Corporate Tax Competition and Profit Shifting to Tax Havens

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Abstract

This paper presents the case that governments set corporate tax rates both in competition for real investment and in response to profit shifting. Multinational firms seek to maximize global profit by allocating capital across countries, leading to strategic interaction using corporate tax rates in competition for real investment. The role of tax havens in artificial profit shifting shows increased profit shifting has led to lower corporate tax rates. A simple theoretical model of tax competition and profit shifting predicts that statutory tax rates are strategic complements, and that tax rates respond negatively to profit shifting. These predictions are empirically confirmed by a spatial autoregressive model with bilateral investment weights instead of size, distance or uniform weights. Strategic interaction between governments for real investment is significant but smaller than previously estimated, and profit shifting to tax havens significantly affects corporate tax rates. The observed trend of falling corporate tax rates is a function of both tax competition for investment and profit shifting to tax havens.

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Keywords: Tax Competition; Corporate Taxation; Profit Shifting; Tax Havens

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1 Introduction

This research presents evidence on the existence and nature of international tax competition, and offers an alternative interpretation of the results. I incorporate two simple ideas that allow for an alternative explanation: firstly, multinational corporations are key decision-makers in cross-country investment decisions that shape tax competition; secondly, profit shifting is mainly under the purview of tax havens which do not compete for real investment. This theoretical model predicts that governments use their statutory tax rate both to compete for productive investment and to react to profit shifting behaviour of multinational firms. These predictions are confirmed by the empirical evidence.

Early models of tax competition tended to ignore the role of profit shifting. After the issuance of the OECD's Harmful Tax Competition Report in 1998, researchers such as Haufler and Schjelderup (2000), Stöwhase (2005), Devereux et al. (2008), and Stöwhase (2013) began to study the implications of this practice. However, the OECD's more recent project on base erosion and profit shifting (BEPS) specifically defines it as 'tax avoidance strategies that exploit gaps and mismatches in tax rules to artificially shift profits to low or no-tax locations.' To match the concerns of the OECD, the role of low or no-tax jurisdictions in profit shifting was incorporated by Slemrod and Wilson (2009), Hong and Smart (2010), Johannesen (2010) and Krautheim and Schmidt-Eisenlohr (2011).

Empirical evidence supports the existence of profit shifting. Similarly to the OECD's view of profit shifting, most of them put low or no-tax jurisdictions in the spotlight. One might consider that the OECD and G20 would not be so concerned about BEPS if profit shifting were simply a game played among their member states. Dharmapala (2014) shows that 42.6% of the foreign net income of US multinational corporations (MNCs) was reported in tax havens in 2011. Zucman (2014) says 20% of all US corporate profits are booked in tax havens.

The majority of profit shifting is enacted from non-haven countries to tax havens, shown in detail by Davies et al. (2015). A model of profit shifting without tax havens assumes that that non-haven countries compete for 'artificial' or 'paper' profits. This assumption leads to the logical conclusion that governments use their corporate tax rate as an instrument of competing for paper profits. This is at odds with the empirical evidence. Johannesen (2010) shows theoretically how easily this conclusion becomes undone once tax havens are introduced into the model.

If not competition for artificial profits, what explains empirical evidence of strategic interaction among governments using their corporate tax rate? Once some proportion of revenues are forced to be recognized as profits in a non-haven jurisdiction, a government who taxes profit would wish to attract productive activity in order to attract taxable profits. Importantly, a theoretical model that does not include the multinational firm's cross-country investment decision will exclude this interpretation of tax competition.

I follow works such as Stöwhase (2005), Johannesen (2010) and Eichner and Runkel (2011) in describing the multinational firm's cross-country investment decision as the core tax competition mechanism. This contrasts with the simplification made by much of the theoretical literature that countries with strictly domestic firms will engage in tax competition via the capital market's competitive allocation of capital. To empirically examine tax competition, I adhere to the more realistic literature on the theory of the multinational firm, which suggests that the multinational's choice of financing location can be separated from the multinational's choice of production location.

The theoretical model in this paper is similar to those used by Johannesen (2010) and Eichner and Runkel (2011). I consider a single multinational firm allocating capital across N symmetric countries with the goal of maximizing global after-tax profits. Each government has the power to tax profits arising from production within its borders, meaning that the multinational's allocation of capital is determined by the full set of tax rates. The model is then extended to include profit

shifting to tax havens.

The main predictions of the model are that governments react positively to changes in tax rates in neighbouring countries, and that greater profit shifting leads to lower tax rates. Using a spatial autoregressive model, the empirical evidence suggests that these theoretical predictions are correct. I also uncover empirical evidence that a country's reactions to tax competition and profit shifting are in part determined by their perspective on the taxation of foreign income, whether based on the source or residence principles. The explanation for this finding is contained within the simple theoretical framework provided here.

I primarily diverge from the important work in this strand of the literature by Devereux et al. (2008) in the specification of the theoretical model. I concentrate on the multinational firm case rather than the multiple domestic firm instance, while assuming that multinationals will rationally choose to shift profits to tax havens as Johannesen (2010) shows. Empirically, I diverge from Devereux et al. (2008) and Overesch and Rincke (2011) by using time-varying bilateral foreign direct investment (FDI) weights rather than size or distance weights. This produces robust long-run estimates of tax competition that are less than half the size of those uncovered by those authors. Further, I introduce FDI directed to tax havens and services imports from tax havens as proxies for profit shifting behaviour, both empirically confirming the predicted negative reaction of tax rates to increased profit shifting.

This paper proposes a simpler but hopefully more realistic framework for examining corporate tax competition and profit shifting, placing emphasis on the role of multinational firms. The choice of theoretical assumptions leads me to interpret the finding of strategic interaction among governments using their statutory tax rates (STRs) as evidence of tax competition for real investment rather than competition for artificial profits. This solves two of the peculiarities arising from the Devereux et al. (2008) model: firstly, incomplete tax deductability of the costs of capital is not required for tax competition for real investment to exist; secondly, weak empirical evidence of strategic interaction on effective marginal tax rates (EMTRs) does not mean that governments do not compete for real investment.

The following section describes the existing literature in greater detail and logically identifies issues that will be addressed here. I address the main issues in Section 3 by formulating a theoretical model of competition for real investment, then augment it by considering also tax havens and profit shifting. The strategy used to empirically test this model are described in Section 4 and implemented in 5.

2 Background

2.1 Capital Tax

Wilson and Wildasin (2004) define tax competition broadly as 'any form of noncooperative tax setting by independent governments'. More specifically, they suggest that tax competition is defined by the situation where each government's choice of tax policy influences the way that a mobile tax base is allocated among these jurisdictions. A more pointed definition is given by Rohác (2006) as the process of uncooperative setting of tax rates to attract mobile tax bases.

Much of the theoretical work on tax competition stems from an original model of tax competition derived from two separate works by Zodrow and Mieszkowski (1986) and Wilson (1986) (henceforth ZMW). The standard model is an elegant one that captures the idea of governments engaging in Cournot-Nash competition using taxes on capital to attract productive capital. Keen and Konrad (2014) provide an extensive treatment of the original ZMW model.

In the ZMW model, the form of the firm's profit function is: $\Pi_i = f(k_i) - (r + \tau_i)k_i$ where the return to capital is r and the tax is τ. This means that the tax considered in the model is truly a 'capital' tax as it is directly incident on capital. The first order condition for the firm's profit maximization is $f'(k_i) - \tau_i = r$. The tax therefore acts as a wedge between the marginal product of capital and the marginal cost of capital, causing the owners of capital to be paid an amount less than the marginal product of capital.

Moreover, it means that the mechanism for tax competition is quite straightforward: the capital market (the investor) moves capital in and out of jurisdictions given a fixed supply of capital $\sum_{i=1}^{N} k_i = \kappa$ seeking the highest return on capital. Capital movement across borders adjusts the marginal product of capital $f'(k_i)$ across countries until the combination of the marginal product of capital less the capital tax is equal across all countries in equilibrium. A change in any tax rate τ_i would cause a reallocation. The equilibrium condition is that the after-tax return must be the same for all investors subject to the global capital constraint. In the ZMW model, investors are the agents who allocate capital across countries by deciding where they want to invest their capital.

2.2 Profit Tax

Keen and Konrad (2014) indicate that a limitation of adapting this approach to international corporate tax competition is that in reality the corporate income tax is not actually directly incident on capital. In reality, tax is levied directly on profits. That means that taxes are only indirectly incident on capital if the firm cannot deduct all of the costs of renting capital when calculating taxable profits. This is the concept of *incomplete deductibility*. In the accounting sense - which is what taxes are based upon - labour is already fully compensated for its role in production so net business income is considered returns to capital, whether or not economists choose to think of it as 'normal' returns or 'excess' returns. Therefore a tax on profit is still a tax on capital, despite not being directly incident on the rental cost of capital.

To address this shortcoming Haufler and Schjelderup (2000) introduced a model of two tax instruments: a tax rate and a tax base. In their model, the 'tax base' is formed by the government choosing a level of deductibility of capital costs. This is shown by a profit function $\Pi_i = f(k_i) - rk_i - \tau_i(f(k_i) - ark_i)$, where $a \in [0, 1]$ is the tax base parameter determining what proportion of the rental cost of capital can be subtracted from revenues in determining taxable profits. The taxable base then ranges from the lower limit of pure profits to the upper limit of pure profits plus the rental cost of capital, entirely at the discretion of the government. Possible practical explanations for this incomplete deduction include different treatment of different sources/forms of capital or disparity between depreciation allowances and real economic depreciation. The resulting first order condition for the optimal allocation of capital across countries is:

$$f'(k_i) = \frac{1 - a_i\tau_i}{1 - \tau_i} r \tag{1}$$

In the case where full deduction of capital costs is allowed, $a = 1$, the corporate tax falls only on pure profits and the first order condition reduces to $f'(k_i) = r$, which suggests that $\frac{\partial k_i}{\partial \tau_i}$ becomes zero. That is, no tax is levied on capital costs and the statutory tax rate does not affect the allocation of capital. When the capital market is responsible for the allocation of capital across countries, investors are only concerned with the amount of tax incident on capital - whether directly or indirectly incident.

Devereux et al. (2008) extend the model of Haufler and Schjelderup (2000), suggesting that the combined statutory tax rate and tax base in Equation 1 can be boiled down to a direct choice of the effective marginal tax rate - z. This reduces the first order condition to $f'(k_i) = zr$ and would mean

that governments set the effective marginal tax rate z to attract real investment. Devereux et al. (2008) explains that interaction between governments using z depends on their ability to influence the world rental rate on capital r. However, as the number of countries in the model $n \to \infty$, the ability of countries to influence the world rental rate on capital diminishes $\frac{\partial r}{\partial \tau_i} \to 0$. With very weak empirical evidence to suggest any real strategic interaction on effective marginal tax rates in Devereux et al. (2008) and none found in Overesch and Rincke (2011), the assumptions of this type of theoretical model leads us to the conclusion that there is little empirical evidence that governments compete for real investment. Devereux et al. (2008) suggest that smaller countries in its sample inability to influence the world interest rate likely drives the evidence of weak interaction.

In order to interpret strong empirical evidence of strategic interaction in statutory tax rates, denoted by τ in the model, Devereux et al. (2008) used a mechanism similar to that developed by Haufler and Schjelderup (2000). In their model the firm owns a subsidiary in the foreign country from which it purchases an input that it can price differently from the true cost. The firm then makes no cross-country investment decision across countries; its only investment decision is how much to employ at home. The only cross-country decision made by the firm is a pricing decision on whether to deviate from the actual cost of the input. This allows the firm to recognize profit in the foreign country that was actually generated by production in the home economy. The final profit function appearing in Devereux et al. (2008) for a two-country model then is:

$$\Pi_i = f(k) - rk_i - q_i - \tau_i(f'(k_i) - a_i r k_i - q_i) + (1 - \tau_j)(q_i - c_i) \tag{2}$$

where the price of the input q is subtracted from the taxable base in country i rather than the true cost of the input c. That means the profit shifted from jurisdiction i to j is $(q - c)$. Clearly then the optimal choice of q relative to c is dependent on the tax rates τ_i and τ_j, creating an interaction between governments that leads to competition for profits. The empirical evidence Devereux et al. (2008) uncover portrays a strong strategic interaction between governments' statutory tax rates, which is therefore interpreted as evidence of competition for artificial profits.

2.3 Multinational Corporations

The firm considered in Devereux et al. (2008) is not a true multinational corporation as it makes no cross-country investment decision, not even in the production of the input good. This is representative of a domestic firm purchasing a foreign input, meaning that the central decision-making agent whose behaviour the government accounts for is not a multinational firm. The firm's only cross-country decision is the choice of artificial profit shifting - the deliberate cross-national misalignment of profits and the productive activity that generated the profits. It remains the capital market that allocates capital cross-nationally.

The aim of the supply side of the capital market is to maximize the rental rate on capital; the firm - as the demand side - seeks to minimize the rental cost of capital. The conflicting objectives are the key characteristic of a competitive market for capital. If we use the competitive capital market as the allocation mechanism in explaining tax competition, we abstract from the firm's true objective of profit maximization - a key element when considering profit tax.

Johannesen (2010) chooses to model the firm as a multinational corporation making cross-country *real investment* decisions, ignoring the capital market's role in the allocation of capital. Markusen (2004) makes it clear, in building a general equilibrium theory of the multinational firm, that the decision of where to invest and produce is distinct from the decision where to raise the financing for that investment and production. Similarly, I focus on the production decision of the multinational corporation rather than the decision of where capital is raised.

The movement of capital through the capital market from many lenders to borrower is akin to portfolio investment while the movement of capital by multinational firms for production purposes having already rented capital is more likely to be captured by foreign direct investment flows since they will entirely own the new investment. This distinction is important because governments usually make it clear that they attempt to attract foreign direct investment through location of multinational firms. Apart from the additional productive capacity and economic activity, foreign direct investment also brings information and knowledge flows and the added benefit of greater stability of capital flows (Goldstein and Razin, 2006).

In this paper I abstract from the competitive allocation problem of the capital market as it constitutes cross-border financing. I instead focus on the cross-border allocation problem of the multinational firm in seeking to maximize profits. This is an apt change of focus because the tax of interest is levied on profits rather than on capital.

2.4 Tax Havens

When the existence of tax havens is considered, it quickly becomes clear that they will capture a substantial portion of the market for paper profits. There exists almost no competition in the attraction of pure paper profits between a jurisdiction with a regular (high) tax rate of say 35% and a tax haven with a 0% tax rate. Additionally, when one considers that a transaction between two non-havens will likely face double the scrutiny that a transaction between a non-haven and a haven faces due to the inherent regulatory 'blind eye' of the tax haven, the small benefits of trying to shift profits between two non-haven countries sound unlikely to be worth the hassle. Krautheim and Schmidt-Eisenlohr (2011) effectively base their work on a similar premise of profit shifting being a phenomenon that primarily takes place between a large country and a tax haven.

This point is made more broadly by Johannesen (2010). He distinguishes clearly between the competition for profits and the competition for real investment. He shows that, subject to cost constraints, tax havens will be used as location for paper profits, forcing non-haven countries to compete among themselves only in the game for real investment.

This is not an unrealistic result: Davies et al. (2015) find strong empirical evidence to support the idea that profits are shifted almost entirely to tax havens and a negligible portion of profits are shifted to non-haven countries. The authors use data on transfer pricing for French multinational firms' exports to determine the level of deviation of actual pricing from actual cost in the manner modeled by Devereux et al. (2008): $(q - c)$. That the authors find almost no evidence of profit shifting once exports to tax havens are disregarded suggests strongly that interpreting empirical evidence of strategic interaction between governments' statutory tax rates as evidence of competition for profits is likely not the appropriate explanation.

In fact, much of the empirical literature does not even consider profit shifting between 'high-tax' jurisdictions, but profit shifting from 'high-tax' to 'low-tax' jurisdictions. Important empirical works on profit shifting such as Hines Jr and Rice (1994), Huizinga and Laeven (2008), Buettner and Wamser (2013), Dischinger et al. (2014) and Zucman (2014) consider solely the role of 'low-tax' jurisdictions or tax havens as recipients of shifted artificial profits. A full review of this empirical literature is carried out by Dharmapala (2014).

2.5 Similar Works

The theoretical model I use draws on the assumptions of a number of other theoretical works to bear out important facts. Ultimately it is a simpler framework that the works cited in this section as I use the model to interpret empirical results rather than a full theoretical inquiry. It is especially

similar to Eichner and Runkel (2011) who consider a single MNC producing across countries with non-zero profits. As I do here, they consider taxes levied on profits rather than directly on capital, but they include the more general case where there is incomplete deductability. This suggests my main theoretical predictions would continue to hold even in that case.

An earlier work by Stöwhase (2005) considered a two-country version of the multinational firm. However, his work maintained the simplifying assumption of a unit tax on capital and the idea of tax base shifting between those two productive countries. Mintz and Smart (2004) and Stöwhase (2013) are provide important works connecting profit shifting to the game of tax competition for real investment.Mintz and Smart (2004) suggest that profit shifting could make taxable income more responsive to tax rate differentials while simultaneously causing real investment decisions to become less responsive to tax rates. Stöwhase (2013) extends the analysis to the context of discrete investment choices, finding that a reduced cost of profit shifting will actually lead high tax countries to increase their tax rate since small countries will be happy to win the game for profits and compete less intensely or not at all in the game for real investment.

The underlying structure of the theoretical model used here is close to the key concepts of the final evolution of Johannesen (2010) dual game for investment and profits. That is, tax havens are effectively the only players in the game for paper profits with zero tax rates, leaving non-haven governments to compete among themselves for real investment as tax havens by assumption do not host real investment. Similarly, the theoretical model I use seeks to elucidate the idea mooted in both Hong and Smart (2010) and Johannesen (2010) that profit shifting to tax havens could alter the intensity of tax competition between non-haven countries for different reasons. While Johannesen (2010) suggests that forcing governments out of the competition for profits leads them to set higher tax rates, Hong and Smart (2010) suggest that profit shifting effectively allows governments to differentiate between mobile tax bases and immobile tax bases, raising the rate to tax the immobile tax base more heavily.

3 Tax Competition Model

I follow loosely the broad outline of the Zodrow and Mieszkowski (1986) and Wilson (1986) framework. I concentrate on the N-country case with competition between governments in a Cournot fashion. The firm makes its decisions taking the governments' choices as given, while each government assumes it knows how the firm will react optimally to its own choices. Further, in a model of a large number n of small countries, each government takes the tax rates of all the other governments as given. The model is solved backwards, considering first the firms problem, then the government's, and finally investigating strategic interaction between the governments.

Tax is levied on profits rather than a unit or ad valorem tax on capital, reflecting the incidence of the corporate income tax. Unlike Haufler and Schjelderup (2000) and Devereux et al. (2008) I do not use incomplete deductibility to force the profit tax to be incident on capital. Throughout the theoretical section I assume that the rental cost of capital is completely deductible from revenue in calculating the tax base.

Rather than each jurisdiction hosting a single domestic firm, I consider instead a single multinational firm Johannesen (2010). The multinational firm seeks to maximize global revenue, rather than considering individual firms each with their own profit maximizing objective. Importantly, this means that the government is optimizing based on the optimal choices of a global entity.

This change abstracts from the competitive allocation of the capital market. Instead I consider the world rental rate on capital to be fixed at rate r. There is a fixed supply of global capital that is inelastically supplied to the multinational firm at the rental rate r.

The owner of capital (the investor) and the user of capital (the firm) have vastly different motives in a competitive capital market. The investor seeks the highest after-tax return on capital while the firm seeks the greatest profit, which by duality can be considered as minimizing the cost of capital. More clearly, the change of allocation mechanism for capital from the investor to the firm means that the allocation is no longer based on the highest return on capital r, but now on the highest output less the cost of capital $f'(k) - rk$ (profit).

Summarily, the model considers a tax on capital with complete deducibility of the rental cost of capital. In the Devereux et al. (2008) and Haufler and Schjelderup (2000) model this would mean that tax competition for real investment disappears. By considering a multinational firm, the allocation decision no longer demands that tax competition be based on the competitive allocation of the capital market. This is in line with the suggestion of Markusen (2004) that the financing location decision of the firm is distinct from the production location decision of the firm. It is also in line with the importance of production location in determining the location of tax liability, as made clear by the OECD's BEPS Action Plan.

In this model, the government accounts for the optimal cross-border allocation of capital by a multinational firm. Tax competition does not disappear if the corporate income tax is not incident on capital. Rather, tax competition is defined by the multinational's search for profit.

3.1 The Multinational Firm

There is a single multinational firm with production capacity in each of N symmetric countries in the model, which will be called the firm or the multinational. The firm produces a single good using a single choice of input - capital. Capital is perfectly divisible and mobile across countries. The latter means the firm can locate any amount it chooses in any location with no attached frictions or costs.

The multinational has the same production function in each of the N countries. Production is a function only of capital but may require some other fixed factors that shape the production function $f(k)$. While others consider profits to be compensation of some fixed factor, I abstract from this theme and consider profits to be pure profits. The production function is strictly concave with $f'(k_i) > 0$, $f''(k_i) < 0$ and $f'''(k_i) = 0$. The tax competition literature typically relies on a quadratic production function that satisfies these assumptions (also used in Haufler and Wooton (1999); Bucovetsky (2009); Stöwhase (2005); Devereux et al. (2008); Bucovetsky (1991); Vrijburg and de Mooij (2016)). Given the simplicity of the model, it is not necessary to impose this additional structure on the multinational's production function. Each country is initially endowed with a fixed amount of capital s, which, for simplicity is entirely lent to the firm at the fixed rental rate r.

The tax rate of the government is the only other variable in the profit function. The firm takes the tax rate chosen by the government as given, where $\tau \in [0, 1]$. As this tax is levied directly on profit, τ is the statutory tax rate. The statutory tax rate here is based on the source principle, which says that profit is taxed based on the location of production rather than the residence of the firm. As explained in Slemrod and Wilson (2009), this assumption is used throughout the tax competition literature and reflects the difficulties that countries with worldwide tax systems face in taxing the foreign income of resident multinational firms. It means here that the after-tax income in each country is influenced by the tax rate of that country.

The multinational firm seeks to maximize global profits given the opportunity to produce in all countries N using the global capital supply Ns. The global capital supply acts as the constraint to the firm, meaning that capital employed cannot exceed the global capital supply. To maximize global after-tax profit, the firm seeks to maximize the sum of domestic after-tax profits subject to

the global capital constraint:

$$\max_{k_i{}_{i=1}^{N}} \quad \Pi = \sum_{i=1}^{N} f(k_i) - rk_i - \tau_i[f(k_i) - rk_i]$$
$$s.t. \sum_{i=1}^{N} k_i = Ns \tag{3}$$

where the multinational chooses the level of investment k_i for all countries $i = \{1, ..., N\}$. Setting up the Lagrangian to solve the problem:

$$\max_{k_i{}_{i=1}^{N}} \quad \mathcal{L} = \sum_{i=1}^{N} \{(1 - \tau_i)(f(k_i) - rk_i)\} - \lambda \left[\left(\sum_{i=1}^{N} k_i \right) - Ns \right] \tag{4}$$

the resulting first order condition requires that the statutory tax rate does not disappear because of the added capital constraint on the firm:

$$\frac{\partial \mathcal{L}}{\partial k_i} = f'(k_i) - r - \tau_i f'(k_i) - \tau_i r - \lambda = 0 \tag{5}$$

$$\frac{\partial \mathcal{L}}{\partial \lambda} = \sum_{i=1}^{N} k_i - Ns = 0 \tag{6}$$

First order condition 5 can be rearranged to:

$$(f'(k_i) - r)(1 - \tau_i) = \lambda \tag{7}$$

The expression $f'(k_i) - r$ is the marginal product of capital minus the marginal cost of capital, which in turn is altogether the marginal before-tax profit. The entire left side can then be considered to be the marginal after-tax profit since tax is also deducted by $(1 - \tau_i)$. This is interpreted as the marginal increase in net profit that would result from a one unit increase in capital. Now consider the Lagrange multiplier, which tells us how much global profit would increase given a unit increase in capital. This is the shadow price of capital. The optimality conditions require that the marginal after-tax profit in jurisdiction i be equal to the firm's shadow price of capital. This means that the marginal after-tax profit must be equal across all countries at a value λ for the multinational to maximize global profit.

The rental rate on capital r does not determine the competitive allocation of capital, but represents only the cost of its use. This contrasts with much of the earlier literature where the value r is endogenously determined by firms competing for capital. Instead, the marginal product of capital must exceed the cost of capital r by at least λ. In the case of a non-zero tax rate τ_i, capital is allocated to country i so that the marginal product of capital exceeds the cost by $\frac{\lambda}{1-\tau_i}$, a value greater than λ since $\tau \in [0, 1]$ and lambda is always positive since profit is increasing in capital, holding all else constant.

This means that the optimal value of λ is determined by the entire set of tax rates for all N countries. To see more clearly what this means in terms of the allocation of capital, consider the partial derivatives of capital in jurisdiction i firstly with respect to the own-country tax rate τ_i. To do so, the after-tax marginal profit is equalized across jurisdictions $i = (1, ..., N)$ by the shadow

price of capital λ using the first order conditions 5 and 6:

$$\begin{aligned} f'(k_i) - r - \tau_i f'(k_i) + \tau_i r &= \lambda \\ (f'(k_i) - r)(1 - \tau_i) &= \lambda \\ (f'(k_i) - r)(1 - \tau_i) = \lambda &= (f'(k_j) - r)(1 - \tau_j) \\ (f'(k_i) - r)(1 - \tau_i) = \lambda &= \frac{\sum_{j \neq i}^{N} (f'(k_j) - r)(1 - \tau_j)}{(N-1)} \\ (f'(k_i) - r)(1 - \tau_i) - \frac{\sum_{j \neq i}^{N} (f'(k_j) - r)(1 - \tau_j)}{(N-1)} &= 0 \end{aligned} \tag{8}$$

Importantly then, this suggests that it is the equalization of the 'internal value' or shadow price of capital λ rather than the 'external' price of capital r that determines the final allocation. This is the key concept for understanding competition with a multinational firm.

Applying the implicit function theorem to Equation 8, the partial derivatives are calculated:

$$\frac{\partial k_i}{\partial \tau_i} = \frac{f'(k_i) - r}{f''(k_i)(1 - \tau_i)} < 0 \tag{9}$$

$$\frac{\partial k_i}{\partial \tau_j} = -\frac{f'(k_j) - r}{(N-1)(f''(k_i)(1 - \tau_i))} > 0 \tag{10}$$

which can then be used to show that

$$\frac{\partial k_i}{\partial \tau_i} = -\frac{\partial k_i}{\partial \tau_j} \frac{1}{(N-1)} \tag{11}$$

Proposition 1 *Assuming countries are symmetric, the global profit-maximizing multinational firm responds to a higher corporate income tax rate in any jurisdiction by shifting capital away from that country and proportionally reallocating capital to all other countries.*

Considering that the Lagrange multiplier is positive, from Equation 9 $(f'(k) - r)$ will be positive. A negative second derivative for the production function $f''(k) < 0$ means that the implicit differential $\frac{\partial k_i}{\partial \tau_i}$ in Equation 9 will be negative. That is, an increase in country i's tax rate will cause capital to flow out of country i. Inversely, an increase in country j's tax rate increases the capital allocated to country i. Equation 10 then shows that these two effects are opposite sides of the same coin: when a single country i raises its tax rate, holding all other tax rates constant, the capital that flows out of country i is reallocated to all other countries $-i$ (this notation is used throughout to denote all N countries except i), lowering the marginal profit in country i and increasing the marginal profit in countries $-i$ until they meet again at an internal value λ. With N symmetric countries, the outflow from i is inversely proportional to the individual inflow into all other countries j by a factor $\frac{1}{N-1}$.

This is the key result needed to align this model with the traditional models of capital tax competition. It shows that, even without tax being incident on capital, tax rates set by governments in all countries in the model $i = 1, .., N$ affect the final allocation of capital, or more succinctly $k_i(\tau_1, ..., \tau_N)$ for all i. This implies, in line with reality, that the firm is influenced in its capital allocation decision by tax rates because the location of capital leads to tax liability, which affects its global after-tax profit.

3.2 The Government

The most common assumption in the literature is of a benevolent government seeking to maximize the welfare of its citizens. This allows authors to make judgments about the welfare effects of tax competition particularly from the perspective of the efficient provision of the public good based on the Samuelson rule where the marginal benefit of the public good should equal its marginal cost (see Wilson (1999) for indepth discussion).

Welfare functions in the tax competition literature frequently take a linear form $W(c, g) = c + v(g)$ and little is presumed to be lost by this functional restriction Keen and Konrad (2014). Devereux et al. (2008) and Bucovetsky (2009) further specify the function as $W = c + \gamma g$. The parameter γ is the marginal cost of public funds, meaning that the marginal rate of substitution between the private good c and the public good g is constant. Devereux et al. (2008) restricts $\gamma > 1$ while Bucovetsky (2009) allows $\gamma \geq 1$, noting that if $\gamma = 1$, it reduces to the model in Peralta and van Ypersele (2005). Where $\gamma > 1$, it constitutes a strict preference for the public good over the private good at all levels of consumption. Bucovetsky (2009) points out that if a government optimally chooses its other tax rates (e.g. labour, consumption) and the corporate income tax makes up a small portion of tax revenues, then changes in corporate tax revenues may have little effect on the government's overall marginal cost of public funds at the optimum, meaning that utility can be appropriately assumed to be linear in corporate tax revenue at the optimum.

Importantly, Vrijburg and de Mooij (2016) show that a constant marginal rate of substitution between private and public consumption ensures a positively sloped tax reaction function, meaning that tax rates will be strategic complements. Further, if the marginal rate of substitution goes to infinity, then welfare maximization coincides with revenue maximization. That revenue maximization is simply a special case of welfare maximization with a linear utility function suggests that when we are only interested in the sign of the reaction function and not the welfare properties of tax competition - as I am here - a simplified revenue maximizing objective function for the government is appropriate.

There is a strand of literature that dates back at least to Kanbur and Keen (1993) and further includes Stöwhase (2005) and Haufler and Stähler (2009), which uses the revenue maximizing government under the rationale that is coincides with a welfare maximizing government with a high marginal valuation of public consumption. I choose to use a revenue maximizing objective for the government. Similarly to Johannesen (2010), it will not affect the substance of the results, particularly as I do not consider investors, labour or ownership of the MNC.

More intuitively, Eichner and Runkel (2011) also use a revenue-maximizing objective function, motivated by the fact that in many countries the revenue from corporate taxation falls short of the revenue from other taxes, particularly with corporations finding new ways to 'hide' corporate income. Voters tend to view this development as unfair and push politicians to seek to rectify this by maximizing the revenue from corporate tax. This is embodied by the broad push for global companies to 'pay their fair share' of taxes. More broadly, it is a small component of the recent push for greater taxation of capital by those who deem the distribution of capital ownership to be unequal (Piketty and Saez, 2012; Piketty, 2014).

Therefore, the government in country i faces the problem of setting a tax rate τ_i on the profits of the MNC generated in country i:

$$\max_{\tau_i} \quad R_i = \tau_i[f(k_i) - rk_i] \tag{12}$$

While the government takes all other tax rates τ_{-i} as given, it knows the firms problem and the firm's optimal response to its choice of tax rates and therefore the optimal capital allocation. The

first order condition of this problem is:

$$\frac{\partial R_i}{\partial \tau_i} = f(k_i) - rk_i + \tau_i \left(f'(k_i)\frac{\partial k_i}{\partial \tau_i} - r\frac{\partial k_i}{\partial \tau_i} \right) = 0$$
$$\{f(k_i) - rk_i\} + \left\{ \tau_i \frac{\partial k_i}{\partial \tau_i}(f'(k_i) - r) \right\} = 0 \tag{13}$$

This gives us the government's best response function to the combination of other countries' tax rates in a Cournot-style game. Analogous to the Johannesen (2010) description, the term in the first set of curly braces represents the 'rate effect' and the second set of braces is the 'base effect'.

The rate effect represents the increase in tax revenue that the government would recover based on the existing tax base, which is the firm's gross profit realized in country i. The base effect captures the fact that an increase in the tax rate will alter the firm's optimal allocation of capital, reducing capital located in country i and therefore reducing the government's taxable base. This trade-off between the rate and base effect is a key element in understanding tax competition, and the simplicity of a revenue-maximizing government allows us to focus on this trade-off. The government sets its tax rate at the point where these two contrasting effects are balanced. That is, at the point where:

$$\{f(k_i) - rk_i\} = -\left\{ \tau_i \frac{\partial k_i}{\partial \tau_i}(f'(k_i) - r) \right\} \tag{14}$$

at the optimal tax rate τ_i^*, the size of the rate effect must be equal to the size of the base effect, balancing the government's two concerns exactly. At that rate τ_i^*, no increased revenue is to be gained by increasing or decreasing the tax rate. This equation describes the tension between the intensive and extensive margins.

3.3 Tax Competition

The key result in this section is establishing whether tax rates are strategic *complements* or strategic *substitutes*. Strategic complements are defined in the case where a greater tax rate in jurisdiction j leads jurisdiction i to re-optimize at a higher tax rate as well. Strategic substitutes are the inverse: where a greater tax rate in jurisdiction j leads jurisdiction i to re-optimize at a lower tax rate. I test this by investigating the sign of the derivative of τ_i^* with respect to τ_j. The derivative is:

$$\frac{d\tau_i^*}{d\tau_j} = -\frac{\frac{\partial^2 R}{\partial \tau_i \partial \tau_j}}{\frac{\partial^2 R}{\partial \tau_i^2}} \tag{15}$$

Under the revenue maximizing condition that the second order condition is negative (which is shown below), then the total derivative will take the same sign as the cross partial derivative of the revenue equation. Here a simplifying assumption is made as in the vast majority of the tax competition literature of a quadratic production function, then the third derivative $f'''(k) = 0$. Substituting in for $\frac{\partial k_i}{\partial \tau_i}$,

$$\begin{aligned}\frac{\partial R}{\partial \tau_i} &= f(k_i) - r(k_i) + \tau_i \frac{\partial k_i}{\partial \tau_i}(f'(k_i) - r) \\ &= f(k_i) - rk_i + \tau_i \frac{f'(k_i) - r}{f''(k_i)(1-\tau_i)}(f'(k_i) - r) \\ &= f(k_i) - rk_i + \frac{\tau_i (f'(k_i) - r)^2}{f''(k_i)(1-\tau_i)}\end{aligned} \tag{16}$$

and differentiating with respect to τ_j, I derive the following expression:

$$\begin{aligned}
\frac{\partial^2 R}{\partial \tau_i \partial \tau_j} &= f'(k_i)\frac{\partial k_i}{\partial \tau_j} - r\frac{\partial k_i}{\partial \tau_j} + \frac{2\tau_i(f'(k_i)-r)f''(k_i)\frac{\partial k_i}{\partial \tau_j}}{f''(k_i)(1-\tau_i)} - \frac{\tau_i(f'(k_i)-r)^2\frac{\partial k_i}{\partial \tau_j}f'''(k_i)(1-\tau_i)}{[(f''(k_i)(1-\tau_i)]^2} \\
&= (f'(k_i)-r)\frac{\partial k_i}{\partial \tau_j} + \frac{2\tau_i(f'(k_i)-r)\frac{\partial k_i}{\partial \tau_j}}{(1-\tau_i)} - 0 \\
&= (f'(k_i)-r)\frac{\partial k_i}{\partial \tau_j}\left[1 + \frac{2\tau_i}{1-\tau_i}\right] \\
&= (f'(k_i)-r)\frac{\partial k_i}{\partial \tau_j}\left[\frac{1+\tau_i}{1-\tau_i}\right] > 0
\end{aligned} \tag{17}$$

Proposition 2 *The tax reaction function $d\tau_i/d\tau_j$ is positive, meaning that τ_i and τ_j are strategic complements.*

The first term in brackets has already been shown to be positive, while $\partial k_i/\partial \tau_j$ is positive and the final term is positive for any value of $0 \leq \tau_i < 1$. This shows then that $\frac{d\tau_i^*}{d\tau_j}$ is positive and tax rates are, as in the traditional tax competition game, strategic complements.

To confirm that the second derivative is negative, I differentiate the first order condition from Equation 13 with respect to τ_i again.

$$\begin{aligned}
\frac{\partial^2 R}{\partial \tau_i^2} &= f'(k_i)\frac{\partial k_i}{\partial \tau_i} - r\frac{\partial k_i}{\partial \tau_i} + \frac{(f'(k_i)-r)^2 + 2\tau_i(f'(k_i)-r)f''(k_i)\frac{\partial k_i}{\partial \tau_i}}{f''(k_i)(1-\tau_i)} \\
&= (f'(k_i)-r)\frac{\partial k_i}{\partial \tau_i} + \frac{(f'(k_i)-r)^2}{f''(k_i)(1-\tau_i)} + \frac{2\tau_i(f'(k_i)-r)f''(k_i)\frac{\partial k_i}{\partial \tau_i}}{f''(k_i)(1-\tau_i)} \\
&= \frac{(f'(k_i)-r)(f'(k_i)-r)}{f''(k_i)(1-\tau_i)} + \frac{(f'(k_i)-r)^2}{f''(k_i)(1-\tau_i)} + \frac{2\tau_i(f'(k_i)-r)f''(k_i)(f'(k_i)-r)}{f''(k_i)(1-\tau_i)f''(k_i)(1-\tau_i)} \\
&= \frac{2(f'(k_i)-r)^2}{f''(k_i)(1-\tau_i)} + \frac{2\tau_i(f'(k_i)-r)^2}{f''(k_i)(1-\tau_i)^2} \\
&= \frac{2(f'(k_i)-r)^2}{f''(k_i)(1-\tau_i)}\left[1 + \frac{\tau_i}{1-\tau_i}\right] \\
&= \frac{2(f'(k_i)-r)^2}{f''(k_i)(1-\tau_i)}\left[\frac{1}{1-\tau_i}\right] \times \frac{f''(k_i)}{f''(k_i)} \\
&= 2\left(\frac{\partial k_i}{\partial \tau_i}\right)^2 f''(k_i) < 0
\end{aligned} \tag{18}$$

Reducing the equation to this form allows me to sign the second derivative. With the square of the bracketed term positive, the negative second derivative of the production function ensures that the government achieves a maximum as the second derivative of the revenue function with respect to the tax rate is negative.

3.4 Tax Havens and Profit Shifting

Because of the numerous methods of shifting profits multinational corporations possess, a number of different mechanisms have been used in the literature to describe the various accounting methods of transferring tax liability from the country where it was generated to another, lower

taxed country. An IMF (2014) policy paper describes nine common methods multinationals use to shift profits. In a literature considering a unit tax on capital, it made sense for authors to consider the ability to misreport the level of capital invested in a jurisdiction in order to shift profits as in Stöwhase (2005) and Johannesen (2010). However, when updating the model to a tax on profits, Haufler and Schjelderup (2000) and Devereux et al. (2008) considered transfer pricing as an appropriate mechanism to describe profit shifting. Profit shifting via transfer pricing is ability to deviate from cost when pricing an intra-firm transaction that allows the firm to shift profit from one country to another by recognizing higher costs in the high-tax jurisdiction and lower costs in the low-tax jurisdiction. Mintz and Smart (2004) and Hong and Smart (2010) both use the idea that firms can use their capital structure to transfer profits. That is, a multinational could set up a subsidiary in another jurisdiction using equity capital, which is in turn lent to the headquarters (or even to another subsidiary) for real investment. The subsidiary is paid the interest which would be taxed as profits at a lower rate while the interest paid counts as a deductible expense for the headquarters in the higher tax country, reducing the multinational's overall tax liability by altering the financial structure on paper.

Given that this paper is not concerned with a tax directly incident on capital, it means that the model can introduce a substantially simplified representation of profit shifting. Further, this simplified version is probably more general than others which might be forced to be analogous to some current practice of multinational corporations. The benefit is that we only have partial knowledge about the practices and methods multinational companies use to shift profits and these are sometimes very complex transactions. They are constantly evolving and it is likely a simple representation can best continue to capture future changes in behaviour. The outcome is always the same: taxable profits are reduced in the high tax jurisdiction by some amount and are instead realized in the tax haven. Here I model this key fact.

As a result, adding profit shifting to tax havens to the model turns out to be relatively straightforward. It requires no additional countries to the tax competition game as profit shifting only happens in one direction - from the countries already specified to tax havens. Following Johannesen (2010), I make simplifying assumptions about tax havens that are mainly quite justifiable. Firstly, tax havens have a zero tax rate; secondly, they have no or negligible initial capital endowment; and thirdly, they do not host any real investment or production. Profit shifted reduces the taxable profit generated through real production in jurisdiction i by an amount q_i.

A cost of profit shifting is added to ensure an accurate representation. Were profit shifting costless, a corner solution would be observed in practice where multinational firms would recognize no profit in jurisdictions with a non-zero tax rate. Some of the actual costs attached to profit shifting might include setting up a subsidiary in the tax haven, costs of pursuing accounting profit-shifting techniques, reputational costs and the potential costs of being fined for this activity. As in Johannesen (2010), the cost of profit shifting is specified as a function of profits shifted $c(q_i)$. Unlike Johannesen (2010), however, I specify a simple quadratic cost function in the vein of earlier works such as Stöwhase (2005) and Devereux et al. (2008):

$$c(q_i) = \frac{\alpha_i q_i^2}{2} \tag{19}$$

The parameter α_i is the profit shifting cost parameter and is given exogenously in the model, but can vary across countries. The result is that the multinational firm chooses both k_i and q_i for all

countries $i = 1, ..., N$ taking the tax rates τ_i and α_i as given. The updated profit function is then:

$$\begin{aligned} \max_{k_i, q_i{}_{i=1}^{N}} \quad & \Pi = \sum_{i=1}^{N} f(k_i) - rk_i - \tau_i[f(k_i) - rk_i - q_i] - c(q_i) \\ & s.t. \sum_{i=1}^{N} k_i = Ns \end{aligned} \tag{20}$$

The firm's first order conditions in Equations 5 and 6 remain unchanged. As a result of an additional choice variable, however, a third first order condition is added that defines the optimal choice of q_i:

$$\begin{aligned} \frac{\partial \mathcal{L}}{\partial q_i} = \tau_i - c'(q_i) &= 0 \\ c'(q_i) &= \tau_i \end{aligned} \tag{21}$$

which says that the firm will shift profits out of jurisdiction i into tax havens up to the point where the marginal cost of shifting profit is equal to the marginal benefit of shifting profit. The marginal benefit is the amount of tax payments saved on an extra dollar of profit - the statutory tax rate. Employing the functional form:

$$\begin{aligned} c'(q_i) &= \tau_i \\ \alpha_i q_i &= \tau_i \\ q_i &= \frac{\tau_i}{\alpha_i} \end{aligned} \tag{22}$$

The optimal level of profit shifting is therefore increasing in the tax rate and declining in the cost of profit shifting.

The government's problem is also easily updated to:

$$\max_{\tau_i} \quad R_i = \tau_i[f(k_i) - rk_i - q_i] \tag{23}$$

which gives the first order condition:

$$\frac{\partial R_i}{\partial \tau_i} = f(k_i) - rk_i - q_i + \tau_i \left(f'(k_i) \frac{\partial k_i}{\partial \tau_i} - r \frac{\partial k_i}{\partial \tau_i} - \frac{\partial q_i}{\partial \tau_i} \right) = 0 \tag{24a}$$

$$\{f(k_i) - rk_i\} + \left\{ \tau_i \frac{\partial k_i}{\partial \tau_i} (f'(k_i) - r) \right\} + \left\{ -q_i - \frac{\tau_i}{\alpha_i} \right\} = 0 \tag{24b}$$

In Equation 24a above, the rate and base effects are updated to include the effects of profit shifting, but their interpretations remain broadly the same. In Equation 24b, I separate the profit shifting effects from the main tax competition effects to show the impact clearly. The additional term in the third set of braces captures the reduction in taxable profits created by profit shifting and the effect that an increased tax rate would have on the level of profit shifting and therefore the tax base.

This does not change the sign of the reaction function $\frac{d\tau_i^*}{d\tau_j}$ as the cross partial derivative does

not change. I show that the second order condition remains negative:

$$\begin{aligned}
\frac{\partial^2 R}{\partial \tau_i^2} &= 2\left(\frac{\partial k_i}{\partial \tau_i}\right)^2 f''(k_i) - \frac{\partial q_i}{\partial \tau_i} - \frac{1}{\alpha_i} \\
\frac{\partial^2 R}{\partial \tau_i^2} &= 2\left(\frac{\partial k_i}{\partial \tau_i}\right)^2 f''(k_i) - \frac{1}{\alpha_i} - \frac{1}{\alpha_i} \\
\frac{\partial^2 R}{\partial \tau_i^2} &= 2\left(\frac{\partial k_i}{\partial \tau_i}\right)^2 f''(k_i) - \frac{2}{\alpha_i} \\
\frac{\partial^2 R}{\partial \tau_i^2} &= 2\left[\left(\frac{\partial k_i}{\partial \tau_i}\right)^2 f''(k_i) - \frac{1}{\alpha_i}\right] < 0
\end{aligned} \tag{25}$$

where $\frac{\partial q_i}{\partial \tau_i}$ is shown to be $\frac{1}{\alpha_i}$ in Equation 22.

Considering the profit shifting cost parameter α_i as the parameter of interest in the tax haven set-up as it is exogenous to the model, I calculate the partial derivative of the tax rate with respect to the cost of profit shifting. This is similar to the exercise carried out in both Stöwhase (2005) and Hong and Smart (2010) who check the comparative statics for the exogenous parameter whether it be profits shifted or the cost of profit shifting. Using the implicit function theorem, the partial derivative of the tax rate with respect to the cost of profit shifting is:

$$\frac{\partial \tau_i^*}{\partial \alpha_i} = -\frac{\frac{\partial^2 R}{\partial \tau_i \partial \alpha_i}}{\frac{\partial^2 R}{\partial \tau_i^2}} \tag{26}$$

Once again, the denominator of the equation is negative and so I only need to sign the numerator:

$$\begin{aligned}
\frac{\partial^2 R}{\partial \tau_i \partial \alpha_i} &= -\frac{\partial q_i}{\partial \alpha_i} + \frac{\tau_i}{\alpha_i^2} \\
&= -\frac{-\tau_i}{\alpha_i^2} + \frac{\tau_i}{\alpha_i^2} \\
&= \frac{\tau_i}{\alpha_i^2} + \frac{\tau_i}{\alpha_i^2} \\
&= \frac{2\tau_i}{\alpha_i^2}
\end{aligned} \tag{27}$$

Proposition 3 *An increase in the exogenous cost of profit shifting results in a reduction of the optimal level of profit shifting and an increase in the optimal tax rate.*

Equation 27 is unambiguously positive. This means that $\frac{\partial \tau_i^*}{\partial \alpha_i}$ is positive, or more plainly that an increase in the *cost* of profit shifting reduces profits shifted and encourages or allows the government to raise its tax rate. The higher the cost of profit shifting, the lower the optimal level of profit shifting will be at any tax rate, meaning that the government has a broader tax base relative to the case of a lower cost of profit shifting. From Equation 24b, the government balances the level of profit shifting against the firm's cost of profit shifting using the tax rate. As the higher cost of profit shifting gives the government a greater taxable base, it will maximize revenues at a higher tax rate as a result.

I therefore expect a decline in the cost of profit shifting to lead not only to more profits being shifted but also to a lower tax rate. Also of interest in this simple model is whether a change in

the cost of profit shifting would impact the slope of the tax reaction function. While some authors such as Keen (2001), Mintz and Smart (2004) and Stöwhase (2005, 2013) have a bit to say about the effect of profit shifting between non-haven countries on tax competition, only Hong and Smart (2010) and Johannesen (2010) have sought to investigate the effect of profit shifting to tax havens on tax competition. Their findings are broadly similar: profit shifting is expected to mitigate the intensity of tax competition for three main reasons. Firstly, it stops non-haven countries from competing for profits. Secondly, it allows countries to distinguish between mobile and immobile capital, where the theory of optimal capital taxation suggests that mobile capital be left untaxed while taxing immobile capital more heavily. The third reason is that real investment would become less responsive to tax rate differentials if profits are already being taxed at low rates elsewhere.

It was previously shown that the slope of the reaction function $\frac{d\tau_i^*}{d\tau_j}$ is positive. A large positive value then suggests a steeper slope of the reaction function and vice versa. To simplify the symbolic representations, let the reaction function $\frac{d\tau_i^*}{d\tau_j} = h_{ij}$ and let $R_{\tau_i\tau_i}$ represent the second derivative of the revenue function with respect to τ_i. Symbolically then, taking the derivative of h_{ij} with respect to α_i:

$$\frac{\partial h_{ij}}{\partial \alpha_i} = \frac{(-R_{\tau_i\tau_j\alpha_i})R_{\tau_i\tau_i} - (-R_{\tau_i\tau_j})R_{\tau_i\tau_i\alpha_i}}{R_{\tau_i\tau_i}^2} \tag{28}$$

From Equation 17, the value of $R_{\tau_i\tau_j\alpha_i}$ is zero. The second term of importance is $R_{\tau_i\tau_i\alpha_i}$, derived from Equation 25:

$$R_{\tau_i\tau_i\alpha_i} = \frac{2}{\alpha_i^2} \tag{29}$$

which is positive. From Equation 28, the denominator is positive while the first term in the numerator disappears, leaving:

$$\frac{\partial h_{ij}}{\partial \alpha_i} = \frac{R_{\tau_i\tau_j}R_{\tau_i\tau_i\alpha_i}}{R_{\tau_i\tau_i}^2} > 0 \tag{30}$$

Proposition 4 *An increase in the cost of profit shifting results in a decline in optimal profit shifting and a steeper slope for the tax reaction function.*

All three values in Equation 30 are considered to be positive. The interpretation of a positive value for $\frac{\partial h_{ij}}{\partial \alpha_i}$ is that an increase in the cost of profit shifting, which leads to a decline in profit shifting, actually suggests a steeper slope of the tax reaction function. The steeper the slope of the reaction function, the larger government i's optimal change in tax rate will be to an exogenous change in government j's tax rate. This is frequently described as an increase in the *intensity* of tax competition for capital. In this simple model, the suggestion is that profit shifting seems likely to mitigate tax competition. This result is suggested by both Hong and Smart (2010) and Johannesen (2010). That this result is obtainable in a simple model is useful.

3.5 Discussion

The key take-away from the model is that the government's statutory tax rate can affect the multinational firm's global allocation of profit - and therefore the optimal allocation of capital. The firm seeks to maximize global profit and in the process of doing so, sets the shadow value of capital equal to the after-tax marginal profit in every country. As a result, governments face a trade-off between the *intensive* margin (taxing available profits at a higher rate) and the *extensive* margin

(attracting higher levels of production and profit) in setting their optimal tax rate. As the allocation of capital is determined by the entire set of tax rates $k_i(\tau_1, ..., \tau_N)$, governments also interact with one another in resolving this trade off. This interaction is modeled as a non-cooperative game where the optimal tax rate of any country takes into account the full set of tax rates set by all the other countries. For a simple 2-country example, the resulting reaction function can be shown graphically as in Figure 1, with each government having upward sloping best response functions that intersect at the Nash equilibrium E.

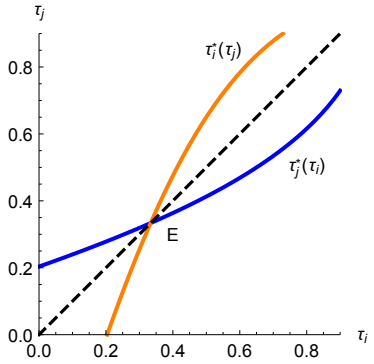


Figure 1: Reaction Function Example

The novelty of the result is not in proving that tax competition exists. Figure 1 is clearly analogous to the depiction in Keen and Konrad (2014). The key contribution of this model is showing that governments compete for real investment using their statutory tax rates. I show that tax competition for real investment exists where a multinational firm making cross-country investment decisions is the key agent allocating capital. This holds even when the tax is not directly incident on capital once tax liability arises from production. This allows us to consider empirically the strategic interaction of statutory tax rates as a sign of competition for real investment.

Therefore, in contrast to Devereux et al. (2008), I do not interpret empirical evidence of strategic interaction on statutory tax rates as countries competing for paper profits. Instead, the theoretical model has shown that strategic interaction on statutory tax rates is likely due to competition for real investment for two reasons: (1) governments compete for production location of multinational firms who are able to allocate rented capital to any country, and (2) non-haven governments rarely compete for profits as multinational firms have extremely strong incentives to use tax havens as vehicles for reducing their tax liability via profit shifting since tax havens offer no or very low tax rates on profits and typically do not require any substantial economic activity to be undertaken in the jurisdiction.

The model considers only horizontal movement in capital - producing the same goods across different markets - which, according to Markusen (2004), is the main form of FDI. However, such a model is also mainly applicable to the case of vertical movement of capital - where different stages of production are fragmented geographically - as vertical FDI continues to require cross-country investment-production decisions to be made by the multinational firm.

The second contribution is that the model is able to show in a concise manner how profit shifting is likely to affect governments, both in setting tax rates and how they interact with one another. Profit shifting intensifies the government's trade-off between the intensive and extensive margins: a higher tax rate encourages greater profit shifting but a lower tax rate does not capture as much revenue per unit of profit recognized. The prediction of the model is that lower costs of profit shifting, associated with higher levels of profit shifting, are likely to result in lower tax rates being

set. Adding another trade off for the government to think about distorts the original optimal tax decision slightly, reducing the government's sensitivity to tax competition. The knock on effect is that this results in a flatter tax reaction function for the home country, likely leading to less intense levels of tax competition.

I capture only a basic description of the vast number of choices a multinational corporation has available to it. I propose that they are the main cog in the wheel of tax competition, effectively driving governments' interaction with one another. In reality, multinationals are able to play off one government against another in securing the best deals and reaching its target of maximizing global profit. This has been especially apparent recently with high-profile cases multinationals pitting one government against another in securing beneficial tax deals (Avi-Yonah and Xu, 2016). Adding tax havens to the model emphasizes the key role of multinationals in shaping the face of global tax policy; Rota-Graziosi (2016) goes as far as suggesting that tax havens effectively share the same objective function as the firm.

4 Empirical Strategy

4.1 Spatial Econometric Model

This section empirically tests the three main predictions of the theoretical model with respect to corporate tax rates. First, that statutory tax rates are strategic complements. Second, that statutory tax rates are set in response to multinationals' profit shifting activity. Third, that profit shifting may alter the way countries interact using their statutory tax rates.

The spatial econometric model is the method of choice for estimating the existence and magnitude of tax competition. The spatial econometric model is built on the idea that values observed in one region depend on the values observed in neighbouring regions. A simple representation of this in a three-region model with countries i, j, k would look like:

$$\begin{aligned} y_i &= \alpha_{ij} y_j + \alpha_{ik} y_k + X_i \beta + \varepsilon_i \\ \varepsilon_i &\approx N(0, \sigma^2) \end{aligned} \tag{31}$$

However, in an n-region format, this is an unfeasible method for estimation with too many parameters to be estimated. The solution to this over-parameterization is to linearly combine the terms using some structural form, usually based on a spatial weight matrix. The typical format looks like:

$$y_i = \rho \sum_{j=1}^{n} W_{ij} y_j + X_i \beta + \varepsilon_i \tag{32}$$

into what is known as a spatial autoregressive (SAR) model. In Equation 32, W_{ij} is the spatial weight matrix usually representing the 'distance' between region i and its neighbours. If each row in the weight matrix sums to 1, the term $\sum_{j=1}^{n} W_{ij} y_j$ becomes the weighted average of the outcomes of i's neighbours. This combination is usually known as the spatial lag.

The spatial autoregressive model has a few nice properties for this research. Some argue that tax competition should be considered a dynamic process, where the current value of country i's outcome y_t should be dependent on the lagged values of the spatial lag (Overesch and Rincke, 2011). This is a valid argument as it is common for economic agents to consider the past decisions of other agents in making its own decision. However, LeSage and Pace (2009) show that observed cross-sectional spatial dependence in a SAR can be interpreted as the long-run equilibrium or steady state arising from inherently time-dependent decisions. With this proof in mind, I do not

complicate the analysis with dynamic versions of either the theoretical or empirical models as I consider only the long run equilibrium spatial dependence in this paper.

In equation 32, parameter ρ captures the endogenous interaction effects between neighbours' outcomes. It is sometimes termed a pure endogenous-effects model, assuming that there are neither exogenous effects nor correlated effects. *Exogenous effects* refer to the possibility that an individual's behaviour is directly affected by the determinants of the outcomes of its neighbours. *Correlated effects* refers to the case where the weight matrix affects the outcomes due to some similarity of characteristics. This assumption allows reasonable basis for identification of the strategic interaction parameter ρ (Manski, 1993). To control for the possibility that unobservables might have a direct effect on outcomes, I use control for country fixed effects to remove unobservables that are fixed over time and could possibly be sources of endogeneity.

There remains the fact that the spatial lag is a purely endogenous regressor; the theoretical model tells us that tax rates are jointly determined. One alternative strategy found in the tax competition literature is to use the weighted average of neighbours' determinants $\sum_{j=1}^{n} W_{ij}X_j$ as an instrument for the spatial dependent lag (Besley and Case, 1995; Brett and Pinkse, 2000; Devereux et al., 2008; Overesch and Rincke, 2011). Assuming that there are no exogenous effects, this strategy provides an important test for the robustness of the results.

4.2 Econometric Issues

Overesch and Rincke (2011) look for time correlations in tax rates by adding a temporally lagged dependent variable. The aim is to account for sluggish adjustment of tax rates over time. While it does not add substantial explanatory power to the model, it allows the comparison of short-run and long-run strategic effects. Overesch and Rincke (2011) find comparable long-run estimates to Devereux et al. (2008) who do not use the partial adjustment model. Angrist and Pischke (2008) tells us that the conditions for consistent estimation are extremely demanding when one chooses to mix both fixed effects and the lagged dependent variable. Alternative estimation techniques such as the Arellano-Bond GMM estimator or the Blundell-Bond estimator try to handle this problem. In the case that the combination of fixed effects and temporally lagged dependent variable is the true model, the fixed effects only model would tend to overestimate the true results while the lagged dependent variable only model would tend to underestimate the parameters. These likely then serve as an upper and lower bound on the estimates if the true model lies somewhere in between.

Group-level or common shocks can sometimes cause spurious strategic interaction, creating statistical correlation where there is no causal link (Angrist and Pischke, 2008). Chirinko and Wilson (2011) find a negative reaction function among US states in setting tax rates contrary to the existing literature, attributed to the author's decision to control for aggregate shocks. Devereux et al. (2008) uses a country-specific time trend while Overesch and Rincke (2011) adds common period effects instead. Xiao (2014) thinks that it requires a greater weapon, using a double clustering technique that allows jurisdictions to respond heterogeneously to shocks.

In the context of sub-national competition, the choice to control for shocks appears appropriate as there are closer ties, inter-dependencies, free movement of labour and common exposure to national institutions. For example, Chirinko and Wilson (2011) suggest that some of these aggregate shocks could be energy prices, U.S. macroeconomic conditions, tax rates and input costs abroad. Neither Overesch and Rincke (2011) nor Xiao (2014) provide justification for their decision to control for common shocks or examples of what form these shocks could possibly take in an international context. This is important because there would be no need to control for shocks that already work through the determinants (controls) specified; unobservable or incalculable shocks are those that validate adding controls for common shocks.

The concern with adding a time trend or year-specific dummies without justification is that it would almost entirely capture the very stylized fact that motivates this research - the steady decline in statutory tax rates over time. In contrast, this adds almost no interpretive power. Figure 2 shows the strong downward trend in the average top statutory tax rate across the OECD and G20 countries that motivates much of the research on international corporate tax competition. A simple linear trend line would probably be the best fit but would tell us nothing helpful about the nature of tax rate changes.

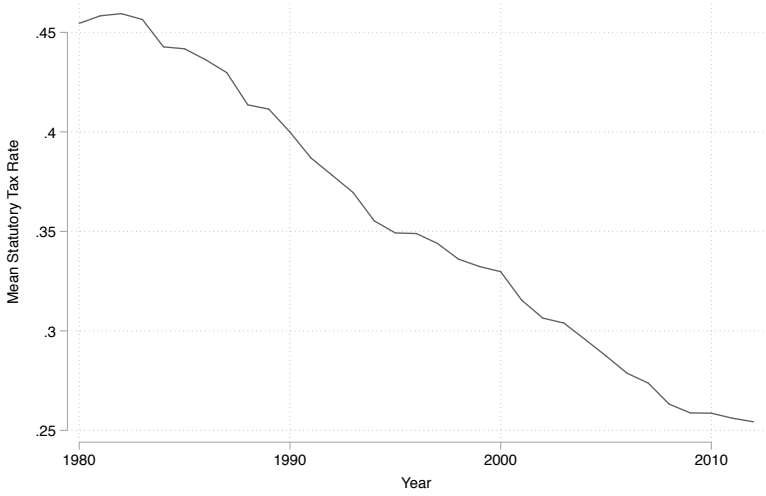


Figure 2: Mean Statutory Tax Rates (1980-2012)

Franzese and Hays (2014) write that the obvious optimal practice in dealing with common spatially correlated shocks remains the precise and careful specification of the model. The most likely form a global shock would take is a global economic downturn. This shock can either be captured by using an indicator of economic activity as a control or adding world gross domestic product (GDP) as a common factor. Additionally, I control for country-specific shocks by using clustered standard errors.

4.3 Spatial Weight Matrix

While the choice of the weight matrix is important, the true weight matrix is almost never known and the assumptions made about the weight matrix are crucial Gibbons and Overman (2012). Devereux et al. (2008) test three weight matrices - GDP size weights, FDI size weights and uniform weights - and find only the uniform weights to be useful. Overesch and Rincke (2011) suggest that in the case of a large number of countries, the uniform weights will cause the regressor $\mathbf{w}y_{-i}$ to be very similar for all countries i in any given period, making it almost collinear to a common period effect. They suggest that this also holds to some extent for GDP and FDI weights, making it very difficult to identify common period shocks from the causal spatial interdependence.

To combat this, Overesch and Rincke (2011) use an inverse bilateral distance weight on the grounds that it influences the cost of profit shifting and that there is a strong inverse relationship between distance and FDI. (Heinemann et al., 2010) further amend this inverse distance weight with a population size measure. My suggestion, similar to Redoano (2007), is that tax competition is likely best identified when economic weighting functions are used rather than uniform, size or distance weights.

The size measures Devereux et al. (2008) use as alternatives to the uniform weight matrix depend on the assumption that the larger a country is, the greater its impact on the entire network of countries, and that this impact is homogeneous across the network. This is unlikely to be true, since countries form special relationships within the network that are not entirely dependent on size. The distance weight Overesch and Rincke (2011) use assumes that the geographical distance between countries is the defining factor driving the heterogeneous links between countries. While (Heinemann et al., 2010) combines these two assumptions, it is unlikely that this captures the entirety of the link between each pair of countries.

I use bilateral FDI weights to form the spatial weight matrix. Overesch and Rincke (2011) and (Heinemann et al., 2010) both make the point that bilaterally determined weights are more important than homogeneous size weights. The economic links between two countries are more important for tax competition than their geographic distance alone. Further, Blonigen (2005) reviews the literature on the determinants of FDI and finds it likely that distance and size effects play a role in determining FDI movement between countries. I propose that bilateral FDI weights subsume the size and distance weights previously used. The relationship between two countries in competition for capital should be evidently manifest in the cross-country network of FDI, particularly given the strong narrative formed around FDI in the public tax competition debate.

This work benefits partly from the passage of time, as earlier works would unfortunately have been constrained by the unavailability of data were they interested in using bilateral FDI weights. The collection of bilateral FDI data has substantially increased and improved through the 2000's, and enables this research to use a more plausible weighting scheme. While earlier measures attempt to provide some approximation to the investment relationship between two countries, there is little doubt that FDI weights should nudge us closer to the 'true' weight matrix than uniform, distance or size weights. All estimates are weighted in this manner except where explicitly stated.

4.4 Profit Shifting

4.4.1 Foreign Direct Investment

Foreign direct investment (FDI) is defined by the IMF (2009) in the Balance of Payments and International Investment Position Manual as "a category of cross-border investment associated with a resident in one economy having control or a significant degree of influence on the management of an enterprise that is resident in another economy." The OECD (2008) in the Benchmark Definition of FDI defines that FDI is associated with a lasting interest in an enterprise, motivated by the desire for a strategic long-term relationship that allows the investor access to the economy of the direct investment enterprise.

Much has been made of the disproportionate FDI attracted by tax havens relative to the generally small size of their economies. Many view it as a perversion of international capital flows formed by the existence and use of tax havens. Genschel and Schwarz (2011) depict FDI as a path facilitating both the movement of real economic activity and the shifting of profits. Accordingly, FDI and profit shifting are seen to be 'intimately linked' according to those authors. However, in spite of the theoretical assumptions that tax havens do not engage in any real economic activity, they typically have some economic activity of their own in reality, but certainly not enough to justify the outsized portion of global FDI they receive.

To emphasise this point, the average inward FDI stock of tax havens in my sample in 2012 was 129.5% of their GDP, and that excludes three outlier tax havens with figures in excess of 1000%. It means that while a small portion of this FDI might be apportioned to movement of capital for real investment, it is likely an insignificant part of the overall size of the FDI stock held in these

countries.

Corporate profit shifting almost always requires setting up a subsidiary in a tax haven, irrespective of the form profit shifting takes. Setting up subsidiaries leaves a trail of investment - particularly equity ownership - that is captured in foreign direct investment statistics. This sentiment is expressed by Palan et al. (2013), who suggest that the outsized share of global FDI received by tax havens represents investments made to set up financial services companies that operate as profit receivers from high tax countries. That line of reasoning explains why FDI into tax havens should help to pick up the scent of profit shifting. In fact, it likely means that total FDI going into tax havens from a country should be positively correlated with the level of profit shifting out of that country. Further, Blanco and Rogers (2012) empirical finding that tax havens compete for FDI says that it is an important signal of profit shifting activity.

Dharmapala (2008) also suggests that the disproportionate share of US FDI located in tax havens is reflective of tax planning behaviour. Further work by Dharmapala (2014) raises an important point that other countries such as the Netherlands - who do not appear on the typical list of tax havens - carry the same characteristics of disproportionate shares of FDI and a very high share of net income relative to value added. Gravelle (2015) prepared a report for the US Congress that specifically identifies the Netherlands as allowing firms to reduce their taxes and frequently being considered a tax haven as a result. The concern appears justified by the large and rising share of US companies' profits reported in the Netherlands. Van Dijk et al. (2006) indicate that the empirical evidence defines the Netherlands as a tax haven as it offers companies who would not ordinarily be resident in that country the means to reduce its tax liability. Grubert and Altshuler (2008) add Ireland to this list of 'semi-havens', where profits of manufacturing controlled foreign companies are three times the level of their sales.

4.4.2 Trade In Services

Another potential indicator of profit shifting to tax havens is flagged by Hebous and Johannesen (2015). They note that tax havens are principle players in international services trade, a role they do not reprise in goods trade. Using a gravity model, their work shows that OECD countries' services trade with tax havens is approximately six times higher than with non-havens when controlling for size, distance and other typical factors. They do not find a substantial difference when considering trade in goods.

While Hebous and Johannesen (2015) suggest that, in the case of Germany, not all of this excess services trade is attributable to profit shifting, their results strongly suggest that much of the excess importation of services from tax havens are the result of profit shifting. In particular, the finding that there is a strong correlation between services trade and the allocation of global profits within firms suggests that trade in services - especially when identifiable between affiliates - is an important channel of profit shifting.

The main intuition behind these results is the idea that multinational firms set up subsidiaries in tax havens so that they can trade fictitious or mispriced services among between non-haven jurisdictions and tax havens. The resulting outcome, as confirmed by the empirical work of Hebous and Johannesen (2015), is that there is a greater probability of observing trade with subsidiaries in tax havens rather than subsidiaries in non-havens.

Based on this intuition and the results, I use a variable capturing services trade to tax havens as a proxy for profit shifting. Specifically, the use of services imports by non-haven countries from tax havens is a key clue in identifying an approximate level of profit shifting. Much like the FDI variable discussed above, it is the excess bilateral activity with tax havens as compared to non-havens that suggests this would be a good proxy for profit shifting.

4.5 Controls

The factors that shape the demand for the public good are vital in understanding differences in tax rates across countries and over time. Some of them change slowly over time and the characteristics that define the overall demand may be permanent. In the absence of tax competition, the demand for the public good should be the main determinant of how corporate tax rates are set. I seek to use the main factors drivig the demand for the public good in the corporate taxation case as key controls. I do not diverge greatly from those used by Devereux et al. (2008) and Overesch and Rincke (2011), but I try to achieve slightly greater parsimony.

Additionally, when estimating a spatial autoregressive instrumental variable model, the controls of neigbouring countries are the variables used to instrument for the dependent spatial lag. This function of the control variables further increases the importance of the choice of controls. Gibbons and Overman (2012) tell us that using the spatial lag of the exogenous variables $w_{ij}X_j$ is not a straightforward swap for the spatial lag of the dependent variable. In using the IV method, I assume that there are no exogenous spatial effects - that $w_{ij}X_j$ does not impact y_i directly, but only works indirectly through the tax rates set by neighbouring countries. Here I explain the control variables and try to provide justification for the exclusion restrictions for the control variables used.

Conceptually the corporate income tax is viewed as a backstop for the personal income tax (Slemrod, 2004). The idea is that if the corporate tax rate were substantially lower than the personal tax rate, individuals would begin to incorporate themselves to reduce their tax liability. Considering the relative immobility of labour compared to capital, there should be no direct cross-border effect of one country's personal income tax rate on another's capital tax.

Mobility of capital is important in identifying tax competition between governments. Businesses would find it difficult to shift either profits or production with restrictions on capital mobility, thereby dampening any need for governments to respond to their peers. The mobility of capital is commonly defined by the openness of the capital account, either *de jure* or *de facto*. The importance of this factor to tax competition is also empirically shown in Devereux et al. (2008), who use it to identify tax competition apart from other explanations of correlated tax rates. An earlier strand of literature used increased capital openness to measure the possible contribution of competition to falling tax rates (see Baskaran (2014) for a full review). It is unlikely that a change in the level of capital account openness would directly affect the tax rate of another country apart from the increased bilateral exposure the spatial weight matrix might pick up, which is what I propose to capture.

Heterogeneity of countries describes why some are able to set higher tax rates than their peers. This idea has been empirically and theoretically examined in the literature (Bucovetsky, 1991; Haufler and Wooton, 1999). Typically, the easiest way to capture this heterogeneity is to use a measure of size. Many expect that larger countries will be able to set higher tax rates than smaller countries, justified by concepts like market access or agglomeration effects Baldwin and Krugman (2004). Size can matter for tax rates in a number of ways, and it is possible that being located close to a large country with a large market can influence a country's tax rate. However, I expect any direct effect influence of neighbours' country size on tax rates to be small compared to the indirect effect it has on the ability to set a higher or lower tax rate.

I control for the size of public consumption relative to total economic activity. Governments are expected to set tax rates in order to finance a desired level of public consumption based on an electoral mandate. While the yardstick theory suggests that observation of neighbouring regions' public consumption might lead to correlation in the demand for public goods, this relationship is likely to be very weak across countries rather than sub-national territories. However, even in this case the public consumption of neighbouring countries should only affect the home country tax rate

if it forces a change in the tax rates of neighbours.

From a practical perspective, political ideologies tend to play a role in determining what a specific government might view as the optimal level of taxation. Right wing ideologies tend to be more associated with less taxation and smaller government. Additionally, the dependency ratio - the ratio of the population not in the labor force due to young or old age - typically helps to explain the patterns of government spending, and the consequent need to redistribute spending from working generations to non-working generations. Political tendencies and demographics are unlikely to violate the exclusion restrictions.

These controls seem broadly comprehensive and appear unlikely to violate the exclusion restrictions. That is to say, there appears little justification for inclusion of the spatial lag of the controls in the main regression. These variables that describe or determine the demand for public consumption have no intuitive cross-border effects on their own, and should only serve to affect the tax rate of the respective home countries. I propose that spatial exogenous lag is an appropriate instrument for the spatial dependent lag.

4.6 Data

Corporate tax rates are measured by the top statutory tax rate in each country. Data on these are collected from a combination of sources primarily from the World Tax Database created by the University of Michigan and supplemented by the OECD, KPMG, and Ernst and Young tax databases when overlapping data was consistent. These are usually embedded in the legislative framework of the country and should show little measurement error.

Personal income tax rates are captured from a combination of sources including Urban-Brookings Tax Policy Center and the OECD. Once again, the top personal income tax rate is used. Due to a greater level of progressiveness embedded in personal tax rates, they are usually more difficult to capture appropriately and data is sometimes scarce. In some cases top local tax rates are combined with top federal tax rates to produce an overall top personal income tax rate.

Public consumption is quantified as public expenditure as a percentage of nominal GDP. This data is obtained from the World Bank. Gross Domestic Product (GDP) and population data are also obtained from the World Bank. I control for country size mainly using the population, although using nominal GDP as a ratio to US GDP is tested as well. However, (Overesch and Rincke, 2011) suggest using the population size to escape any further potential endogeneity issues.

FDI data - both bilateral and totals - are obtained from a combination of the UN Conference on Trade and Development (UNCTAD) database and the OECD's database. The primary source is the OECD's database, with UNCTAD data used to fill the gaps. To measure capital account openness, the total combined stock of inward and outward FDI as a percentage of nominal GDP for each country is the ideal candidate. The bilateral FDI weights are measured using FDI stocks as well. The Chinn-Ito index of capital account openness (Chinn and Ito, 2008) is tested as an alternative measure to compare the *de jure* measure with the *de facto* measure. Data on services imports are obtained from the World Bank and UNCTAD databases.

The countries used in the sample are the OECD and G20 countries. Some countries are included in both. Given their leading roles in the current Base Erosion and Profit shifting Action Plan, it seems to be an appropriate and timely sample. This almost subsumes the samples used in both (Devereux et al., 2008) and (Overesch and Rincke, 2011).

I define *tax havens* empirically in the manner used by Davies et al. (2015): those countries with abnormally corporate-friendly tax policies that are likely to encourage artificial location of profits. I do not consider the possible 'secrecy' function that is sometimes attached to the term tax haven as in Slemrod and Wilson (2009). The only feature of tax havens described in the theoretical

model is the existence of substantially preferential tax regimes that encourage the artificial shifting of profits. As a result, I decided that any country that carried this main characteristic would be classified as a tax haven in the empirical analysis to align closely with the theoretical model.

The primary sample of tax havens is drawn from the OECD's original blacklist of 37 countries. This was drawn up in 2001, very close to the middle of the time period the data is drawn from. This means that there is likely a strong belief both pre- and post-2001 that these countries were tax havens. I broaden this sample to include a number of countries that are widely acknowledged to be tax havens. There were a few countries whose exclusion on the list was widely believed to be due only to their links with the OECD or with prominent OECD members, but continued to carry the features of being a tax haven. Importantly, because I am estimating reaction functions, the discussion whether a country is or is not a tax haven as defined here is moot, since it is only the non-haven governments' perception of a country's tax regime that matters.

The initial list of OECD and G20 members is made up of 43 countries. Five of those are excluded from the sample because I include them as tax havens in the analysis. That leaves 38 countries whose corporate tax reaction functions are to be estimated and a total of 65 tax havens. The full lists are available upon request.

I use two variables as proxies for profit shifting. Conceptually they are both calculated as the percentage of a country's total international transactions directed to countries defined as tax havens. Tax haven FDI is calculated as the stock of country i's outward FDI held in tax havens as a percentage of country i's total outward FDI. Similarly, tax haven services imports is calculated as the total services imported by country i from tax haven countries as a percentage of country i's total services imports. Relative values give an approximation of how widespread profit shifting is, providing consistency across time and comparability across countries.

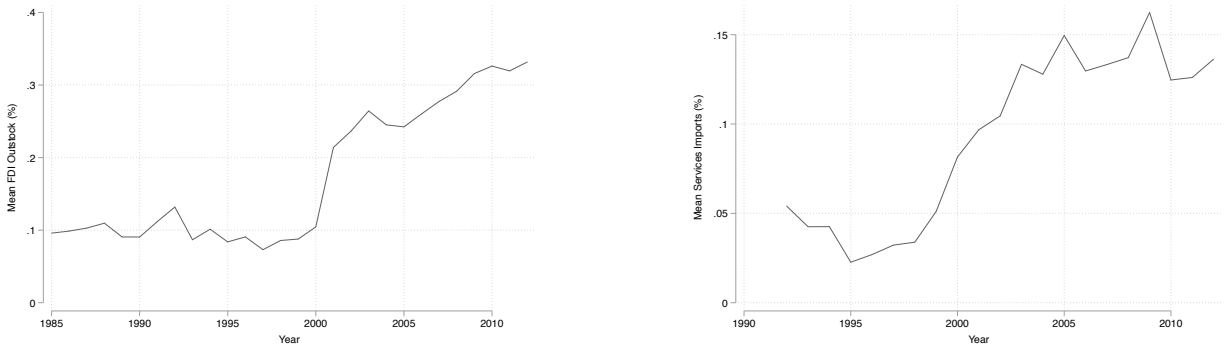
Historical data on the choice of tax system - territorial or worldwide - is obtained from PwC. The variable representing this is a dummy: 1 for territorial and 0 for worldwide. Both Devereux et al. (2008) and Overesch and Rincke (2011) control for demographics by including the proportion of the population under 14 and the proportion of the population over 65. Here, they are combined into one variable called the dependency ratio as in Egger et al. (2005). A dummy is included that is set to one if the sitting government in any year is considered to be 'right' wing or to the right of centre. This data is taken from the World Bank's World Development Indicators.

Table 1: Descriptive Statistics

	Mean					
	mean	min	max	sd	skewness	count
τ_{i}	0.345	0.100	0.650	0.104	0.328	1124
$\bar{\tau}_{\mathrm{j}}$	0.334	0.000	0.590	0.084	-0.915	967
Tax Haven FDI	0.189	-0.402	0.893	0.185	1.012	877
Tax Haven Services Imports	0.100	0.000	0.318	0.068	0.416	673
Public Consumption	0.181	0.052	0.375	0.050	-0.038	1204
Capital Openness	0.343	0.000	3.929	0.373	3.769	1159
Trade Openness	0.604	0.097	1.799	0.304	1.114	1204
PIT	0.439	0.000	0.930	0.142	-0.537	1120
Ln Population	16.965	12.317	21.014	1.721	0.020	1254
Dependency Ratio	34.598	25.647	49.104	3.657	0.970	1254
Territorial	0.357	0.000	1.000	0.479	0.596	1254

Table 1 provides a summary description of the data. One important point to note is that the minimum value for FDI stock in tax havens as a percentage of total outward FDI stock is negative. It is possible for a country's outward FDI stock to another country to be negative. This occurs when there is disinvestment or reverse investment related directly to the original investment in the country. This is caused where either equity capital, reinvested earnings or intra-company loans is negative and not offset by positive values of the remaining components according to UNCTAD. It might be concerning to note that reverse FDI could be recorded due to profit shifting activities, for example, in the case of intra-company lending. However, such activity is almost always offset by an equivalent equity capital injection and the net effect is usually zero. These negative values are likely to be, in some cases, a consequence of limited availability of data, and in others, a true reflection of ongoing disinvestment. The main culprit in the data is New Zealand during the 1990's, particularly in its relationship with the Netherlands. It is difficult to distinguish any particular historical anomaly in their relationship that suggests that the data is misleading. In any case, however, the results presented below remain robust to the exclusion both of New Zealand and of all negative values for FDI to tax havens.

Time series graphs of the averages of the two measures of profit shifting to tax havens is shown in Figure 3. Interestingly, there are increases in both measures through the late 1990's to early 2000's. The data suggests that tax havens are becoming increasingly important to the international economic landscape.



(a) Mean Percentage of FDI Stock Held in Tax Havens (1985-2012)

(b) Mean Percentage of Services Imports from Tax Havens (1992-2012)

Figure 3: Measures of Profit Shifting to Tax Havens

5 Empirical Results

5.1 Main Results

The main model estimated is:

$$\tau_{it} = \delta_i + \rho \sum_{j=1}^{N} W_{ij,t}\tau_{jt} + X_{it}\beta + \varepsilon_{it} \tag{33}$$

where δ_i is the country-specific intercept, W_{ij} is the spatial weight matrix for country i with respect to all other countries, τ_i is the home statutory tax rate, τ_j is the neighbour statutory tax rate, X_i is the vector of control variables and ε_i is the error term. The main estimable parameters of interest

are ρ and β.

The main results are described in Table 2. Columns 1 and 2 show the results with the two profit shifting variables estimated independently while column 3 uses both simultaneously. These three models are fixed effects models with no instrument for the dependent spatial lag. Columns 4 and 5 are the instrumented counterparts of columns 1 and 2, estimating the two profit shifting variables independently. Column 6 combines the two.

All models estimated in Table 2 confirm the two core predictions of the theoretical model described in Propositions 2 and 3. The statutory tax rate reaction function is positive, meaning that there is significant evidence of tax competition. Both of the tax haven variables have negative and statistically significant coefficients in all six specifications. This suggests that the observed increase in profit shifting to tax havens shown in Figure 3 has had a negative effect on tax rates.

The absolute size of the coefficients for the tax haven FDI variable are smaller than the coefficients for the tax haven services imports variable. This is likely due to the larger range of values observed for the FDI variable compared to the services imports variable. When applying instrumental variable regression, the values are not substantially altered.

We can also interpret the size of the coefficients in the context of changes observed over time. At around -0.04, a 1 percentage point increase in the share of FDI stock held in tax havens corresponds with an average 0.04 percentage point decline in tax rates. Put in context, the average value for FDI stock in tax havens as a percentage of total outward FDI stock has increased from 9.6% in 1985 to 33.2% in 2012. Similarly, a coefficient of around -0.16 suggests that a 1 percentage point increase in the share of services imports a country receives from tax havens is associated with an average 0.16 percentage point decline in that country's corporate tax rate. The overall mean is 10%, while the annual mean has increased from 5.4% in 1992 to 13.6% in 2012. These averages are relatively moderate, neither high nor low, leaving ample space for significant upward or downward shocks to profit shifting activity in the future.

The size of the coefficients on the dependent spatial lag in Table 2 are substantially smaller than those in earlier works . My estimates of the slope of the reaction function range from 0.19 to 0.26, less than half of the long-run estimates of 0.69 in Overesch and Rincke (2011) and 0.68 Devereux et al. (2008). To test whether this is purely the effect of adding the tax haven variables, I remove them in column 3 of Table 6; the coefficient on the spatial lag actually shrinks to 0.17 in this case. That makes it likely that the weight matrices used in earlier works inflated the estimated size of tax competition.

I rerun the models described in Table 2 using uniform weights rather than bilateral FDI weights. The results are described in Table 8. The coefficients range from 0.60 to 1.15, much closer to the large coefficients obtained in previous works. Uniform weights leads to a substantial reduction in the cross-country variation in the spatial lag when the number of countries in the sample becomes large. I have described why I expect FDI weights to be a substantial improvement in moving closer to the 'true' weight matrix and as a result, why the smaller estimates obtained under bilateral economic weights should be closer to the true average reaction function slope than the larger estimates obtained under uniform, size or distance weights. This idea that weights based on bilateral economic ties would produce the closest approximation of the true weight matrix is supported by Zirgulis and Staehr (2015). Bilateral FDI weights, in particular, should subsume the effects meant to be conveyed by both size and distance weights.

Interestingly, this substantially reduces the evidence for the case made by Overesch and Rincke (2011) that tax competition accounted for a 12.5 percentage points of the 21.7 percentage point decline in the average statutory tax rate in European countries from 1983 to 2006. The results suggest that tax competition, when considering the economic context in which it is played out, has not been as dominant a force in accounting for the decline in statutory tax rates over the past few

decades.

I add the temporal lag that Overesch and Rincke (2011) suggest is important to reflect the sluggish adjustment of tax rates. The results are reported in Table 7. It gives the added benefit of being able to split out the short-run response from the long-term effects. The short-run effects Overesch and Rincke (2011) uncovers are almost as large as my main estimates (0.18). I estimate short run effects ranging from 0.05 to 0.10, around half the size of the original long-run estimates. However, the long-run coefficients in this temporal and spatial lag model are somewhat larger than in the main results. The long-run one way spillover of tax competition is given by $\rho/(1-\gamma)$ where ρ is the coefficient on the spatial lag and γ is the coefficient on the temporal lag of the dependent variable. For example, in column 3 of Table 7, this gives a long-run coefficient of 0.36, larger than the initial upper range of 0.26.

While there is real concern about the consistency of estimation when using fixed effects and lagged dependent variables, this provides useful insight. The temporal lag can help to account for time-variant omitted variables and attempts to use information contained in the previous period's tax rate. While the long-run estimates are larger than the main results, they are still only about half the size of the coefficients estimated in earlier works. The short-run estimates suggest that the immediate response to a 1 percentage point change in neighbours' tax rates is on average less than 10 basis points.

Finally, I consider specific global shocks, namely shocks to economic activity. Using the baseline version of the model from Table 2 Column 3 - fixed effects with no instrumental variables and both tax haven variables - I add three separate measures of global GDP shocks. In columns 1 to 3 of Table 9, I have added global nominal GDP growth, global real GDP growth and GDP growth in advanced countries respectively. The GDP growth rate of advanced economies is the only significant variable of the three, a not unsurprising finding given that 24 of the 38 countries in the sample are included on the IMF's list of advanced economies, which accounts for not only a large part of global GDP, but act as an important signal of global economic health. Importantly, the inclusion of a common GDP growth variable does not alter the main results.

Note that the dummy accounting for whether a country has a territorial tax system is negative and significant in almost all specifications discussed above. However, when neither capital tax competition nor profit shifting are accounted for, it cannot be considered statistically significantly different from zero (see Table 6). Trade openness also carries a negative and significant coefficient in most specifications, suggesting that countries with greater trade openness tend to set lower tax rates. In contrast, I do not find capital openness to have a significant impact on tax rates in almost all the specifications described, whether using *de facto* or *de jure* measures of tax competition. The results displayed use the sum of inward and outward FDI as a percentage of GDP rather than the Chinn-Ito Index. A positive and significant correlation between the personal income tax and the corporate income tax is uncovered in some specifications - an expected result. Accounting for size using the natural log of the population size uncovers a mainly negative relationship between the statutory tax rate and population size, suggesting that the larger non-haven countries in my sample actually tend to set lower tax rates. This finding, while contrary to typical theoretical predictions, is similar to the empirical results in Overesch and Rincke (2011). Interestingly, I do not find public consumption to be a significant determinant of statutory tax rates. This tends to suggest that there is little direct correlation between government spending and corporate tax rates *within countries over time*. This suggests that even if there was correlation in public consumption demand across countries driving the governments' spending as in yardstick competition, it hardly affects the governments' choices of corporate tax rates.

With respect to robustness, the Hansen's J-statistic testing for overidentifying restrictions suggests we are unable to reject the null that these are a valid set of instruments in Table 2. Further,

sufficiently large Kleingberg-Papp F-statistics suggests there is no need to worry about the strength of the instruments. Additionally, Table 7 uses the Arellano-Bond method of estimation when the dynamic lags are added to check whether the results are robust to any endogeneity created by the temporal lag. Once again the results remain mainly unchanged.

The results show that there is robust evidence of significant tax competition, displaying a positive reaction function that is directly in line with the predictions of the theoretical model. This estimation uses bilateral economic weights in the form of bilateral FDI stocks to create the spatial lag in contrast to earlier works that used uniform, size or distance weights. The greatest difference is that I find the effect of tax competition to be smaller - about half the size - but far more robust under an FDI specification of the weight matrix.

Importantly, both variables measuring the level of profit shifting to tax havens are negative and significant. The correlation between the two is 0.37, and while it suggests there is some positive co-movement as you would expect, the two are far from perfectly collinear. It suggests that they capture somewhat varied aspects of profit shifting to tax havens but the results they produce both fit the predictions of the theoretical model; each variable seems to add some measure of additional information about the size and frequency of profit shifting taking place in a country.

Golgher and Voss (2014) gives the correct interpretation of the coefficients on regular exogenous variables such as the tax haven variables. To derive the partial derivative of the statutory tax rate with respect to any variable x, use:

$$\frac{\partial y}{\partial x} = \frac{\beta}{1-\rho^2} \tag{34}$$

Added to the β which normally gives the partial derivative is an indirect spillover effect regulated by the feedback in the spatial parameter ρ. This exacerbates the effect of an increase in profit shifting on tax rates. For example, coefficients of -0.056 and -0.137 for the tax haven FDI and tax haven services imports variables respectively will give slightly more negative partial derivatives of -0.058 and -0.142 using a spatial lag coefficient of 0.193 as in the baseline model (Table 2 Column 3).

Table 2: Spatial Tax Competition Estimates

	(1)	(2)	(3)	(4)	(5)	(6)
	τ_{i}	τ_{i}	τ_{i}	τ_{i}	τ_{i}	τ_{i}
	b/se	b/se	b/se	b/se	b/se	b/se
$\bar{\tau}_{\mathrm{j}}$	0.195***	0.209***	0.193***	0.231***	0.260***	0.250***
	(0.060)	(0.068)	(0.059)	(0.060)	(0.077)	(0.066)
Public Consumption	-0.026	0.109	0.217	-0.032	0.124	0.234
	(0.318)	(0.301)	(0.305)	(0.312)	(0.302)	(0.305)
Capital Openness	-0.017	-0.006	-0.008	-0.017	-0.005	-0.007
	(0.015)	(0.007)	(0.007)	(0.014)	(0.006)	(0.006)
Trade Openness	-0.096***	-0.103***	-0.079**	-0.093***	-0.098***	-0.074***
	(0.032)	(0.025)	(0.029)	(0.031)	(0.024)	(0.028)
PIT	0.212**	0.129	0.132	0.211**	0.123	0.128
	(0.085)	(0.085)	(0.088)	(0.083)	(0.083)	(0.086)
Ln Population	-0.288***	-0.155	-0.151	-0.283***	-0.142	-0.139
	(0.089)	(0.107)	(0.104)	(0.086)	(0.102)	(0.101)
Dependency Ratio	-0.004	0.002	-0.002	-0.003	0.002	-0.002
	(0.004)	(0.006)	(0.006)	(0.004)	(0.005)	(0.005)
Territorial	-0.035**	-0.028*	-0.028*	-0.034**	-0.026*	-0.026*
	(0.014)	(0.015)	(0.015)	(0.014)	(0.015)	(0.014)
Right-Wing	-0.006	-0.001	-0.005	-0.005	-0.001	-0.004
	(0.006)	(0.007)	(0.006)	(0.006)	(0.007)	(0.006)
Tax Haven FDI	-0.046**		-0.056***	-0.044**		-0.055***
	(0.021)		(0.017)	(0.021)		(0.016)
Tax Haven Services Imports		-0.167**	-0.137*		-0.162**	-0.132*
		(0.077)	(0.072)		(0.075)	(0.069)
Constant	5.290***	2.854	2.902			
	(1.533)	(1.903)	(1.853)			
Observations	827	654	643	827	652	641
Within R^2	0.549	0.486	0.495	0.548	0.480	0.487
Estimator	FE	FE	FE	IV	IV	IV

5.2 Identifying Tax Competition

Devereux et al. (2008) suggests using capital account openness to determine whether the strategic interaction observed can truly be described as tax competition. Competing alternative theories include yardstick competition and common intellectual trends. Yardstick competition, described in Besley and Case (1995), suggests that voters use neighbouring jurisdictions to evaluate the performance and choices of the government, particularly with respect to setting tax rates and determining expenditure. This would force the government look at the behaviour of other governments before setting its own tax rates. Common intellectual trends describes the possibility that governments have been lowering tax rates over the past few decades because they are being mutually enlightened about the need for lower corporate tax rates, maybe through academic discourse or experience Griffith and Klemm (2004). These alternative theories do not require capital account openness for them to be perceived as driving the positive coefficient on the spatial lag; tax competition is the only one that requires an open capital account.

I use the Chinn-Ito index, created by Chinn and Ito (2008) as a measure of capital acocunt openness. The index uses the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions to produce an index running on a scale from 0 to 1, with 0 representing a completely closed capital account and 1 a completely open capital account. The variable is based on the presence of multiple exchange rates, whether there are restrictions on current account transactions, whether there are restrictions on capital account transactions whether regulations require the surrender of export proceeds. This *de jure* measure of capital account openness focuses on the regulatory constraints placed on the free cross-border flow of money.

I split the sample into two, using a Chinn-Ito score of 0.25 as the cut-off score for whether a country can be considered to have a 'closed' capital account. There are two main reasons for this. The first is that there are four main areas of capital account freedom which the index captures, meaning that a score in the lower quarter of the index suggests there are at least traces of restrictions in all four. Secondly - and possibly due to the first reason - there is a natural lull in the sample of index scores between 0.25 and 0.4. This is shown in Figure 4.

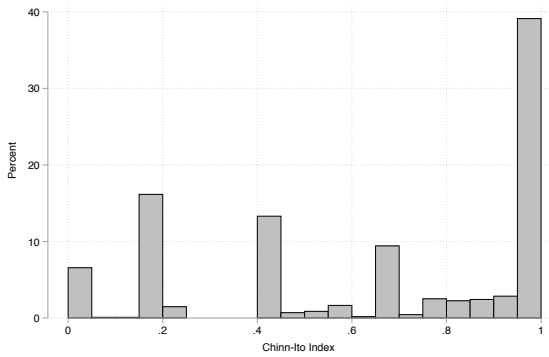


Figure 4: Histogram of Chinn-Ito Index

I test whether countries with a Chinn-Ito score below 0.25 - those I consider closed - react to their neighbours' tax rates in the same way that countries with a score above 0.40 do. This is a simpler method than used in Devereux et al. (2008); the sample can be split because I use a bilateral economic weight rather than uniform weights - I do not need to re-weight the samples. The emphasis here is on examining heterogeneity in how the home country reacts, rather than to which countries they react.

Splitting the sample rather than using a simple interaction term allows for flexibility in how the two groups of countries respond to all the regressors specified. That is, using an interaction term only on one or two variables restricts all the other effects to be exactly the same across all economies. Splitting the sample is the equivalent of allowing the slope to vary for each regressor. In this case, I think this level of flexibility is necessary because of the potentially very different drivers of tax rates under closed and open economies.

Doing this creates uneven sample splits. However, the skewed sample splits reflects the fact that there are far less instances of completely closed economies, and it is that minority I wish to test against the majority of countries whose capital accounts are relatively open enough to be concerned about tax competition. The aim is not to examine how the slope of the reaction function varies with openness, but to test whether the very closed economies behave in a different manner.

Table 3: Equality of Coefficients by Openness

		$\bar{\tau}_j$		Tax Haven FDI		Tax Haven SI	
	Chinn-Ito	< 0.25	> 0.40	< 0.25	> 0.40	< 0.25	> 0.40
(1)	β	0.001	0.259***				
	s.e.	0.057	0.079				
	N	183	746				
	p-value	0.006***					
	chi-sq	7.68					
(2)	β	0.107	0.184***	0.0460**	-0.058**		
	s.e.	0.067	0.071	0.023	0.026		
	N	129	698	129	698		
	p-value	0.418		0.002***			
	chi-sq	-0.66		9.48			
(3)	β	0.081	0.185***			0.015	-0.184**
	s.e.	0.512	0.066			0.053	0.083
	N	98	556			98	556
	p-value	0.4129				0.044**	
	chi-sq	0.67				4.07	
(4)	β	0.098	0.163***	0.074***	-0.075***	0.024	-0.145*
	s.e.	0.112	0.063	0.023	0.018	0.048	0.082
	N	93	550	93	550	93	550
	p-value	0.633		0.000***		0.084*	
	chi-sq	0.23		26.31		2.98	

The sample is split and tested on four formulations: without the tax haven variables included, with each tax haven variable individually and with them both included. I then use a Chi-squared test to determine whether the coefficients are statistically different across the two sub-samples. The results are given in Table 3, with just the coefficients of interest, their standard errors, the number

of observations in each sub-sample, the value of the chi-squared test and the resulting probability of rejecting the null of equal coefficients.

The first model with no tax haven variables allows a larger sub-samples for both closed (<0.25) and open (>0.40) economies. The results here are very clear: the coefficient in the closed economy sub-sample is 0.001 compared to 0.259 in the open economy sub-sample, a difference large enough to suggest we can not accept the null hypothesis of equal coefficients. In models 2, 3 and 4, the difference between the coefficients are not as large as model 1. While the coefficient remains statistically different from zero only in the open economy sub-sample, the Chi-squared test tells us that we are no longer able to reject the null of equal coefficients.

In stark contrast, however, each test of equality of coefficients for the tax haven variables can be rejected at least at the 10% confidence level. For closed economies, the coefficient on FDI to tax havens is actually positive and statistically higher than zero. The tax haven services import effect is not statistically significant for closed economies. Unlike strict tax competition, these variables are measured as flows between a country and a tax haven, meaning that it is likely that there is little variation in the tax haven variables for closed economies. More importantly, however, it suggests that there is little reaction of tax rates to profit shifting in closed economies. This provides evidence that the theoretical and empirical hypotheses of the importance of tax havens might be correct.

This exercise falls somewhere between the findings of Devereux et al. (2008) and Overesch and Rincke (2011). There is a very observable difference in the slope of the reaction functions of closed and open economies. However, only in the case where I do not account for profit shifting to tax havens is it found to be a statistically significant difference. There is a strong likelihood that this is influenced by the larger sample of closed capital account observations available in the first model - an approximately 41% larger sample. I find that strategic interaction on corporate tax rates is not observed for those countries with substantially closed capital accounts. While statistically significant strategic interaction is observed for open economies, not all formulations of the model find that the heterogeneity is large enough to be considered statistically different.

5.3 Tax Competition Intensity

I wish to test whether there are any dampening or intensifying effects of profit shifting on tax competition. The prediction of the theoretical model is that increased profit shifting should reduce the sensitivity of tax rates to changes in neighbours' tax rates. I test this using an interaction effect between the spatial lag and the tax haven variables.

The simple linear form is considered 'additive' in that the effects of two independent variables have separate and independent effects on the dependent variable. When you suspect that there may be some interactivity - that the effect of one independent variable might depend on the value of another independent variable - then you might consider a 'multiplicative' form. That is, you enter a third term in the estimated equation that is the product of the two independent variables:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_1 x_2 \tag{35}$$

which is called the interaction term while x_1 and x_2 remain the main terms.

In a simple additive estimation, the coefficients on the main terms are interpreted as the partial derivatives of y with respect to the exogenous variable of interest, implicitly evaluating all other exogenous variables at their respective means. However, adding the interaction term changes the interpretation of the recovered coefficients. In Equation 35, the partial derivative of y with respect to x_1 has to be recovered from a combination of the coefficients and the other independent variable

x_2:

$$\frac{\partial y}{\partial x_1} = \beta_1 + \beta_3 x_2 \tag{36}$$

In such a specification, β_1 would be interpreted as the partial derivative of y with respect to x_1 evaluated at $x_2 = 0$. In order to produce estimates on the main effects comparable to the additive model, a common practice is to center the variables in the interaction term:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 (x_1 - \bar{x}_1)(x_2 - \bar{x}_2) \tag{37}$$

which should give a similar value for β_3 but coefficients for β_1 and β_2 comparable to the coefficients in a simple additive estimation. I estimate the model with the interaction term both in levels and country mean-centred.

Table 4 shows the results of the estimations using both the Tax Haven FDI and Tax Haven Services Imports variables. Column 1 and 3 use the interaction term in levels while column 2 and 4 use the interaction term based on country-mean centred versions of the spatial lag and the tax haven proxy. The estimates for the main effects in columns 2 and 4 are comparable to those in Table 2. However, none of these specifications produces an interaction effect that can be considered significantly different from zero. It appears quite clear that we have not been unable to uncover any significant mitigating or intensifying effect of profit shifting to tax havens on tax competition.

Table 4: Interaction Between Tax Competition and Profit Shifting

	(1) τ_i b/se	(2) τ_i b/se	(3) τ_i b/se	(4) τ_i b/se
Public Consumption	-0.018	-0.009	0.125	0.133
	(0.318)	(0.319)	(0.304)	(0.307)
Capital Openness	-0.016	-0.016	-0.006	-0.007
	(0.015)	(0.015)	(0.007)	(0.007)
Trade Openness	-0.094***	-0.094***	-0.094***	-0.091***
	(0.032)	(0.032)	(0.029)	(0.029)
PIT	0.212**	0.214**	0.133	0.134
	(0.086)	(0.086)	(0.092)	(0.091)
Ln Population	-0.288***	-0.280***	-0.171	-0.166
	(0.089)	(0.086)	(0.111)	(0.111)
Dependency Ratio	-0.004	-0.003	0.000	0.000
	(0.004)	(0.004)	(0.006)	(0.006)
Territorial	-0.034**	-0.034**	-0.028*	-0.027*
	(0.014)	(0.014)	(0.015)	(0.015)
Right-Wing	-0.006	-0.005	-0.003	-0.002
	(0.006)	(0.006)	(0.006)	(0.006)
$\bar{\tau}_j$	0.178***	0.228***	0.174**	0.233***
	(0.064)	(0.066)	(0.078)	(0.065)
Tax Haven FDI	-0.121	-0.044**		
	(0.104)	(0.021)		
$\bar{\tau}_j$ * Tax Haven FDI (l)	0.236			
	(0.309)			
$\bar{\tau}_j$ * Tax Haven FDI (c)		0.407		
		(0.298)		
Tax Haven SI			-0.320	-0.171**
			(0.242)	(0.078)
$\bar{\tau}_j$ * Tax Haven SI (l)			0.474	
			(0.705)	
$\bar{\tau}_j$ * Tax Haven SI (c)				1.643
				(1.089)
Constant	5.287***	5.117***	3.180	3.070
	(1.528)	(1.474)	(1.970)	(1.982)
Observations	827	827	643	643
Within R^2	0.550	0.552	0.479	0.483

5.4 Tax System

Also of interest is the assumption underpinning the theoretical model that all tax systems are effectively territorial or source-based tax systems. A territorial tax system is one in which profit is taxed based on the source of where profit was generated rather than the headquarters or residence of the company. This assumption is a standard one in the literature on tax competition and is justified on the grounds that the majority of countries who do impose a worldwide or residence tax on corporate income have great difficulties in collecting taxes on foreign source income (Slemrod and Wilson, 2009). Further, the lines between worldwide and territorial tax systems have become blurred with loopholes such as deferral and credits for taxes paid in other countries tacked onto many worldwide systems. It is frequently noted that there are very few, if any, pure worldwide corporate tax systems remaining. Becker and Fuest (2011) provide a more detailed discussion of the taxation of foreign profits, the feature that differentiates these two systems.

It was interesting to note that in the results of Table 2 - and broadly across all specifications - there is significant evidence that countries with territorial tax systems tend to have lower tax rates than countries with worldwide tax systems. While the assumptions of the theoretical model suggest that we ignore worldwide tax systems, the empirical evidence suggests that despite many of them being watered-down, there remains some justifiable difference between the two. One would expect that a country with a pure worldwide tax system would be impervious to tax competition and legitimate forms of profit shifting.

I split the sample into two: countries with worldwide tax systems and countries with territorial tax systems. The objective is to examine whether, in addition to the already uncovered difference in the level of tax rates, there is a substantial difference in the responsiveness of tax rates to competitors' tax rates and profit shifting to tax havens. The splits of the samples are relatively even, with a slight skew in favour of observations with worldwide tax systems.

I estimate the split sample firstly on the baseline model using fixed effects and including both tax haven variables. The results are given in Table 5. Columns 1 and 2 are the samples for worldwide and territorial tax systems respectively. Column 1 gives a significant and large coefficient on the spatial lag while the coefficients on the tax haven variables cannot be distinguished from zero. Column 2 gives a statistically insignificant coefficient on the spatial lag but significantly negative coefficients on the tax haven variables. The results suggest that countries with worldwide tax systems respond to tax rates of other non-haven countries, engaging in tax competition; in contrast, it appears that countries with territorial tax systems tend to react to profit shifting to tax havens rather than tax competition.

First, I check whether this result is being driven by countries with closed capital accounts, particularly in the territorial sample. Columns 3 and 4 display these results. Once again the coefficient on the spatial lag for territorial tax systems is so small as to be statistically indistinguishable from zero. Interestingly, one tax haven variable is now negatively significant for worldwide countries - FDI to tax havens.

To further consider the robustness of these results, I note that there has been a trend of countries switching from worldwide tax systems to territorial tax systems during the sample period. I show in 5 the fraction of countries with territorial tax systems in the sample. The appears to have been a jump in 2004, with 5 of 38 countries changing their tax systems from worldwide to territorial, taking the percentage of territorial tax systems in the sample from 34% to 47%. I add a dummy that accounts for the 2004-onward period. Finally, I also notice a sizable skew towards being net capital importers among countries with worldwide tax systems. There is no noticeable skew among territorial countries. I add a dummy capturing whether a country's inward capital stock exceeds its outward capital stock. The results of these added robustness checks are included in columns 5

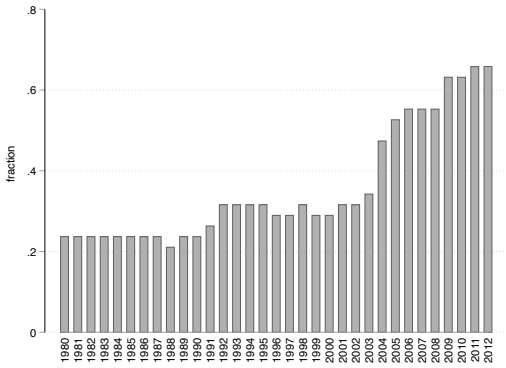


Figure 5: Fraction of Countries with Territorial Tax Systems by Year (1980-2012)

and 6 of Table 5. See also Table 10 for a separation of the two tax haven variables. The results remain robust to all of these specifications.

These findings - and their robustness - are surprising given the basic assumption that there should be no substantial difference between worldwide and territorial tax systems in how they respond to tax competition. Within the current context of the broad political and academic debates about the principles of source and residence taxation of active income, this result deserves a closer look.

A pure worldwide tax system should make firms indifferent between domestic and international production when the marginal profits in both countries are the same. That is, a worldwide tax system tends to equalize gross returns while territorial tax systems tend to equalize net returns (Sinn, 1990). However, most countries designated as having 'worldwide' tax system do not have pure worldwide tax systems. There are a few main ways in which a pure worldwide tax system may be watered down and approach something closer to a territorial tax system. Firstly, many worldwide tax systems offer foreign tax credits in order to mitigate the effects of double taxation. Secondly, some countries apply the rule that profits are not taxable in the home country until they are repatriated. The result is that US companies for example are reported to have $2.1 trillion in untaxed profits held internationally and designated as 'permanently reinvested'. Thirdly, a number of countries have entered into bilateral tax treaties with 'tax sparing' provisions that allow foreign tax credits for taxes not actually paid when the firm is offered special tax rates below the standard rate in the host country. Despite all these leniencies, Matheson et al. (2014) suggests that territoriality should make corporations more sensitive to host country taxes, and it encourages them to divert investment from high-tax to low-tax jurisdictions.

The theoretical literature's assumption - and the one made here - is that the impurity of worldwide tax systems make them vulnerable to tax competition. However, one would expect that countries with worldwide tax systems might be less vulnerable to profit shifting to tax havens. The reasons for this: firstly, they demand payment of tax at least up to the home country tax rate, meaning that the use of a tax haven likely provides no cost advantage; secondly, non-haven countries are unlikely to sign tax sparing or even double tax treaties with tax havens. This suggests that the worldwide country's optimal tax rate would be more closely aligned with the optimality condition given by the government's first order conditions in Equation 13, which is the model without profit shifting to tax havens included.

In contrast, a territorial tax system means that the government is forced to worry about both tax competition and profit shifting as in Equation 24b. This added dimension could firstly explain

the significantly lower tax rates observed under territorial tax systems as shown by the negative coefficient on the territorial dummy in Table 2. Secondly, it means that the with the government balancing two trade-offs, one could easily become more important than the other. Importantly, this is not to say that profit shifting does not happen in countries with worldwide tax systems, but as Markle (2015) finds, that profit shifting is more prevalent in multinational corporations subject to territorial tax systems relative to those subject to worldwide tax systems.

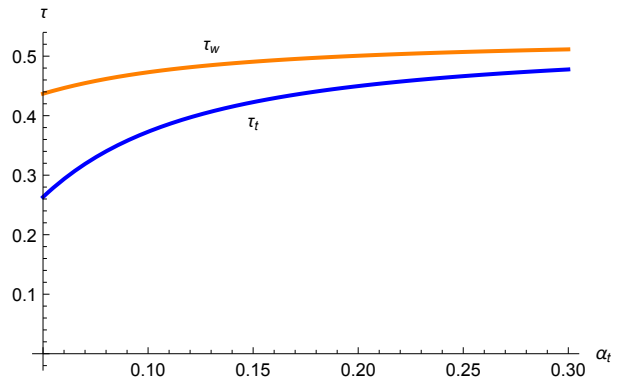


Figure 6: Territorial v Worldwide Optimal Tax Rates Under Varying Profit Shifting Costs

Within that context, the theoretical model presented here is able explain the results of Table 5. A simple calibrated two-country simulation of the theoretical model is enough to make this point. Using a territorial government (labeled T) with first order conditions as in Equation 24b and a worldwide government (labeled W) with first order conditions as in Equation 13 respectively:

$$\{f(k_T) - r(k_T)\} + \left\{\tau_T \frac{\partial k_T}{\partial \tau_T}(f'(k_T) - r)\right\} + \left\{-q_T - \frac{\tau_T}{\alpha_T}\right\} = 0 \tag{38}$$

$$\{f(k_W) - rk_W\} + \left\{\tau_W \frac{\partial k_W}{\partial \tau_W}(f'(k_W) - r)\right\} = 0 \tag{39}$$

Figure 6 depicts what optimal tax rates in these two countries would look like given only a change in profit shifting cost for the territorial country α_t. The graph shows that the tax rate of the territorial country τ_t is lower than the tax rate of the worldwide country τ_w. As the cost of profit shifting falls, the territorial tax rate declines in response. Interestingly, this transmits to the worldwide country who shifts in response to a lower tax rate for the territorial country. This indicates that territorial countries will react strongly to profit shifting, leading worldwide countries to react directly to the resulting new tax rates in territorial countries. It also explains clearly the negative coefficient on the territorial dummy across the results.

The change in the worldwide country's tax rate is entirely a reaction to the change in the territorial country's tax rate. Empirically, that would be interpreted entirely as evidence of tax competition. Note that this means the difference between the two tax lines in Figure 6 is the effect of profit shifting, and is far larger than the gentle decline in tax rates in the worldwide country. It is not surprising then that I uncover a response to profit shifting in territorial countries that is far larger than the response to tax competition.

To put this into context, note that the trend of increasing levels of profit shifting displayed in Figure 3, combined with the increasing trend of territorial tax systems shown in Figure 5 are likely important in explaining the steady decline in average tax rates depicted in Figure 2. For territorial countries, it is therefore plausible that profit shifting could have been the main concern, overshadowing possible reactions to tax competition.

The empirical results of this inquiry suggest that the tax system is a key difference in understanding how governments react. Splitting the sample tells us that countries with worldwide tax systems tend to respond to tax competition for capital, but consider profit shifting much less when setting tax rates, even if there is substantial profit shifting activity. In contrast, countries with territorial tax rates respond strongly to changes in profit shifting while there is much less evidence that they respond to tax competition. These results can be explained within the bounds of the simple theoretical model presented here. It appears that the increases in profit shifting activities - particularly visible from the late 1990's onward - overshadow the tax competition game for countries with territorial tax systems.

6 Conclusion

I revisit the existing theoretical and empirical evidence on tax competition. Rather than considering the capital market as the mechanism that drives tax competition through the firm's financing decision, I model the multinational firm's production decision as the cross-border capital-allocating mechanism. Production is allocated based on the multinational firm's profit maximising objective, a feature that is more in line with observed reality. It also puts tax competition in context of the strained relationship between multinational corporation and government.

I model the possibility that profits are shifted artificially from non-havens to tax havens rather than between non-havens. This aptly describes the core concern of the OECD and G20's Base Erosion and Profit Shifting Action Plan: tax avoidance strategies that exploit gaps and mismatches in tax rules to artificially shift profits to low or no-tax locations. This is distinct from competition for location of real investment.

This allows me to explain the decline in statutory tax rates over the past three decades as a function of two separate and distinct phenomena: tax competition and profit shifting. The resulting model provides two main testable predictions: firstly, that government's statutory tax rates are expected to be strategic complements due to competition for real investment; secondly, that governments are expected to lower their tax rates in response to lower costs of profit shifting and the resulting higher levels of profit shifting by firms.

The empirical analysis confirms these two predictions in a number of specifications. I use a spatial autoregressive model that captures the relationship between each pair of countries using bilateral foreign direct investment weights rather than size, distance or uniform weights as in previous works. The result is that the coefficient on the spatial dependent lag in this empirical analysis is less than half the size of that uncovered in previous works. Further, the effects of profit shifting on statutory tax rates are shown to be negative and statistically significant.

Additionally, I show that statutory tax rates in closed economies do not respond to tax competition, suggesting that the effects uncovered here are likely to be appropriately ascribed to the theory of tax competition rather than an alternative theory that does not require capital account openness to exist. Further, I show that countries with worldwide and territorial tax systems respond differently to the separate phenomena of tax competition and profit shifting, a finding that can be explained within the context of the theoretical model.

This paper provides theoretical and empirical evidence on the existence and form of tax competition and profit shifting in a manner that aligns with reality.

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Table 5: Split Sample by Tax System - Worlwide versus Territorial

	(1)	(2)	(3)	(4)	(5)	(6)
	τ_{i}	τ_{i}	τ_{i}	τ_{i}	τ_{i}	τ_{i}
	b/se	b/se	b/se	b/se	b/se	b/se
$\bar{\tau}_{\mathrm{j}}$	0.223***	-0.028	0.239***	0.063	0.220***	-0.098
	(0.062)	(0.101)	(0.080)	(0.089)	(0.061)	(0.099)
Tax Haven FDI	-0.031	-0.064**	-0.056***	-0.050*	-0.026	-0.059**
	(0.019)	(0.025)	(0.016)	(0.024)	(0.016)	(0.022)
Tax Haven SI	-0.002	-0.253**	-0.004	-0.193*	0.001	-0.209*
	(0.058)	(0.106)	(0.073)	(0.111)	(0.048)	(0.105)
Public Consumption	0.156	0.235	0.242	-0.132	0.158	0.237
	(0.342)	(0.417)	(0.292)	(0.403)	(0.322)	(0.467)
Capital Openness	-0.063**	-0.015**	-0.034	-0.015**	-0.059**	-0.010
	(0.024)	(0.006)	(0.027)	(0.006)	(0.023)	(0.007)
Trade Openness	-0.070	-0.067*	-0.089**	-0.012	-0.053	-0.047
	(0.045)	(0.036)	(0.038)	(0.033)	(0.051)	(0.034)
PIT	0.220***	-0.105	0.285***	-0.119	0.194**	-0.107
	(0.079)	(0.068)	(0.076)	(0.082)	(0.075)	(0.072)
Ln Population	-0.046	-0.288**	-0.168	-0.333**	0.028	-0.105
	(0.118)	(0.132)	(0.112)	(0.156)	(0.117)	(0.092)
Dependency Ratio	0.001	-0.022*	-0.002	-0.025**	0.002	-0.020*
	(0.006)	(0.012)	(0.006)	(0.012)	(0.006)	(0.011)
Right-Wing	-0.012	0.000	-0.007	-0.003	-0.011	0.002
	(0.008)	(0.009)	(0.006)	(0.006)	(0.007)	(0.008)
Post-2004 Dummy					-0.010	-0.032***
					(0.007)	(0.009)
Capital Exporter					-0.025	-0.020***
					(0.017)	(0.005)
Constant	0.991	5.876***	3.148	6.738**	-0.351	2.836*
	(2.137)	(2.076)	(1.995)	(2.477)	(2.086)	(1.483)
Observations	336	307	257	293	336	307
Within R^2	0.431	0.496	0.499	0.540	0.450	0.546
Tax System	Worldwide	Territorial	Worldwide	Territorial	Worldwide	Territorial

Table 6: Preliminary Results

	(1)	(2)	(3)
	τ_{i}	τ_{i}	τ_{i}
	b/se	b/se	b/se
Public Consumption	-0.269	-0.332	-0.281
	(0.270)	(0.357)	(0.266)
Capital Openness	-0.035		-0.022
	(0.026)		(0.017)
Trade Openness	-0.165***	-0.218***	-0.146***
	(0.041)	(0.055)	(0.034)
PIT	0.220***	0.247***	0.206**
	(0.070)	(0.080)	(0.083)
Ln Population	-0.261***		-0.226***
	(0.062)		(0.078)
Dependency Ratio	-0.003	0.006	-0.000
	(0.004)	(0.005)	(0.004)
Territorial	-0.022	-0.021	-0.027
	(0.019)	(0.020)	(0.018)
Right-Wing	0.003	0.005	0.000
	(0.008)	(0.008)	(0.008)
Chinn-Ito Index		-0.025	
		(0.030)	
gdpusd		0.107	
		(0.139)	
$\bar{\tau}_{\mathrm{j}}$			0.171**
			(0.065)
Constant	4.964***	0.229	4.206***
	(1.176)	(0.243)	(1.378)
Observations	1056	1074	929
Within R^2	0.527	0.454	0.520
Estimator	FE	FE	FE

Table 7: Temporal Lags of the Dependent Variable

	(1)	(2)	(3)	(4)	(5)	(6)
	τ_{i}	τ_{i}	τ_{i}	τ_{i}	τ_{i}	τ_{i}
	b/se	b/se	b/se	b/se	b/se	b/se
L.τ_{i}	0.787***	0.798***	0.787***	0.739***	0.782***	0.762***
	(0.032)	(0.035)	(0.039)	(0.046)	(0.044)	(0.048)
$\bar{\tau}_{j}$	0.054**	0.090***	0.076**	0.060*	0.104**	0.095**
	(0.026)	(0.032)	(0.033)	(0.031)	(0.044)	(0.039)
Public Consumption	0.067	0.092	0.132	0.146	0.189	0.227*
	(0.082)	(0.114)	(0.120)	(0.125)	(0.132)	(0.133)
Trade Openness	-0.000	-0.003	0.004	0.005	0.005	0.011
	(0.012)	(0.012)	(0.013)	(0.016)	(0.010)	(0.010)
PIT	0.067	0.018	0.021	0.069*	0.046**	0.050**
	(0.040)	(0.028)	(0.030)	(0.042)	(0.020)	(0.022)
Ln Population	-0.046*	-0.030	-0.025	-0.059**	-0.060**	-0.059**
	(0.024)	(0.027)	(0.027)	(0.027)	(0.030)	(0.029)
Dependency Ratio	-0.000	0.000	-0.001	-0.000	0.000	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
Territorial	-0.010***	-0.009*	-0.011**	-0.017***	-0.012**	-0.014***
	(0.004)	(0.004)	(0.005)	(0.005)	(0.005)	(0.005)
Right-Wing	-0.001	0.001	-0.001	-0.002	0.002	0.001
	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)
Capital Openness	0.001	0.002	0.002	-0.005	0.001	-0.001
	(0.003)	(0.003)	(0.003)	(0.006)	(0.005)	(0.005)
Tax Haven FDI	-0.012*		-0.013**	-0.014**		-0.011**
	(0.007)		(0.006)	(0.006)		(0.006)
Tax Haven Services Imports		-0.039**	-0.039**		-0.028	-0.034*
		(0.018)	(0.019)		(0.020)	(0.020)
Constant	0.808*	0.511	0.456	1.040**	0.988*	1.019**
	(0.413)	(0.482)	(0.481)	(0.473)	(0.518)	(0.503)
Observations	823	653	642	781	613	601
Within R^2	0.856	0.842	0.836	0.210	0.122	0.108
Estimator	FE	FE	FE	AB	AB	AB

Table 8: Uniform Weights

	(1) τ_i b/se	(2) τ_i b/se	(3) τ_i b/se	(4) τ_i b/se	(5) τ_i b/se	(6) τ_i b/se
$\bar{\tau}_j$	0.599***	0.974***	0.155**	0.325***	0.736***	1.149***
	(0.188)	(0.233)	(0.071)	(0.076)	(0.194)	(0.258)
Public Consumption	0.217	0.297	0.129	0.143	0.267	0.352
	(0.301)	(0.301)	(0.085)	(0.108)	(0.301)	(0.301)
Capital Openness	-0.007	0.005	0.004	0.006**	-0.004	0.008
	(0.011)	(0.005)	(0.003)	(0.003)	(0.010)	(0.006)
Trade Openness	-0.059	-0.043	0.009	0.013	-0.047	-0.030
	(0.038)	(0.029)	(0.014)	(0.012)	(0.038)	(0.030)
PIT	0.178*	0.115	0.059	0.023	0.170*	0.110
	(0.089)	(0.076)	(0.042)	(0.025)	(0.088)	(0.074)
Ln Population	-0.051	0.171*	0.015	0.066**	0.008	0.234**
	(0.131)	(0.097)	(0.036)	(0.028)	(0.133)	(0.102)
Dependency Ratio	-0.003	0.001	-0.000	0.000	-0.002	0.001
	(0.004)	(0.005)	(0.001)	(0.001)	(0.004)	(0.005)
Territorial	-0.025*	-0.020	-0.008**	-0.007	-0.022	-0.018
	(0.014)	(0.017)	(0.004)	(0.005)	(0.014)	(0.017)
Right-Wing	-0.007	-0.001	-0.002	0.000	-0.006	-0.001
	(0.006)	(0.007)	(0.002)	(0.002)	(0.006)	(0.007)
Tax Haven FDI	-0.025		-0.007		-0.018	
	(0.021)		(0.006)		(0.021)	
Tax Haven SI		-0.013		0.010		0.017
		(0.055)		(0.017)		(0.051)
L.τ_i			0.782***	0.774***		
			(0.031)	(0.028)		
Constant	1.026	-3.014*	-0.286	-1.226**		
	(2.258)	(1.682)	(0.629)	(0.489)		
Observations	833	663	829	662	833	661
Within R^2	0.557	0.534	0.856	0.844	0.556	0.525
Estimator	FE	FE	FE	FE	IV	IV

Table 9: Common GDP Shocks

	(1) τ_i b/se	(2) τ_i b/se	(3) τ_i b/se
$\bar{\tau}_j$	0.193***	0.193***	0.190***
	(0.060)	(0.059)	(0.058)
Tax Haven FDI	-0.056***	-0.056***	-0.054***
	(0.016)	(0.017)	(0.017)
Tax Haven Services Imports	-0.137*	-0.136*	-0.127*
	(0.071)	(0.072)	(0.072)
Public Consumption	0.218	0.224	0.286
	(0.308)	(0.310)	(0.312)
Capital Openness	-0.008	-0.008	-0.007
	(0.007)	(0.007)	(0.006)
Trade Openness	-0.079**	-0.080**	-0.081**
	(0.030)	(0.030)	(0.030)
PIT	0.132	0.132	0.130
	(0.088)	(0.088)	(0.087)
Ln Population	-0.152	-0.153	-0.143
	(0.105)	(0.105)	(0.102)
Dependency Ratio	-0.002	-0.002	-0.003
	(0.006)	(0.006)	(0.006)
Territorial	-0.028*	-0.028*	-0.027*
	(0.015)	(0.015)	(0.015)
Right-Wing	-0.005	-0.005	-0.004
	(0.006)	(0.006)	(0.006)
World GDP (Nom)	0.297		
	(2.225)		
World GDP (Real)		0.041	
		(0.076)	
Advanced GDP (Real)			0.219**
			(0.099)
Constant	2.909	2.929	2.761
	(1.867)	(1.872)	(1.815)
Observations	643	643	643
Within R^2	0.495	0.495	0.499
Estimator	FE	FE	FE

Table 10: Split Sample by Tax System - Separate Tax Haven Variables

	(1) τ_{i} b/se	(2) τ_{i} b/se	(3) τ_{i} b/se	(4) τ_{i} b/se
$\bar{\tau}_{\mathrm{j}}$	0.211***	0.068	0.246***	-0.071
	(0.067)	(0.081)	(0.078)	(0.119)
Public Consumption	0.315	-0.204	0.122	0.107
	(0.316)	(0.420)	(0.323)	(0.456)
Capital Openness	-0.048	-0.010	-0.055**	-0.014**
	(0.033)	(0.010)	(0.025)	(0.007)
Trade Openness	-0.066	-0.081**	-0.099**	-0.110**
	(0.045)	(0.035)	(0.037)	(0.044)
PIT	0.303***	0.062	0.203***	-0.123
	(0.089)	(0.133)	(0.072)	(0.084)
Ln Population	-0.231*	-0.504***	-0.045	-0.297**
	(0.116)	(0.101)	(0.118)	(0.141)
Dependency Ratio	-0.002	-0.017	0.003	-0.019
	(0.004)	(0.012)	(0.005)	(0.012)
Right-Wing	-0.017**	-0.004	-0.009	0.002
	(0.008)	(0.009)	(0.007)	(0.009)
Tax Haven FDI	-0.022	-0.080**		
	(0.024)	(0.033)		
Tax Haven SI			-0.024	-0.276**
			(0.067)	(0.110)
Constant	4.225**	9.247***	0.923	6.017**
	(2.035)	(1.628)	(2.162)	(2.208)
Observations	471	356	343	311
Within R^2	0.529	0.493	0.431	0.472
Tax System	Worldwide	Territorial	Worldwide	Territorial