good and thus enhance social welfare if countries facing the rise of tax havens change their enforcement strategies in response.

The purpose of this paper is not to "compare" the two competition regimes. In fact, these two regimes are not fairly comparable because in the TEC and in the case of no tax havens, there is no scope for competition. Instead, we present a story of how the utilization of tax enforcement policies may counteract the under-provision of public goods caused by tax havens. More importantly, while in the standard tax

[19] Intuitively one may expect that cooperation in information sharing is welfare-improving. However, Makris (2003) surprisingly shows that such cooperation does not matter in equilibrium outcomes. He therefore argues that there is no need for such cooperation.

competition model tax havens cannot increase the public goods of high-tax countries, this analysis provides a possible explanation for the recent empirical evidence that the corporate tax revenues in high-tax countries have actually increased with the growth in the flow of FDI to tax havens.

Finally, we remark on the limitations of our study. First, to examine the pure effect of a tax enforcement policy, we have assumed that tax rates are fixed in the tax enforcement competition game. One could also allow countries to simultaneously alter the tax rates and the enforcement policies (e.g., Cremer and Gahvari, 2000; Peralta et al., 2006) and to investigate the mixed results. Second, we have examined the effect on the public good and welfare of an exogenous rise in tax havens. An interesting extension would be to consider heterogeneous countries and to endogenize the determination of becoming a tax haven. More fruitful results may be obtained if the analysis is extended to include this issue.

Appendix A: Proof of Proposition 1

We first derive the effect of raising the tax rate on the private consumption and the public good. This can be done by differentiating x and g with respect to t and inserting (4), (5), (6) and (8). Thus we have:

$$\frac{\partial x}{\partial t} = -r(1-\varphi(\cdot)t)\bar{k}\,, \tag{A1}$$

$$\frac{\partial g}{\partial t} = \left[-\varphi t\bar{k} + (1-\varphi t)\bar{k} + (1-\varphi t)t\frac{\partial k}{\partial t}\right]r = \left[(1-2\varphi t)\bar{k} + (1-\varphi t)t\frac{(1-\varphi t)r}{f_{kk}}\right]r$$

$$= \left[1-2\varphi t - \frac{\varepsilon(1-\varphi t)^2}{1+t-\varphi t^2/2}\right]r\bar{k}\,. \tag{A2}$$

The government chooses the tax rate to maximize the representative household's utility taking as given its budget constraint:

$$\max_t u = x + Z(g), \quad \text{s.t.} \quad g = (1-s)rtk. \tag{A3}$$

The optimization condition can thus be obtained by solving $\partial x/\partial t + Z_g \cdot \partial g/\partial t = 0$. Substituting (A1) and (A2) into the above equation yields:

$$Z_g^R = -\frac{\partial x/\partial t}{\partial g/\partial t} = \frac{1-\varphi t}{1-2\varphi t - \dfrac{\varepsilon t(1-\varphi t)^2}{1+t-\varphi t^2/2}}. \tag{A4}$$

By rearranging (A4) we can obtain (11) in the text. The tax rate and the provision of the public good are defined simultaneously from the system of (9) and (11). We define:

$$g = H(t,\varphi) = \frac{t(1-\varphi t)}{1+t-\varphi t^2/2}\rho k, \tag{A5}$$

$$Z_g^R = h(t,\varphi) = \left[1 - \frac{\varphi t}{1-\varphi t} - \frac{\varepsilon t(1-\varphi t)}{1+t-\varphi t^2/2}\right]^{-1}. \tag{A6}$$

From (A5) and (A6) we can obtain the following:

$$H_t = \frac{\rho k(1-2\varphi t-\varphi t^2/2)}{(1+t-\varphi t^2/2)^2}, \quad H_\varphi = -\frac{\rho k t^2(t+2)}{2(1+t-\varphi t^2/2)^2} < 0,$$

$$h_t = \frac{1}{\Delta^2}\left[\frac{\varphi}{(1+\varphi t)^2} + \frac{\varepsilon(1-2\varphi t-\varphi t^2/2)}{(1+t-\varphi t^2/2)^2}\right], \quad h_\varphi = \frac{-t}{\Delta^2}\left[-\frac{1}{(1+\varphi t)^2} + \frac{\varepsilon t(1+t/2)}{(1+t-\varphi t^2/2)^2}\right],$$

where $\Delta = 1 - \dfrac{\varphi t}{1-\varphi t} - \dfrac{\varepsilon t(1-\varphi t)}{1+t-\varphi t^2/2} > 0$.

Given Assumption 3, we have $H_t > 0$ and $h_t > 0$. Moreover, by Assumption 2 we can prove that:

$$\begin{aligned} &-\frac{1}{(1+\varphi t)^2} + \frac{\varepsilon t(1+t/2)}{(1+t-\varphi t^2/2)^2} < -\frac{1}{(1+\varphi t)^2} + \frac{(1+t)(1+t/2)}{(1+t-\varphi t^2/2)^2} \\ &= \frac{-2\varphi t - t/2 - 2\varphi t^2 - t^2/2 + \varphi^2 t^2 + 3\varphi^2 t^3/2 + \varphi^2 t^4/4}{(1+\varphi t)^2(1+t-\varphi t^2/2)^2} \end{aligned}, \tag{A7}$$

which is negative given $\varphi t \le 1$ and $t < 1$, and thus indicates that $h_\varphi > 0$.

Next, the implicit function theorem is applied:

$$Z_{gg}^{R} dg = h_t dt + h_\varphi d\varphi , \tag{A8}$$

$$dg = H_t dt + H_\varphi d\varphi . \tag{A9}$$

Finally, by utilizing Cramer's rule, we can derive the relationship

$$\begin{bmatrix} Z_{gg}^{R} & -h_t \\ 1 & -H_t \end{bmatrix} \begin{bmatrix} dg/d\varphi \\ dg/dt \end{bmatrix} = \begin{bmatrix} h_\varphi \\ H_\varphi \end{bmatrix}, \tag{A10}$$

or

$$\frac{dg}{d\varphi} = \frac{-H_t h_\varphi + h_t H_\varphi}{-H_t Z_{gg}^{R} + h_t} < 0 . \tag{A11}$$

Thus Proposition 1 is proved. ■

Appendix B: Proof of Proposition 2

We first need to obtain the effects of changing the enforcement policy on the private consumption and the public good. Differentiating x and g with respect to α and utilizing (4), (5), (7) and (8) yields:

$$\frac{\partial x}{\partial \alpha} = \frac{r}{2} t^2 \varphi_\alpha \bar{k} , \tag{A12}$$

$$\frac{\partial g}{\partial \alpha} = \left[-\varphi_\alpha t\bar{k} + (1-\varphi t)\frac{\partial k}{\partial \alpha} \right] tr = \left[-\varphi_\alpha t\bar{k} - (1-\varphi t)\frac{rt^2\varphi_\alpha}{2 f_{kk}} \right] tr$$

$$= \left[-1 + \frac{\varepsilon t(1-\varphi t)}{2(1+t-\varphi t^2/2)} \right] rt^2 \varphi_\alpha \bar{k} . \tag{A13}$$

The government adjusts the enforcement policy to maximize the representative household's utility taking as given its budget constraint:

$$\max_{\alpha} u = x + Z(g), \quad \text{s.t.} \quad g = (1-s)rtk . \tag{A14}$$

Substituting (A12) and (A13) into (12) yields (13) in the text. Then we compare the magnitudes of Z_g^E and Z_g^N:

$$
\begin{aligned}
Z_g^E - Z_g^N &= Z_g^E Z_g^N (Z_g^{N^{-1}} - Z_g^{E^{-1}}) \\
&= Z_g^E Z_g^N \left[1 - \frac{\varepsilon t}{1+t} - 2 + \frac{\varepsilon t(1-\varphi t)}{1+t-\varphi t^2/2} \right] \\
&= Z_g^E Z_g^N \Omega \left[-(1+t)(1+t-\frac{\varphi t^2}{2}) - \varepsilon t(1+t-\frac{\varphi t^2}{2}) + \varepsilon t(1+t)(1-\varphi t)) \right] \\
&= Z_g^E Z_g^N \Omega \left[-(1+t)(1+t-\frac{\varphi t^2}{2}) - \varepsilon \varphi t^2 (1+\frac{t}{2}) \right] < 0, \qquad \text{(A15)}
\end{aligned}
$$

where $\Omega = [(1+t)(1+t-\varphi t^2/2)]^{-1} > 0$. The above equation together with the property of $Z_{gg} < 0$ completes the proof of Proposition 2. ■

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