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CESIFO WORKING PAPER NO. 3867
CATEGORY 1: PUBLIC FINANCE
JUNE 2012

PRESENTED AT CESIFO AREA CONFERENCE ON PUBLIC SECTOR ECONOMICS, APRIL 2012

CESifo *Working Paper No. 3867*

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Abstract

Rent-sharing between firm owners and workers is a robust empirical finding. If workers bargain with firms, information on the actual surplus is essential. When the firm can use profit shifting to create private information on the surplus, it can thereby reduce its wage bill. We study how rent sharing and this wage incentive for profit shifting affect the ability of governments to tax multinational companies in a standard model of international tax competition. We find that if firms only have a tax incentive for profit shifting, rent-sharing decreases the competitive pressure on the large country and leads to higher equilibrium tax rates. When we allow for the wage channel, this result can change. If the wage incentive is sufficiently strong, rent-sharing increases the competitive pressure on the large country, implying a lower equilibrium tax rate.

JEL-Code: F230, H250, H730.

Keywords: wages, tax competition, rent-sharing, profit shifting, tax havens, private information.

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This version: June 2012
We would like to thank Mike Devereux, Daniel Dreßler, Carsten Eckel, Ben Ferrett, Clemens Fuest, Giorgia Maffini, Andreas Haufler, Eckard Janeba, Marko Koethenbuerger, Udo Kreickemeier, Frank Stähler as well as seminar participants at the CBT Summer Symposium 2011, Loughborough University, University of Tübingen, ZEW Mannheim, University of Namur, CESifo Public Sector Economics Area Conference and Humboldt University Berlin for fruitful discussions and comments. Any remaining errors are our own. Schmidt-Eisenlohr acknowledges financial support from the ESRC (Grant No RES -060-25-0033) and CESifo, Munich.

1 Introduction

Rent-sharing between firm owners and workers is a robust finding in a large number of empirical studies. That is, more profitable firms pay higher wages to their employees than comparable firms with lower profits. Moreover, when management and workers bargain over observable rents, the management of a firm can limit the amount of rents going to workers by under-reporting profits and withholding relevant information on profitability. Several studies provide evidence for this mechanism: in the presence of wage bargaining, management tends to under-report profits and create informational opacity.[1]

While most firms can adjust reported income and limit information to some extent, multinational firms have ample opportunities to do so.[2] They have an extensive ability to shift surplus between jurisdictions, for example by setting transfer prices, royalty payments and intra-group interest rates. To limit wage costs, the management of a multinational may therefore shift surplus away from affiliates with large and strong work forces and limit information on affiliate profitability available to workers.

When multinationals can use profit shifting to reduce their wage bill, the wage setting process affects the allocation of profits across borders. As these profits constitute the tax bases of national governments, this shifting incentive influences the actions of governments competing for an internationally mobile tax base.

How do rent-sharing and the wage incentive for profit shifting affect the ability of national governments to tax corporate profits of multinational companies? To study this question, we introduce rent-sharing between firms and workers into a standard model of international tax competition. We start the analysis from a benchmark case where firms only have a tax incentive for profit shifting, the common approach in the literature. We show that in this case rent-sharing *reduces* the competitive pressure on governments. In this benchmark, the sole effect of rent-sharing is an increase in the share of surplus going to workers, making shifting less attractive for firms. This reduces the competitive pressure on the government of the large country. It faces a less mobile tax base and sets a higher equilibrium tax rate.

[1] We discuss this literature below.

[2] A case in point is "stateless income". Kleinbard (2011) argues that a share of the surplus of most multinational firms falls into this category. These are rents that are not directly linked to real activities in any specific location and that can be easily moved across jurisdictions.

The introduction of the wage incentive for profit shifting can alter this result substantially. When multinationals can use profit shifting to limit their wage bill, the effect of rent sharing on the strength of tax competition is ambiguous. If the additional incentive for shifting surplus is weak, rent-sharing continues to decrease the strength of tax competition. If the additional incentive is sufficiently strong, the effect is overturned and rent-sharing increases the strength of tax competition. In this case, the large country is forced to set a lower tax rate to limit outflows of surplus.

To further analyze the tax revenue trade-offs faced by the governments, we study the own-tax elasticities of tax revenues of the large country and the tax haven under rent-sharing. These elasticities can be decomposed into a direct effect and a tax base effect. The latter captures the change in the number of shifting firms implied by the change in the tax rate. We find that for both countries this tax base effect decreases in the bargaining power of workers. This is different for the detection ability: it increases the tax base effect of the large country, while it decreases the tax base effect of the tax haven.

While the mechanisms studied should be relevant for tax competition both between similar and dissimilar countries, for analytical tractability, we focus on a tax game between a large country and a tax haven. In our model, firms operate under monopolistic competition and generate positive surpluses. All production takes place in the large country but firms can choose to shift their surplus to an affiliate in the tax haven where profits are taxed at a different rate. Firms differ in the fixed costs of shifting surplus, which are distributed uniformly across firms.

We model the wage setting at the firm level as a Nash bargaining game between workers and firm owners. This leads to rent-sharing and therefore to a positive link between surplus and wages. For a firm declaring its surplus in the large country, the full surplus is bargained over. When the surplus is shifted to the tax haven, only a fraction η of the surplus is taken into account in the wage bargaining. We refer to this fraction η as the *detection ability* of workers. We adopt a flexible setting allowing for anything from no detection to perfect detection of shifted surplus.

This setup allows us to study the main mechanism of interest in a tractable way. It requires, however, that workers do not fully understand the game as they Nash-bargain over the observed surplus as if it was the full surplus. This constitutes a deviation from rational expectations. In section 5 we show how the baseline model can be micro-founded by a model with rational expectations and private information. The micro-foundation is based on a generalization of the Nash bargaining solution to the case of private information developed by Myerson (1984).

This paper contributes to the literature on international tax competition started by Zodrow and Mieszkowski (1986) and Wilson (1986).[3] One important strand of this literature analyzes how multinational firms shift profits across borders responding to tax incentives. Several empirical studies have shown that multinationals indeed use profit shifting to reduce their tax payments.[4] Theoretical work in this area has mainly focused on the question how profit shifting can allow a multinational firm to reduce its tax payments and in how far this limits the ability of governments to raise taxes.[5] We extend the analysis of profit shifting by introducing wage bargaining into the standard tax competition game. Solving for the equilibrium of the extended tax game allows us to evaluate the effect of rent-sharing on tax competition and to study a new incentive for profit shifting: the wage channel.

The most related paper is Riedel (2011). She outlines a model of tax competition with wage bargaining within a multinational firm, but does not derive the equilibrium of the tax game. Instead, she focuses on the case of identical tax rates and analyzes the different implications of separate accounting and formula apportionment.

Our paper also contributes to the recent literature of tax competition with heterogeneous firms. Several papers have introduced firm heterogeneity into models of tax competition. In Burbidge, Cuff, and Leach (2006) firms differ in market specific productivity. Baldwin and Okubo (2009), Davies and Eckel (2010), Krautheim and Schmidt-Eisenlohr (2011) and Haufler and Stähler (forthcoming) model a heterogeneous variable production cost. We follow Mongrain and Wilson (2011) by studying the case of a constant variable production cost combined with heterogeneous shifting costs.

[3] See Wilson (1999), Wilson and Wildasin (2004) or Fuest, Huber, and Mintz (2005) for surveys.

[4] See among others Swenson (2001), Altshuler and Grubert (2003), Clausing (2003), Desai, Foley, and Hines (2004), Bernard, Jensen, and Schott (2006), Huizinga, Laeven, and Nicodeme (2008) and Maffini and Mokkas (2011).

[5] See e.g. Elitzur and Mintz (1996), Haufler and Schjelderup (2000), Janeba (2000), Mintz and Smart (2004), Peralta, Wauthy, and van Ypersele (2006) and Bucovetsky and Haufler (2008).

There is ample empirical evidence of a positive relationship between wages and profits.[6] Several theoretical approaches can generate this link. We follow Blanchflower, Oswald, and Sanfey (1996) who propose a model where workers and firm owners bargain over the generated surplus.[7]

More recently, Budd and Slaughter (2004), Budd, Konings, and Slaughter (2005) and Martins and Yang (2010) provide evidence that within multinational firms rent-sharing also takes place across national borders. Budd, Konings, and Slaughter (2005) and Martins and Yang (2010) show that higher profits in the headquarter are shared with workers in the foreign affiliates. It is of interest to note, however, that both papers do not find robust evidence for rent-sharing in the opposite direction: higher affiliate profits have no significant effect on wages in the headquarters. This asymmetry is consistent with our model: to the extent to which shifted surpluses are not detected by workers, they should not affect domestic wages.

The extent to which the management of a firm manipulates reported income to affect wage bargaining is the focus of a literature in accounting and finance. It analyzes whether managers reduce information provision and under-report income to limit rents that can be appropriated by workers and whether information sharing affects wages. Using stock market and firm level data, Hilary (2006) finds that stronger labor representation is related to more information asymmetry between management and investors. DeAngelo and DeAngelo (1991) study labor negotiations in the steel industry in the 1980s. They find that reported income and management compensation is lower in years when there are labor negotiations than in years when there are none. In particular one-time special charges that can be allocated discretionary by management across years are used to reduce reported income in negotiation years. Kleiner and Bouillon (1988) find that

[6]See for example Katz, Summers, Hall, Schultze, and Topel (1989), Christofides and Oswald (1992), Abowd and Lemieux (1993), Blanchflower, Oswald, and Sanfey (1996), Van Reenen (1996) and Hildreth and Oswald (1997) and references therein. In line with these earlier findings, Helpman, Itskhoki, Muendler, and Redding (2012), who analyze detailed matched firm-worker data from Brazil, find that most of the wage inequality within sectors and occupations is driven by wage differences between firms rather than by wage differences within firms.

[7]An alternative way to generate this link is the 'fair wage' hypothesis introduced by Akerlof and Yellen (1990), according to which workers only provide full effort if they receive a wage they consider 'fair'. The fair wage can depend on factors like wages in other firms, firm profits or the productivity of the firm. Lindbeck and Snower (1988) propose an insider-outsider model of the labor market also generating a link between profits and wages.

wages and benefits increase with information-sharing between management and workers, whereas productivity is unaffected.

The idea that optimal profit shifting decisions by firms are affected by tax considerations as well as by other aspects of profit maximization is also analyzed in a literature in management and accounting. Halperin and Srinidhi (1991), for example, study the trade-off between minimizing the tax bill and using appropriate transfer prices for performance evaluation purposes.

Our paper is also related to the literature on tax havens. The quantitative importance of tax havens has been documented by Hines and Rice (1994), Hines (2005) and Desai, Foley, and Hines (2006). Two recent theoretical contributions, Slemrod and Wilson (2009) and Hong and Smart (2010), discuss the desirability of tax havens. Marceau, Mongrain, and Wilson (2010) show that, in a non-preferential regime, the effect of a tax haven on equilibrium tax rates of larger countries might be limited.

A recent literature studies the tax incidence of the corporate income tax. Taking tax policy as given, this literature focuses on the question to which extent firms share the burden of taxation with workers. Arulampalam, Devereux, and Maffini (2010) analyze a model where workers wage bargain with the firm over post-tax surplus, which implies that part of the tax burden falls on labor. In support of this prediction, the authors find evidence for a negative correlation between the tax bill and the wage bill of a firm after controlling for value added. Felix and Hines (2009) report similar results on the relationship between tax payments and wages in unionized firms in the US. In our paper, we abstract from this direct tax incidence. Instead, we analyze how wage bargaining affects the profit shifting behavior of firms and thereby the strategic tax game between governments.

The rest of the paper is structured as follows. The next section outlines the model and analyzes the determinants of the cutoff cost level. Section 3 introduces the tax game between the large country and the tax haven and presents the best response functions. The equilibrium of the tax game as well as the main results of the paper are derived in Section 4. Section 5 concludes.

2 The Model

2.1 The Economy

Large country: All production takes place in the large country. Labor is the only input in production. There is a unit mass of workers who each inelastically supply one unit of labor. There are two sectors, one producing varieties of a differentiated good and one producing a homogeneous good used as the numeraire. One unit of the homogeneous good is produced using one unit of labor. This implies that the wage in the homogeneous good sector is one. We only consider equilibria in which the homogeneous good is produced. Wages in the differentiated good sector may be above one, but the sector is too small to accommodate all workers. There is a fixed and exogenous measure of firms in the differentiated good sector of size one, which are owned by consumers in the large country.

The only tax instrument of the government in the large country is a proportional tax t_H on the profits of firms in the large country. Tax income is used to provide government services G to consumers. The government can transform one unit of the numeraire good into one unit of the government services. It is assumed to maximize welfare of its own citizens.

Tax haven: The structure of the tax haven is kept as simple as possible. It does not have a tax base of its own. Its only source of revenue stems from taxing profits of affiliates located in the tax haven with a tax rate of t_X. Taking the tax rate in the large country as given, the tax haven maximizes total revenues $V = t_X \Pi_X$.

Preferences: The workers in the large country are all identical and share the same quasi-linear preferences over the two consumption goods and the good provided by the government:

$$U = \alpha \; lnQ + \beta \; G + q_0 \qquad with \qquad Q = \left(\int_I q_i^{\frac{\sigma-1}{\sigma}} di \right)^{\frac{\sigma}{\sigma-1}}, \tag{1}$$

where q_i is the quantity consumed of variety i and I is the set of available varieties. The elasticity of substitution between varieties is given by $\sigma > 1$. Q represents utility from consumption of a basket of differentiated goods. G is the quantity of a public good provided by the government. The consumption of the numeraire good is given by q_0. α and β are parameters with $0 < \alpha < 1 < \beta$. The parameter β represents marginal utility from the public good. Setting $\beta > 1$ assures that the government has an incentive to provide the public good also when the distortion from tax competition is introduced. Demand for one particular variety is:

$$q_i = \frac{p_i^{-\sigma}}{P^{-\sigma}}\, Q. \tag{2}$$

p_i is the price of variety i, and P is the welfare based price index.[8]

2.2 Surplus Shifting and Wages

Worker compensation: Firms in the differentiated goods sector generate a positive surplus that is shared between workers and firm owners. The fraction of surplus going to each group is determined in a Nash bargaining game.

The Nash product of the bargaining problem in firm i is:

$$[w_i - 1]^{\delta}[(1 - t_H)\pi_i - 0]^{1-\delta}. \tag{3}$$

The parameter δ represents the bargaining power of workers. Wage payments in firm i are denoted by w_i, the outside option of workers is employment in the homogeneous good sector with a wage of one. After tax profits of the firm are $(1 - t_H)\pi_i$ and the outside option of the firm is no production with zero profits. We define s_i as the overall surplus (at wages of unity) generated by firm i. We denote the fraction of this surplus payed to workers by x_i, so that overall wage payments are $(1 + x_i s_i)$ and profits are given by $(1 - x_i)s_i$. We can thus rewrite equation (3):

$$[x_i s_i]^{\delta}[(1 - t_H)(1 - x_i)s_i]^{(1-\delta)}. \tag{4}$$

Maximizing the Nash product implies that the worker's fraction of surplus equals their

[8] The welfare based price index is defined as $P = \left(\int_I p_i^{1-\sigma} di\right)^{\frac{1}{1-\sigma}}$.

bargaining power: $x_i = \delta \ \forall i$. This implies a simple sharing rule where surplus-dependent payments to workers are $b_H = \delta s_i$ and pre-tax profits are $\pi_H = (1-\delta)s_i$.

Prices and surplus: In a model without rent-sharing between the firm and workers ($\delta = 0$), firms charge a constant mark up over marginal cost. In the model with rent-sharing ($\delta > 0$) we find that the optimal pricing rule of firms is unchanged:

$$p_i = \frac{\sigma}{\sigma - 1}\ a. \tag{5}$$

The firm gives a fraction of its surplus to workers. It then pays a share of the remaining surplus (its pre-tax profits) as taxes to the government. The price maximizing total surplus is the same as the price maximizing post-tax profits. Since all firms share the same productivity, all firms charge the same price $p_i = p, \ \forall i$. The surplus of a firm is given by:

$$s_i = qp - aq = \frac{\alpha}{\sigma}. \tag{6}$$

It follows that surplus-dependent payments to workers are $b_H = \delta\frac{\alpha}{\sigma}$ and pre-tax profits are $\pi_H = (1-\delta)\frac{\alpha}{\sigma}$.

Surplus shifting: Firms in the large country have the ability to open an affiliate in the tax haven, which allows them to shift surplus abroad. There are two ways in which a firm can benefit from surplus shifting. Shifted surplus is taxed in the tax haven at the rate t_X, but not at home, where the firm declares zero profits.

In addition, only a fraction $\eta \in [0,1]$ of its shifted surplus is detected by workers and therefore taken into account in the wage bargaining. When firms shift the surplus abroad, $(1-\eta)s_i$ of it is not detected by the workers, so that bargaining is over ηs_i only. The Nash product in the shifting case becomes:

$$[x_i \eta s_i]^{\delta}[(1-t_X)(1-x_i)\eta s_i]^{(1-\delta)}. \tag{7}$$

For the benchmark case of perfect detection ($\eta = 1$), this is identical to equation (4). If workers cannot detect all shifted surplus ($\eta < 1$), workers and the firm bargain only over a fraction of the actual surplus. Varying $\eta \in [0, 1]$ allows considering the whole range of cases between no detection and perfect detection of shifted surplus.

We assume that workers only observe a fraction of shifted surplus and then Nash-bargain with the firm as if it was the true surplus. That is, we model the problem as Nash-bargaining under complete information, where one party (the workers) has a false belief about the true nature of the game. This simplifying assumption implies a deviation from rational expectations, but allows us to study the main mechanism of interest in a tractable way. In section 5 we show how the main setup can be micro-founded by a model featuring rational expectations and private information. The micro-foundation is based on the neutral bargaining solution, a generalization of the Nash bargaining solution, developed by Myerson (1984).

Self selection into surplus shifting: Opening an affiliate in the tax haven requires paying a fixed cost c_i. These fixed costs are distributed uniformly between zero and one, i.e. $F(c) = c$ with $c \in [0, 1]$. We assume that this cost is borne completely by the owners of the firm, and that it is neither tax deductible in the tax haven, nor does it affect the surplus bargained over with workers. The welfare maximizing government does, nevertheless, take into account the loss of resources due to the fixed cost of surplus shifting.

Of the surplus generated by a shifting firm, surplus-dependent payments to workers are $b_X = \eta\delta\frac{\alpha}{\sigma}$ and after-tax payments to shareholders are $(1-t_X)\pi_X = (1-t_X)(1-\eta\delta)\frac{\alpha}{\sigma}$. The remainder represents tax payments to the government in the tax haven.

The cutoff shifting cost level c^* is defined as the shifting cost of a firm which is indifferent between shifting surplus and paying taxes at home. This cost level is pinned down by $(1 - t_H)\ \pi_H = (1 - t_X)\ \pi_X - c^*$ which can be solved for:

$$c^* = \frac{\alpha}{\sigma}\tilde{\rho}, \tag{8}$$

with:

$$\begin{aligned}\tilde{\rho} &= (1-t_X)(1-\eta\delta)-(1-t_H)(1-\delta) \\ &= \rho-\eta\delta(1-t_X)+\delta(1-t_H),\end{aligned} \tag{9}$$

and $\rho = t_H - t_X$. We label $\tilde{\rho}$ 'effective tax difference'. It reflects the different incentives for surplus shifting. When the wage channel is open, the difference in tax rates is no longer the only determinant of surplus shifting. Firms have to share surplus with workers (reflected by the parameter δ) and shifting allows them to reduce the fraction going to workers to $\eta\delta$.

Note that sharing surplus with workers works exactly like a 100% tax rate on a fraction δ of surplus when surplus is not shifted and on a fraction $\eta\delta$ when surplus is shifted. So the 'effective tax rate' a non-shifting firm is facing is a combination of t_H payed on $(1-\delta)$ of surplus and a 100% tax rate on a share δ. When surplus is shifted, only a fraction $\eta\delta$ is 'taxed away' by workers.[9]

Shifting incentives with rent-sharing and imperfect detection The bargaining power δ and the detection ability η of workers affect the incentives for firms to shift surplus. This can be seen by considering the change in the cutoff shifting cost level c^* that is associated with changes in these two parameters, respectively. First, consider an increase in the bargaining power δ:

Lemma 1 *Suppose $c^* \in (0,1)$. Then, for given tax rates t_H and t_X, an increase in the bargaining power of workers δ,*

- *decreases the number of firms shifting surplus (lower c^*) iff the detection ability η is greater than $\frac{1-t_H}{1-t_X}$.*
- *increases the number of firms shifting surplus (higher c^*) iff the detection ability η is less than $\frac{1-t_H}{1-t_X}$.*
- *does not affect the number of firms shifting surplus (constant c^*) otherwise.*

[9] The 'effective tax rates' for the firms can be defined as $\tilde{t}_H = (1-\delta)t_H + \delta$ and $\tilde{t}_X = (1-\eta\delta)t_X + \eta\delta$. Their difference gives equation (9).

Proof: see Appendix A.

If workers have a strong or perfect ability to detect surplus (high η), the main incentive to shift surplus is to reduce tax payments (tax channel). In this case, an increase in δ reduces shifting incentives for firms. It implies lower pre-tax profits and therefore diminishes the gain from surplus shifting, which are proportional to the pre-tax profits. If workers can only detect a small fraction of the shifted surplus (low η), surplus shifting is attractive due to wage bill considerations. Then, an increase in δ increases the wage difference between shifting and non-shifting firms and thereby increases the incentive to shift surplus.

Second, consider an increase in the detection ability of workers (higher η):

Lemma 2 *Suppose $c^* \in (0,1)$ and $\delta \in (0,1)$. Then, for given tax rates t_H and t_X,*

(i) an increase in the detection ability of workers (η), decreases the number of firms shifting surplus (lower c^*).

(ii) the effect of the detection ability on the shifting behavior is the stronger, the stronger the bargaining power of workers δ.

Proof: see Appendix A.

If workers are less able to detect surplus (lower η), firms gain more from shifting surplus, as they can save more on their wage bill. This effect is the stronger, the larger the bargaining power of workers δ. In this case the ability to reduce the surplus bargained over becomes more beneficial for the firm owners.

Aggregation Aggregate surpluses generated by non-shifters and shifters S_H and S_X are split into aggregate surplus dependent payments B_H and B_X and taxable profits Π_H and Π_X:[10]

$$S_H = \int_{c^*}^{1} \frac{\alpha}{\sigma}\, dF(c) = (1-c^*)\frac{\alpha}{\sigma} \qquad\qquad S_X = c^* \frac{\alpha}{\sigma} \tag{10}$$

[10] As firms are fully characterized by their cost levels, we can take the integral over the support of $F(c)$ in the aggregation.

$$B_H = (1 - c^*)\delta\frac{\alpha}{\sigma} \qquad\qquad B_X = c^*\eta\delta\frac{\alpha}{\sigma} \tag{11}$$

$$\Pi_H = (1 - c^*)(1-\delta)\frac{\alpha}{\sigma} \qquad\qquad \Pi_X = c^*(1-\eta\delta)\frac{\alpha}{\sigma}. \tag{12}$$

Total shifting costs are given by:

$$C = \int_0^{c^*} c dF(c) = \frac{1}{2}(c^*)^2. \tag{13}$$

3 Tax Competition

The only variables governments can set are the profit tax rates in their jurisdictions. Taxes are set in a simultaneous one-shot game.

3.1 Optimization of the Tax Haven

Taking the tax rate in the large country as given, the tax haven maximizes total revenues $V = t_X\Pi_X$, which implies the following best response function of the tax haven:

$$\begin{aligned} t_X(t_H) &= \frac{\tilde{\rho}}{1-\eta\delta} \\ &= \frac{\delta(1-\eta)}{2(1-\eta\delta)} + \frac{1-\delta}{2(1-\eta\delta)}t_H. \end{aligned} \tag{14}$$

Figure 1 illustrates numerical examples of this best response function. The tax rate of the tax haven is plotted on the horizontal line against the tax rate of the large country. The dotted lines are the best response functions of the tax haven for different values of δ (for a constant $\eta = 0.3$). The best response function to the left represents the case of no rent-sharing $\delta = 0$. In this case the intercept in equation (14) becomes zero, implying that the best response is always above the 45 degree line, i.e. the tax haven always undercuts the large country. This is a familiar result from the tax competition literature.

For values of δ larger zero, the wage channel is active. In these cases, the tax haven undercuts the large country for high tax rates in the large country. For low values of t_H, however, the tax haves optimally responds by setting a *higher* tax rate. The range of large country tax rates for which this is the case increases as δ increases.

Figure 1 here.

3.2 Optimization of the Large Country

The government in the large country maximizes welfare of its citizens which is:

$$U = \bar{U} + (1 - t_H)\Pi_H + (1 - t_X)\Pi_X + B_H + B_X + \beta t_H \Pi_H - C. \tag{15}$$

The first term on the right hand side is a constant given by:

$$\bar{U} = \alpha \ln\left(\frac{\alpha}{\sigma}\right) - \alpha + 1.$$

$\bar{U}$ consists of the utility from consuming the basket of differentiated goods, the cost of this basket α and basic labor income 1. The second and third terms in equation (15) are the profits retained by consumers of non-shifting and shifting firms, respectively. The next two terms represent surplus dependent payments to workers. The final two terms are the overall utility from the consumption of the public good and the aggregate costs of surplus shifting.

For the derivation of the best response of the large country two cases need to be distinguished. The large country can set a tax rate that implies an effective tax rate above the tax rate of the tax haven. In this case, some firms shift surplus to the tax haven. Alternatively, the large country can set a tax rate that is sufficiently low to assure zero outflows of tax base. For the construction of the best response function, we consider both cases. For each possible value of t_X the best response is represented by the alternative that implies higher welfare.

Additionally, it has to be taken into account that the tax rate of the large country is bounded from above by one and from below by zero. In the following we focus on interior solutions, where the large country never sets a zero tax rate and where the best response of the large country implies $\tilde{\rho} = 0$ for some $t_X \leq 1$.[11] The best response function of the

[11] For detailed derivations and the full characterization of the best response function of the large country, including all corner solutions, see Appendix C.

large country is then given by:

$$
t_H(t_X) = \begin{cases} \dfrac{(\beta-1)\sigma/\alpha - \beta\delta(1-\eta)}{(1-\delta)(2\beta-1)} + \dfrac{\beta-1}{2\beta-1}\,\dfrac{1-\eta\delta}{1-\delta}t_X & \text{if } 0 \leq t_X < t_X^{k1} \\ \\ -\dfrac{\delta(1-\eta)}{1-\delta} + \dfrac{1-\eta\delta}{1-\delta}t_X & \text{if } t_X^{k1} \leq t_X \leq 1, \end{cases} \tag{16}
$$

with $t_X^{k1} = \frac{(\beta-1)[\sigma/\alpha-\delta(1-\eta)]}{\beta(1-\eta\delta)}$ and $t_X^{k2} = \frac{\beta\delta(1-\eta)-(\beta-1)\sigma/\alpha}{(\beta-1)(1-\eta\delta)}$. For low values of t_X, the large country sets a tax rate t_H such that $\tilde{\rho} > 0$, inducing a positive mass of firms to shift surplus. For higher values of t_X, the large country prevents all outflows by choosing a tax rate t_H which sets the effective tax difference to zero ($\tilde{\rho} = 0$).

Figure 2 here.

The best response function is illustrated graphically in Figure 2. The function to the left represents the benchmark case of $\delta = 0$, where the wage channel is closed down. In this case, tax differences are the only incentives for firms to shift surplus. For low values of t_X, the large country sets a higher tax rate than the tax haven. For high values of t_X, it is optimal for the large country to set its tax rate equal to the tax rate of the tax haven, which in the absence of the wage channel assures zero outflows of tax base. This implies that when the wage channel is not active, the large country always sets a tax rate larger or equal to the tax rate of the tax haven.

When δ is positive (given $\eta = 0.3$), firms have an additional incentive for shifting surplus to the tax haven: reducing their wage bill. With the wage channel open, it can be optimal for the large country to undercut the tax haven. This is reflected by the points below the 45-degree line. A strong wage channel (combination of high δ and low η) can make surplus shifting so attractive for wage reasons that the tax haven can set a higher tax rate than the large country and still attract some of the tax base.

4 Tax Equilibrium and the Wage Channel

4.1 Equilibrium

Based on the best response functions of the tax haven and the large country in equations (14) and (16), we can derive the equilibrium tax rates:

Proposition 1 *There is a unique equilibrium of the tax game. Equilibrium tax rates are given by:*

$$t_H^* = \min\left\{\max\left\{\frac{2(\beta-1)\sigma/\alpha-(\beta+1)\delta(1-\eta)}{(3\beta-1)(1-\delta)},0\right\},1\right\} \tag{17}$$

$$t_X^* = \min\left\{\frac{(\beta-1)[\sigma/\alpha+\delta(1-\eta)]}{(3\beta-1)(1-\eta\delta)},\frac{1}{2}\right\}. \tag{18}$$

Proof: see Appendix D.

The graphs in Figure 3 illustrate equilibria for full, partial and no detection ability of workers. For the benchmark case of perfect detection ($\eta = 1$) we get a standard equilibrium with the tax haven undercutting the large country in the first graph. The second and third graphs illustrate the cases where the wage channel is open and workers can only detect a fraction $\eta = 0.5$ and $\eta = 0$ of shifted surplus. Opening up the wage channel pushes the equilibrium tax rates down. In the second graph ($\eta = 0.5$), we still obtain the standard result that the tax haven undercuts the large country but the equilibrium is closer to the 45 degree line, implying that tax rates are more similar.[12]

Figure 3 here.

In the special case of no detection ($\eta = 0$), the wage channel is so strong that the tax haven even sets a *higher* tax rate than the large country. That is, for extreme parameter values the standard result of the tax haven undercutting the large country can be reversed.

In our model, the wage channel creates an additional incentive for surplus shifting and therefore weakens the standard link between tax rate differentials and the direction

[12] The effects of changes in the detection ability on the equilibrium are discussed in detail in section 4.2.

of surplus shifting. In the next section we investigate the impact of the wage channel on the tax equilibrium and show under which conditions its introduction increases the competitive pressure on the large country.

4.2 Wage Channel and Competitive Pressure

We now analyze the effect of the wage channel on the tax equilibrium. For this analysis, it is key to differentiate between the role of the bargaining power of workers δ and their ability to detect shifted surplus η.

Rent-Sharing: We first analyze the impact of the introduction of rent-sharing on the tax equilibrium as well as on the strength of the competitive pressure the large country faces. In a world without a tax haven (autarky), the optimal tax rate of the large country is equal to one. We use the deviation of the equilibrium tax rate from this welfare maximizing autarky tax rate $1 - t_H^*$ as a measure competitive pressure. For notational convenience, we define $\kappa \equiv 1 - 2\frac{\beta-1}{\beta+1}\frac{\sigma}{\alpha}$. We can now state the following proposition:

Proposition 2 *At an interior equilibrium, i.e. $t_H^* \in (0,1)$, when the bargaining power of workers δ increases,*

(i) the equilibrium tax rate of the large country t_H^*

- *increases (competitive pressure decreases) iff the detection ability η is greater than κ.*
- *decreases (competitive pressure increases) iff the detection ability η is less than κ.*
- *is constant (competitive pressure constant) otherwise.*

(ii) the equilibrium tax rate of the tax haven t_X^* increases.

Proof: see Appendix E.

The impact of the worker's bargaining power δ on the equilibrium tax rates and the strength of competitive pressure depends on the detection ability η. When it is sufficiently strong, surplus shifting does not have a strong impact on the wage bill. In this case, the main incentive for surplus shifting is the tax channel. When δ increases firm owners get a smaller fraction of the surplus. This implies that the tax savings from shifting decrease and are therefore less likely to outweigh the fixed cost of shifting. This reduced incentive to shift surplus reduces the competitive pressure the large country faces.

The bargaining power of workers δ has the opposite effect when detection ability η is sufficiently weak. In this case, surplus shifting becomes more attractive the higher δ: it allows firms to partially neutralize the strong bargaining power of workers by shifting surplus to the tax haven, where only a small fraction of them is detected. As δ increases, the increased competitive pressure forces the government of the large country to set a lower tax rate.

Figure 4 here.

The effects in Proposition 2 are illustrated in Figure 4 where the equilibrium tax rates of the large country (solid line) and of the tax haven (dashed line) are plotted against δ. We consider the two extreme cases of $\eta = 1$ (perfect detection) in the first graph and $\eta = 0$ (no detection) in the second graph.

With perfect detection, an increase in δ weakens the tax channel, decreases competitive pressure and therefore allows the large country to set a higher tax rate. When detection is imperfect ($\eta < 1$), the competitive pressure increases and the schedule of equilibrium tax rates of the large country becomes flatter. It is constant when the condition in Proposition 2 holds with equality. For lower values of η the slope is negative. The second graph in Figure 4 illustrates the case of no detection ($\eta = 0$).

Effect of Detection Ability: We now consider the effect of different degrees of detection ability on the tax competition equilibrium as well as the strength of the competitive pressure the large country faces. These effects are summarized in the following proposition:

Proposition 3 *At an interior equilibrium with rent-sharing, i.e.* $t_H^* \in (0, 1)$ *and* $\delta \in (0, 1)$, *(i) when the detection ability η is weaker, the equilibrium tax rate of the large country t_H^* is lower. Therefore, the degree of tax competition (measured by $1-t_H^*$) is higher.*

(ii) the effect of the detection ability η on the equilibrium tax rate t_H^* is the stronger, the higher the bargaining power δ.

(iii) when the detection ability η is weaker, the equilibrium tax rate of the tax haven t_X^* is lower.

Proof: see Appendix F.

When the detection ability decreases, the wage incentive for surplus shifting gets stronger. *Ceteris paribus*, more firms start shifting surplus. This implies that it becomes more difficult for the large country to prevent its tax base from flowing to the tax haven. This increased competitive pressure forces the large country to set a lower tax rate, optimally trading off the effects of the lower tax rate both on outflows and on tax payments by firms that keep paying taxes at home.[13]

The effect of the detection ability η on the equilibrium tax rate t_H^* increases in the bargaining power of workers δ. The intuition is that the more surplus a firm would have to give to workers at home, the more important becomes the wage bill motive for surplus shifting. The equilibrium tax rate of the tax haven also decreases when detection ability decreases.

Figure 5 here.

Figure 5 illustrates the results in Proposition 3. Both the tax rate of the large country (solid line) and the tax rate of the tax haven are increasing in η. So when workers can detect a smaller fraction of shifted surplus (lower η), surplus shifting is more attractive and the equilibrium tax rates are lower. The fact that the model delivers a negative tax difference (i.e. $t_X > t_H$) for some parameter values is also reflected in Figure 5: for weak detection abilities the tax rate of the tax haven is above the tax rate of the large country.

[13]Section 4.3 provides a detailed analysis of the determinants of the own-tax elasticity of the tax revenues in the large country.

4.3 Tax Revenue Elasticities and the Wage Channel

In this section we study the own-tax elasticities of tax revenues of the large country and the tax haven. While these elasticities are key when revenue maximization is the sole government objective, they only partially determine tax rates set by a welfare maximizing government. In taking a closer look at the revenue aspect of the problem of the government, this section therefore complements our analysis of the tax setting problem of a benevolent government from before.

In our model, the tax revenue elasticities of the large country and the tax haven can be decomposed into a direct effect (DE) and a tax base effect (BE). Holding the tax base constant, an increase in the tax rate increases tax revenue (direct effect). At the same time an increase in the tax rate leads to a reduction in the tax base (tax base effect).

Using Leibnitz rule, the own-tax elasticities of tax revenues for the large country and the tax haven, respectively, can be decomposed into the two effects:

$$\frac{d(\Pi_H t_H)}{dt_H}\frac{1}{\Pi_H} = \underbrace{\frac{1}{\Pi_H}\int_{c^*}^{1}\frac{\partial}{\partial t_H}t_H\pi_H(a)\frac{dF(c)}{dc}dc}_{\text{direct effect } (DE_H)} \underbrace{-\frac{1}{\Pi_H}t_H\pi_H(c^*)\frac{dF(c^*)}{dc}\frac{dc^*}{dt_H}}_{\text{tax base effect } (BE_H)} \tag{19}$$

$$= 1 - \frac{1-\delta}{\frac{\sigma}{\alpha}-\tilde{\rho}}\,t_H. \tag{20}$$

$$\frac{d(\Pi_X t_X)}{dt_X}\frac{1}{\Pi_X} = \underbrace{\frac{1}{\Pi_X}\int_{0}^{c^*}\frac{\partial}{\partial t_X}t_X\pi_X(c)\frac{dF(c)}{dc}dc}_{\text{direct effect } (DE_X)} \underbrace{+\frac{1}{\Pi_X}t_X\pi_X(c^*)\frac{dF(c^*)}{dc}\frac{dc^*}{dt_X}}_{\text{tax base effect } (BE_X)} \tag{21}$$

$$= 1 - \frac{1-\eta\delta}{\tilde{\rho}}t_X. \tag{22}$$

The direct effect holds the tax base constant (constant c^*) and captures the variation in taxes payed by each individual firm. Both for the large country and the tax haven, the direct effect is positive and equal to unity. That is, holding the tax base constant, a one percent increase in the tax rate increases revenues by one percent.

To compute the tax base effect, tax payments of a firm at the cutoff are multiplied with the change in the number of shifting firms implied by the change in the tax rate. As long as some firms are paying taxes in each country ($0 < c^* < 1$), this effect always implies a loss of tax base for the country that raises its tax rate. To facilitate the interpretation, in the following we define as the *strength* of the tax base effect its absolute value. That is: $|BE_H| = |-\frac{1-\delta}{\frac{\sigma}{\alpha}-\tilde{\rho}}\, t_H|$ and $|BE_X| = |\frac{1-\eta\delta}{\tilde{\rho}}|$.

The wage channel affects the own-tax elasticities of both countries through the tax base effect. The effect of rent-sharing on the strength of the tax base effect is summarized in the following proposition:

Proposition 4 *An increase in the bargaining power of workers δ reduces the strength of the tax base effect for both countries, i.e.* $\frac{\partial |BE_H|}{\partial \delta} < 0$ *and* $\frac{\partial |BE_X|}{\partial \delta} < 0$.

Proof: see Appendix G.

If a larger share of the surplus is given to the workers, multinational firms have lower pre-tax profits, implying a weaker incentive to shift surplus. Therefore, an increase in rent-sharing (higher δ) reduces the strength of the tax base effect for both countries.

The detection ability η also affects the strength of the tax base effect, as summarized in the following proposition:

Proposition 5 *If the detection ability η increases, the strength of the tax base effect of the*

(i) large country decreases, i.e. $\frac{\partial |BE_H|}{\partial \eta} < 0$

(ii) tax haven increases, i.e. $\frac{\partial |BE_X|}{\partial \eta} > 0$.

Proof: see Appendix G.

An imperfect detection ability of workers alters the tax competition game in favor of the tax haven, as it gives firms an additional incentive to shift surplus. As a consequence, a weaker detection ability (lower η) has opposing effects for the two countries. For the large country the strength of tax base effect increases which implies that the large country faces a higher own-tax elasticity. For the tax haven we have the opposite case: the strength of its tax base effect decreases implying a lower own-tax elasticity. Thus, a weaker detection ability increases the competitive pressure on the large country.

5 Extension: Bargaining with Private Information

In the baseline model, workers do not know the full game and Nash-bargain with firms over the observed surplus as if it was the true surplus. This allows firms to reduce wages by shifting profits abroad. In this section, we develop a micro foundation that generates this wage channel under rational expectations and private information. It shows that even if workers perfectly know the setup and parameters of the game, shifting surplus can allow a firm to reduce its wage bill by creating an informational rent.

Setup: Firms have a shock on surplus which can be high (s_H) or low (s_L). Denote τ the probability that s_H occurs. If the firm shifts its surplus to the tax haven, the realization of the shock is private information of the firm. Workers do know the possible realizations of the shock and the attached probabilities. They can therefore compute the expected value of surplus of shifting firms. For firms that are not shifting, the shock is perfectly observed by workers and the surplus is shared following standard Nash bargaining.

In the case of profit shifting there is incomplete information. Thus, Nash bargaining cannot be applied. Instead, we use the Neutral Bargaining Solution (NBS) by Myerson (1984), which is a generalization of the Nash bargaining solution to the case with private information. In the exposition we closely follow Kennan (2010) who applies the NBS to wage bargaining, where the firm has private information on the surplus generated by a firm-worker match.

The intuition of the NBS is as follows. If firm and workers do not agree on a sharing rule, the decision is taken through a random dictator game. In this case either the firm or the workers are randomly assigned to impose a sharing rule. If the firm is the dictator it takes the full surplus. Workers, however, do not know whether surplus is high or low. If they request a wage higher than the actual surplus, the firm goes bankrupt and the surplus is zero. Kennan (2010) shows that as long as $\tau s_H < s_L$ it is optimal for the workers not to risk bankruptcy of the firm and take the certain payment of s_L instead. This implies an informational rent for the firm: even if the workers dictate an allocation, the fact that they do not know the realization of the shock leaves the firm with a positive expected surplus.

Bargaining outcomes: Without loss of generality assume that $s_H = As_L$ with $A > 1$ and assume that the expected surplus $E[s]$ is given by $\frac{\alpha}{\sigma}$. The later assumption is made to link the micro foundation closely to the baseline model where the surplus per firm is given by $\frac{\alpha}{\sigma}$. Then the expected surplus of a firm is:

$$E[s] = (1-\tau)s_L + \tau s_H \equiv \frac{\alpha}{\sigma}. \tag{23}$$

This implies the following values for s_H and s_L, respectively:

$$s_H = \frac{A}{\tau A + (1-\tau)} \frac{\alpha}{\sigma} \tag{24}$$

$$s_L = \frac{1}{\tau A + (1-\tau)} \frac{\alpha}{\sigma}. \tag{25}$$

As outlined above, if the workers and the firm do not agree on a bargaining rule, one party is randomly assigned with probability 1/2 to dictate an allocation of surplus. We assume that $\tau s_H < s_L$, which implies that in the random dictator game the workers always choose s_L. This setup maps one to one into the setup in Kennan (2010) with $E[s] = \frac{\alpha}{\sigma}$. Therefore all properties including uniqueness and incentive-efficiency of the NBS shown in Kennan (2010) also apply to our extension of the baseline model.

The NBS implies that the allocation of surplus between workers and a shifting firm takes the following form:

$$b_X = \frac{1}{2}L = \frac{1/2}{\tau A + (1-\tau)} \frac{\alpha}{\sigma} \tag{26}$$

$$E[\pi_X] = \tau s_H + \left(\frac{1}{2} - \tau\right) s_L = \frac{\tau A + 1/2 - \tau}{\tau A + (1-\tau)} \frac{\alpha}{\sigma}. \tag{27}$$

If the firm does not shift profits, there is no private information and standard Nash bargaining takes place. In this case the surplus dependent payments and profits are:

$$b_H = \frac{1}{2}\left(\tau s_H + (1-\tau)s_L\right) = \frac{1}{2}\frac{\alpha}{\sigma} \tag{28}$$

$$E[\pi_H] = \frac{1}{2}\left(\tau s_H + (1-\tau)s_L\right) = \frac{1}{2}\frac{\alpha}{\sigma}. \tag{29}$$

The additional information rent for a firm from shifting its profits to the tax haven is therefore:

$$E[\pi_X] - E[\pi_H] = \frac{1}{2}\tau(s_H - s_L) = \frac{1}{2}\tau\frac{A-1}{\tau A + (1-\tau)}. \tag{30}$$

This implies that the firm can reduce its wage bill by profit shifting. The micro foundation thus generates the wage channel under rational expectations with private information. A difference to the very tractable baseline model is that under the NBS the firm can never appropriate the complete surplus as this would violate $\tau s_H < s_L$.

Introducing η: In the following we discuss how the parameter η from the baseline model which captures the detection ability of workers can be micro-founded. For this consider the following extension. Before bargaining takes place, workers in a shifting firm observe the surplus shock with probability $\tilde{\eta}$. In this case, there is complete information and workers Nash-bargain with the firm over the surplus. If workers do not observe the shock, which happens with probability $1-\tilde{\eta}$, the surplus generated remains private information of the firm. Then, the neutral bargaining solution applies as discussed above. Note that letting the probability of observing the shock $\tilde{\eta}$ vary allows micro-founding a set of different $\eta \in [\underline{\eta}, 1]$, where $\underline{\eta} = \frac{L}{\tau H + (1-\tau)L} = \frac{1}{\tau A + (1-\tau)}$. As $L > \tau H$ it follows that: $\underline{\eta} > \frac{1}{2-\tau} > \frac{1}{2}$.

6 Conclusions

Rent-sharing between workers and firms is a well documented and quantitatively important phenomenon. If firms bargain with workers over the generated surplus, they have an incentive to limit the information available to the latter. When shifting profits to a tax haven creates private information on surplus, firms have an incentive to do so in order to reduce their wage bill. Profits, however, constitute the tax bases of national governments and therefore the wage incentive for profit shifting affects the optimal tax decision. If the wage channel is weak, rent-sharing reduces tax competition. If the wage channel is strong, rent-sharing strengthens tax competition and leads to a lower equilibrium tax rate in the large country.

While our analysis focuses on tax competition between a large country and a tax haven, the mechanisms identified should be generalizable to a wider set of models. Multinational companies producing in different locations, for example, have many opportunities to affect wages by shifting profits. This is particularly relevant as the strength of labor representation typically differs across production locations.

The analysis in this paper shows how in the presence of some indeterminacy in the allocation of profits within a multinational firm, one stakeholder can allocate profits to its advantage and at the expense of other stakeholders. Here, we focus on the bargaining between firm owners and workers. The mechanism should in principle extend to a wider set of conflicts of interest within multinationals. This could include conflicts between equity holders and lenders or majority and minority shareholders. To which extent these cases give rise to similar effects is an interesting question for future research.

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A Proofs of Lemmas 1 and 2: Shifting incentives

Lemma 1 Taking the derivative of c^* with respect to δ delivers:

$$\frac{\partial c^*}{\partial \delta} = \frac{\alpha}{\sigma}\left(-\eta(1-t_X)+1-tH\right).$$

This implies $\frac{\partial c^*}{\partial \delta} > 0 \Leftrightarrow \eta < \frac{1-t_H}{1-t_X}$ and the reverse. q.e.d.

Lemma 2 Taking the derivative of c^* with respect to η delivers:

$$\frac{\partial c^*}{\partial \eta} = -\delta\frac{\alpha}{\sigma}(1-t_X).$$

This implies that $\forall t_X < 1$ and $\delta \in (0,1) : \frac{\partial c^*}{\partial \eta} < 0$. Taking the derivative of this expression with respect to δ delivers:

$$\frac{\partial^2 c^*}{\partial \eta \partial \delta} = -\frac{\alpha}{\sigma}(1-t_X).$$

This implies that $\forall t_X < 1 : \frac{\partial^2 c^*}{\partial \eta \partial \delta} < 0$. q.e.d.

B Best response of large country

$$U = \bar{U} + (1-t_H)\Pi_H + (1-t_X)\Pi_X + B_H + B_X + \beta t_H \Pi_H - C. \tag{31}$$

This can be simplified to:

$$U = \bar{U} + \frac{\alpha}{\sigma} + (\beta-1)t_H\left(1-c^*\right)(1-\delta)\frac{\alpha}{\sigma} - t_X c^*(1-\eta\delta)\frac{\alpha}{\sigma} - \frac{1}{2}(c^*)^2. \tag{32}$$

$$\frac{\partial U}{\partial t_H} = (\beta-1)\left(1-c^*\right)(1-\delta)\frac{\alpha}{\sigma} - (\beta-1)t_H(1-\delta)\frac{\alpha}{\sigma}\frac{\partial c^*}{\partial t_H} - t_X(1-\eta\delta)\frac{\alpha}{\sigma}\frac{\partial c^*}{\partial t_H} - c^*\frac{\partial c^*}{\partial t_H}. \tag{33}$$

$$\frac{\partial c^*}{\partial t_H} = \frac{\alpha}{\sigma}(1-\delta). \tag{34}$$

Setting equal to zero implies:

$$(\beta-1)(1-c^*)(1-\delta)\frac{\alpha}{\sigma}=\frac{\partial c^*}{\partial t_H^*}\left[(\beta-1)t_H^*(1-\delta)\frac{\alpha}{\sigma}+t_X(1-\eta\delta)\frac{\alpha}{\sigma}+c^*\right]. \tag{35}$$

The term in the last parenthesis can be simplified to:

$$\frac{\alpha}{\sigma}\left[\beta t_H^*(1-\delta)+\delta(1-\eta)\right]. \tag{36}$$

Plugging back in and rewriting delivers:

$$t_H^*=\frac{(\beta-1)\sigma/\alpha-\beta\delta(1-\eta)}{(1-\delta)(2\beta-1)}+\frac{(1-\eta\delta)(\beta-1)}{(1-\delta)(2\beta-1)}t_X. \tag{37}$$

q.e.d.

C Derivation of kinks of large country best response function

First kink at $\tilde{\rho}=0$ Best response large country (interior solution $\tilde{\rho}>0$):

$$t_H(t_X)^{\tilde{\rho}>0}=\frac{(\beta-1)\sigma/\alpha-\beta\delta(1-\eta)}{(1-\delta)(2\beta-1)}+\frac{(1-\eta\delta)(\beta-1)}{(1-\delta)(2\beta-1)}t_X. \tag{38}$$

Best response large country (corner solution $\tilde{\rho}=0$):

$$t_H^{\tilde{\rho}=0}(t_X)=\frac{1-\eta\delta}{1-\delta}t_X-\frac{\delta(1-\eta)}{1-\delta}. \tag{39}$$

Note that it is never optimal for the large country to set t_H such that $\tilde{\rho}<0$, as $\tilde{\rho}=0$ already implies zero outflows, i.e. $c^*=0$, but implies higher tax income. Now, the second order condition of the large country maximization problem is:

$$\frac{\partial^2 U}{\partial^2 t_H}=-\frac{\partial^2 c^*}{\partial^2 t_H}\left[(\beta-1)t_H(1-\delta)\frac{\alpha}{\sigma}+t_X(1-\eta\delta)\frac{\alpha}{\sigma}+c^*\right]-\frac{\partial c^*}{\partial t_H}\left[(\beta-1)(1-\delta)\frac{\alpha}{\sigma}+\frac{\partial c^*}{\partial t_H}\right]<0. \tag{40}$$

This implies that the welfare function is strictly concave whenever $c^* > 0$. Thus, there are two cases: if for a given t_X equation (38) implies $\tilde{\rho} \geq 0$, then the first order condition (condition (33)) can be solved for the best response function as given by equation (38). If condition (38) implies $\tilde{\rho} < 0$, then the constraint $\tilde{\rho} = 0$ is binding and the best response function is given by equation (39).

To find the value of t_X where the best response function of the large country changes, we solve for the intercept of functions (38) and (39) which delivers:

$$t_X^{k1} = \frac{(\beta - 1)\left[\sigma/\alpha - \delta(1-\eta)\right]}{\beta(1-\eta\delta)}. \tag{41}$$

Second kink at $t_H = 0$ To find the second kink solve equation (38) for $t_H = 0$, which delivers:

$$t_X^{k2} = \frac{\beta\delta(1-\eta) - (\beta-1)\sigma/\alpha}{(\beta-1)(1-\eta\delta)}. \tag{42}$$

For any value of $t_X \leq t_X^{k2}$ the best response function of the large country is $t_H = 0$. Now check when the equilibrium falls into the area where $t_H > 0$. This is the case if the best response function of the tax haven at $t_H = 0$ is to the right of t_X^{k2}. We first derive $t_X(t_H = 0)$:

$$t_X(t_H = 0) = \frac{\delta(1-\eta)}{2(1-\eta\delta)}. \tag{43}$$

As discussed above, the equilibrium t_H^* is larger zero iff $t_X(t_H = 0) > t_X^{k2}$. This implies

$$t_H^* > 0 \Leftrightarrow \frac{\alpha}{\sigma} < \frac{2(\beta-1)}{(\beta+1)\delta(1-\eta)}. \tag{44}$$

The equilibrium tax rate of the large country is positive if the profits of a representative firm $\frac{\alpha}{\sigma}$ are not too large. Note that under revenue maximization ($\beta \rightarrow \infty$) the level of profits does not matter and this condition is always fulfilled. Then, it becomes:

$$t_H^* > 0 \Leftrightarrow \frac{\alpha}{\sigma} < \frac{2}{\delta(1-\eta)}, \tag{45}$$

which is always true as $\alpha \leq 1, \sigma > 1, \delta \leq 1$ and $\eta \geq 0$.

Figure 6 here.

Best response function large country There are two cases:
First, if $t_X^{k1} \leq 1$ then the best response function of the large country is given by:

$$t_H(t_X) = \begin{cases} \frac{(\beta-1)\sigma/\alpha - \beta\delta(1-\eta)}{(1-\delta)(2\beta-1)} + \frac{\beta-1}{2\beta-1}\frac{1-\eta\delta}{1-\delta}t_X & \text{if } t_X^{k2} < t_X < t_X^{k1} \\ -\frac{\delta(1-\eta)}{1-\delta} + \frac{1-\eta\delta}{1-\delta}t_X & \text{if } t_X \geq t_X^{k1} \\ 0 & \text{if } t_X \leq t_X^{k2}, \end{cases}$$

with $t_X^{k1} = \frac{(\beta-1)[\sigma/\alpha - \delta(1-\eta)]}{\beta(1-\eta\delta)}$ and $t_X^{k2} = \frac{\beta\delta(1-\eta)-(\beta-1)\sigma/\alpha}{(\beta-1)(1-\eta\delta)}$.
Second, if $t_X^{k1} > 1$ then the best response function of the large country is given by:

$$t_H(t_X) = \begin{cases} \min\left\{\frac{(\beta-1)\sigma/\alpha - \beta\delta(1-\eta)}{(1-\delta)(2\beta-1)} + \frac{\beta-1}{2\beta-1}\frac{1-\eta\delta}{1-\delta}t_X, 1\right\} & \text{if } t_X^{k2} < t_X \leq 1 \\ 0 & \text{if } t_X \leq t_X^{k2}. \end{cases}$$

D Proof of Proposition 1: Equilibrium

First, note that the tax haven needs to attract positive inflows of tax base to generate a positive welfare level $V > 0$. It attracts tax base whenever $\tilde{\rho} > 0$, which is the case when:

$$t_X < \frac{\delta(1-\eta)}{1-\eta\delta} + \frac{1-\delta}{1-\eta\delta}t_H. \tag{46}$$

As long as $\delta > 0$, for any $t_H > 0$ there is some tax rate t_X that fulfills this condition. If $\delta > 0$ and $\eta < 1$, the tax haven can also attract tax base if $t_H = 0$. Therefore, a necessary condition for an equilibrium is $\tilde{\rho} > 0$. The equilibrium is determined by the intersection of equation (38) $(t_H(t_X)^{\tilde{\rho}>0})$ with equation (14) $(t_X(t_H))$.
As discussed before, there are two cases for the best response function of the large country. In the following we discuss equilibrium existence for each of them separately.

Case 1, $t_X^{k1} \leq 1$ First, note that in this case the tax rate of the large country t_H in equation (39) is bounded from above by one as $t_H^{\tilde{\rho}=0}(t_X = 1) = 1$. Given that $t_X^{k1} \leq 1$, the tax rate of the large country t_H in equation (38) is bounded from above by equation (39) for $\forall t_X \geq t_X^{k1}$. Consequently, $t_H^{\tilde{\rho}>0}(t_X) \leq 1$. Therefore, the equilibrium is either at $t_H = 0$ if $t_X(t_H = 0) \leq t_X^{k2}$ or it is at the positive intersection between equations (38) and (14). The equilibrium is unique as equations (38) and (14) are strictly monotonously increasing in the other country's tax rate.

Case 2, $t_X^{k1} > 1$ Now, (38) is the best response of the large country for $\forall t_X > t_X^{k2}$. Therefore, the equilibrium is either at $t_H = 0$ if $t_X(t_H = 0) \leq t_X^{k2}$, at the positive intersection between equations (38) and (14) if the intersection is below or equal to one, or at $t_H = 1$ if the two functions (38) and (14) meet at $t_H = 1$. The equilibrium is unique as (38) and (14) are strictly monotonically increasing in the other country's tax rate. q.e.d.

E Proof of Proposition 2: Impact of δ

From equation (17), the large country equilibrium tax rate for an interior solution, i.e. $t_H^* \in (0, 1)$, is given by:

$$t_H^* = \frac{2(\beta - 1)\sigma/\alpha - (\beta + 1)\delta(1 - \eta)}{(3\beta - 1)(1 - \delta)}.$$

Differentiating with respect to δ gives:

$$\frac{\partial t_H^*}{\partial \delta} = \frac{1}{3\beta - 1}\left[\frac{1}{(1 - \delta)^2}\left[2(\beta - 1)\frac{\sigma}{\alpha} - (\beta + 1)\delta(1 - \eta)\right] - \frac{1}{1 - \delta}(\beta + 1)(1 - \eta)\right]. \quad (47)$$

Solving for η delivers the following condition on the sign of $\frac{\partial t_H^*}{\partial \delta}$:

$$\frac{\partial t_H^*}{\partial \delta} > 0 \Longleftrightarrow \eta > 1 - 2\frac{\beta - 1}{\beta + 1}\frac{\sigma}{\alpha}. \quad (48)$$

The sign is therefore ambiguous. When there is perfect detection ($\eta = 1$) we have $\frac{\partial t_H^*}{\partial \delta}|_{\eta=1} > 0$. In the case of no detection ($\eta = 0$) the sign remains positive if the profits of a firm $\frac{\alpha}{\sigma}$ are not too large:

$$\frac{\partial t_H^*}{\partial \delta}|_{\eta=0} > 0 \Longleftrightarrow 2\frac{\beta-1}{\beta+1} > \frac{\alpha}{\sigma}. \tag{49}$$

From equation (18), the tax haven equilibrium tax rate for an interior solution, i.e. $t_H^* \in (0,1)$, is given by:

$$t_X^* = \frac{(\beta-1)[\sigma/\alpha + \delta(1-\eta)]}{(3\beta-1)(1-\eta\delta)}.$$

Differentiating with respect to δ delivers:

$$\frac{\partial t_X^*}{\partial \delta} = \frac{1}{3\beta-1}\left[\frac{\eta}{(1-\eta\delta)^2}(\beta-1)\left(\delta(1-\eta)+\frac{\sigma}{\alpha}\right)+\frac{1}{1-\eta\delta}(\beta-1)(1-\eta)\right] > 0.$$

q.e.d.

F Proof of Proposition 3: Impact of η

The first result follows from differentiating equation (17) with respect to η, which gives:

$$\frac{\partial t_H^*}{\partial \eta} = \frac{(\beta+1)\delta}{(3\beta-1)(1-\delta)} < 0.$$

For the second result, take the cross-derivative of t_H^* with respect to η and δ:

$$\frac{\partial^2 t_H^*}{\partial \eta \partial \delta} = \frac{\beta+1}{(3\beta-1)(1-\delta)^2}.$$

Differentiating (18) with respect to η delivers:

$$\frac{\partial t_X^*}{\partial \eta} = -\frac{\delta(\beta-1)}{(3\beta-1)(1-\eta\delta)} - \frac{(\beta-1)\delta(3\beta-1)\left[\frac{\sigma}{\alpha}+\delta(1-\eta)\right]}{[(3\beta-1)(1-\eta\delta)]^2}.$$

Which implies:

$$\text{sign}\left(\frac{\partial t_X^*}{\partial \eta}\right) = \text{sign}\left(\frac{\sigma}{\alpha}+\delta-1\right).$$

Therefore:

$$\frac{\sigma}{\alpha} + \delta - 1 > 0 \Rightarrow \frac{\partial t_X^*}{\partial \eta} > 0.$$

q.e.d.

G Proofs of Propositions 4 and 5: Own-tax elasticity of revenue

Partial differentiation delivers:

$$\frac{\partial |BE_H|}{\partial (1-\eta)} = -\frac{\delta(1-\delta) t_H (1-t_X)}{(\frac{\sigma}{\alpha} - \tilde{\rho})^2} > 0 \tag{50}$$

$$\frac{\partial |BE_X|}{\partial (1-\eta)} = \frac{\delta(1-\delta) t_X (1-t_H)}{\tilde{\rho}^2} < 0. \tag{51}$$

as well as

$$\frac{\partial |BE_H|}{\partial \delta} = \frac{\frac{\sigma}{\alpha} - (1-t_X)(1-\eta)}{\left(\frac{\sigma}{\alpha} - \tilde{\rho}\right)^2} t_H < 0 \tag{52}$$

$$\frac{\partial |BE_X|}{\partial \delta} = \frac{(1-t_H)(1-\eta)}{(\tilde{\rho})^2} t_X < 0. \tag{53}$$

q.e.d.

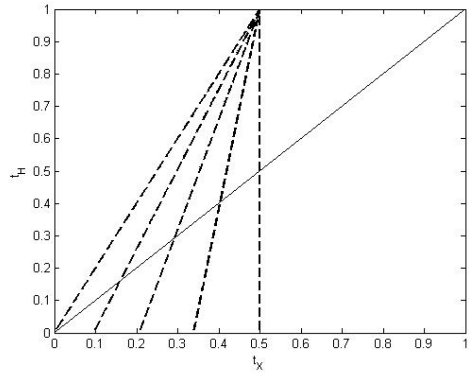


Figure 1: Best response function of tax haven for different δ. Horizontal axis: tax haven tax rate t_X, vertical axis: large country tax rate t_H. $\eta = 0.3$, $\sigma = 4$, $\alpha = 0.7$, $\beta = 1.1$.

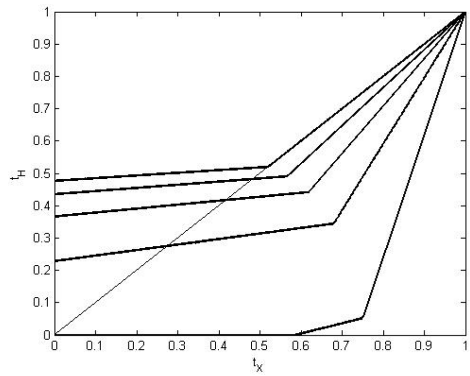
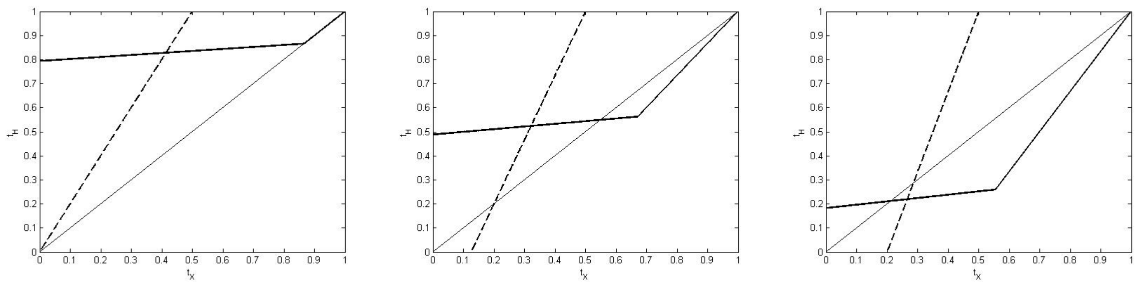
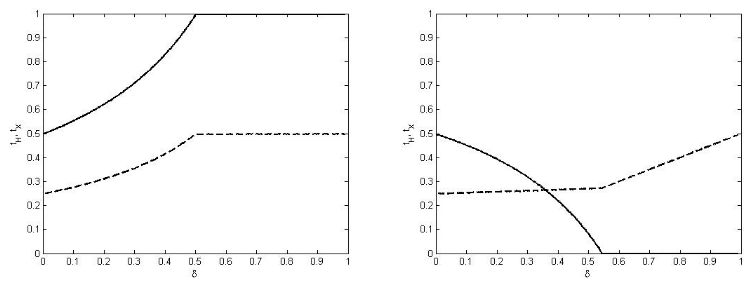


Figure 2: Best response function of large country for different δ. Horizontal axis: tax haven tax rate t_X, vertical axis: large country tax rate t_H. $\eta = 0.3$, $\sigma = 4$, $\alpha = 0.7$, $\beta = 1.1$.



(a) (b) (c)

Figure 3: Equilibria of the tax game for different degrees of detection (a): $\eta = 1$; (b): $\eta = 0.5$ and (c): $\eta = 0$. Horizontal axis: tax haven tax rate t_X (dashed line), vertical axis: large country tax rate t_H (thick solid line). Thin line: 45 degree line. Other parameters: $\delta = 0.4$, $\sigma = 4$, $\alpha = 0.7$, $\beta = 1.1$.



(a) (b)

Figure 4: Equilibrium tax rates of the large country (solid line) and the tax haven (dashed line) as a function of the degree of rent-sharing δ (horizontal axis). Graph (a): $\eta = 1$, graph (b): $\eta = 0$. Other parameters: $\sigma = 4$, $\alpha = 0.7$, $\beta = 1.1$.

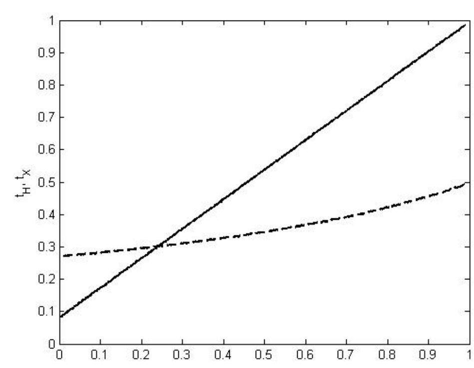


Figure 5: Equilibrium tax rates of the large country (solid line) and the tax haven (dashed line) as a function of the detection parameter η (horizontal axis). Other parameters: $\delta = 0.5$, $\sigma = 4$, $\alpha = 0.7$, $\beta = 1.1$.

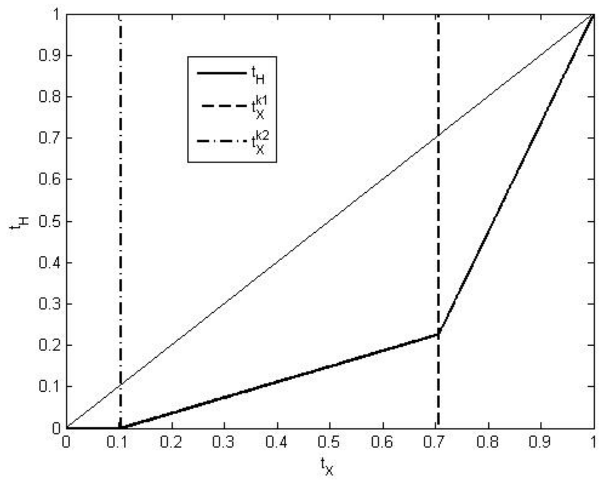


Figure 6: This graph illustrates the two kinks in the large country best response function. The solid line is the best response function of the large country. The left vertical line corresponds to t_X^{k2} and the right vertical line corresponds to t_X^{k1}.