The OECD Model Tax Treaty: Tax Competition and Two-Way Capital Flows

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Abstract. Model tax treaties do not require tax rate coordination, but do call for either credits or exemptions when calculating a multinational's domestic taxes. This contradicts recent models with a single capital exporter where deductions are most efficient. I incorporate the fact that many nations import and export capital. With symmetric countries, credits by both is the only treaty equilibrium, resulting in Pareto optimal effective tax rates which weakly dominate the non-treaty equilibrium rates. With asymmetric countries, the treaty need not offer improvements without tax harmonization. With harmonization, it is always possible to reach efficient capital allocations while increasing both countries' welfares only if neither uses deductions.

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1. Introduction

There is no question that foreign direct investment (FDI) by multinationals is a significant and growing portion of many economies. For example, consider the data summarized in Table 1 (OECD, 1998). In 1985, the United States had $230 billion in FDI abroad and was the location for almost $185 billion of FDI from other countries. By 1995, the U.S. was the source of $711 billion in outbound FDI and was the host for $560 billion of inbound FDI. This pattern holds for almost all countries, where both inbound and outbound FDI as a percentage of GDP increased over the decade 1986-1996. As a host of evidence suggests, both the location and level of multinational investment are sensitive to taxes. For example, Hines (1996) reports that foreign investment shares in a U.S. state would drop 7-9% in response to a 1% increase in the state's tax rate.[1] Given this sensitivity, governments can use their tax policies to influence multinational investment. This manipulation by governments can lead to inefficiencies in FDI due to after-tax differences in relative rates of return. One type of distortion particular to multinational investment is the potential for the double taxation of foreign-earned profits. When profits are generated overseas, they are taxable by the local government immediately. Upon repatriation by the parent firm, these profits are again taxable by the parent's home country.[2] Many governments offer their multinationals some form of relief from this double taxation. This relief can be categorized into three forms: credits, deductions, and exemptions, which are described below. While these relief methods can reduce tax distortions, typically they do not yield fully efficient levels of FDI.

To counter this problem, the OECD proposed a model tax treaty which was most recently updated in 1997 (OECD, 1997). Although the bulk of the model treaty is given over to standardizing tax base

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[1] Additional evidence is reported by Hines (1988) and Wilson (1993).

[2] Hines and Hubbard (1990), Altshuler and Newlon (1991), and Altshuler, Newlon, and Randolph (1995) all highlight the role of taxes in U.S. multinational repatriation decisions.

definitions, the restrictions placed on actual taxation are relatively simple.[3] In particular, Article 23 of the treaty restricts countries to use either credits or exemptions when calculating taxes on foreign-earned profits. No limits on statutory tax rates are imposed, nor is any tax rate coordination required.[4] Thus, the treaty simply rules out the use of deductions. The United Nations (1980) model tax treaty makes a similar recommendation. Although the treaty provides no explicit justification for this rule, its stated objective is to "remove the obstacles that double taxation presents" (OECD, 1997, pg. I-1).[5] Tax treaties following the OECD model are being used more and more often. Treaties imposed by the U.S. quite closely follow the OECD guidelines and, as Table 2 reports, the number of these treaties doubled between 1975 and 1998. According to the Bureau of Economic Analysis (1998), the amount of foreign direct investment (FDI) covered by these treaties in 1998 was approximately $774 billion of U.S. investment abroad (outbound FDI) and $586 billion of foreign investment within the U.S. (inbound FDI). These amounts represented 78% of total U.S. outbound FDI and 96% of the total U.S. inbound FDI. Therefore, the aim of this paper is to analyze the equilibrium performance of the OECD model tax treaty in a general equilibrium model of tax competition. This analysis shows that the OECD model treaty can have a significant role in improving global capital flows.[6] Inherent in this study is an examination of the

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[3] Hines (1994) discusses the importance of tax base definitions on U.S. multinational investment, an aspect not considered in this paper. Janeba (1996) considers the impact of differences in tax base definitions on a model of tax competition with an imperfectly competitive output market.

[4] Articles 10 and 11 of the OECD treaty (1997) do however place limits on dividend and interest withholding taxes respectively. The UN model treaty (1980) limits only dividend withholding taxes.

[5] Tax treaties may have goals other than efficient capital allocation. For example, Gravelle (1988) considers the role of tax treaties in eliminating tax avoidance, while the International Fiscal Association (1992) discusses tax treaties and revenue generation for developing countries.

[6] For an excellent discussion of the workings of the OECD model tax treaty, see Baker (1994).

equilibrium performance of the various double taxation rules.

As stated above, the three basic methods of double taxation relief are deductions, credits, and exemptions. Under the deduction method, the home government treats host taxes as a cost. Thus, after-host-tax profits are taxed by the home government at the home statutory tax rate. Under credits, the home government offers a limited credit for host taxes paid when calculating the home tax bill. This credit is limited in the sense that the home government does not rebate excess credits to the firm. Thus, if the host tax bill is larger than the pre-credit home tax liability, the firm is in an "excess credit" position and no further taxes are paid on the repatriated profits. Alternatively, if the home tax bill exceeds host taxes paid, the multinational is in an "excess limit" position, and the difference between the home and host tax bill must be paid upon repatriation. Finally, the home country may choose to exempt overseas profits. Under this method, no taxes are paid to the home government on foreign-earned profits. Together home and host statutory tax rates combined with home's double taxation method define an effective tax rate on overseas profits. Changes in any of these components will change the effective tax rate and thus the relative after-tax return on overseas investment. This alters multinational investment patterns.

Although tax competition has been closely examined by several researchers, their results do not provide a sound rationale for the model treaty's recommendations. Early work by Bond and Samuelson (1989) compares the equilibria arising under credits and deductions in a tax-setting game between a single capital exporter and a single capital importer.[7] A key feature of their setup is that the capital exporter may practice discriminatory taxation where foreign-earned profits are taxed differently than domestic profits.

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[7] Earlier static models include Hamada (1966) and Musgrave (1969). Hamada suggests that for given statutory tax rates, credits are superior to deductions as they lower the effective tax rate and promote more efficient capital allocation. Exemptions offer a similar improvement. Musgrave points out that although Hamada is correct concerning world income, credits and exemptions yield a lower home income since they encourage excessive FDI from home's point of view.

This results in more aggressive taxation under credits than under deductions. In fact, under credits equilibrium taxes are so large that they result in zero capital flows. Since deductions permit positive equilibrium capital flows, it follows that deductions are superior to credits from a home, host, and world perspective. In this context, the OECD model treaty would reduce world welfare. Feldstein and Hartman (1979) also allow for discriminatory taxation but solve for the Stackelberg equilibrium tax rates rather than the Nash equilibrium tax rates. As with Bond and Samuelson, they find that the capital exporter would choose to use deductions. If credits or exemptions were imposed, however, full efficiency would still not be reached, since foreign taxes would remain positive. Thus again the OECD model treaty would fail to reach its goal.

In contrast, Janeba (1995) finds that in equilibrium deductions and credits are welfare equivalent given a single capital exporter and uniform (i.e. non-discriminatory) tax rates.[8] He shows that the equilibrium capital distributions under credits, deductions, and exemptions are identical, implying government indifference over these methods. In this setting, the OECD model treaty does nothing to improve welfare. Janeba does demonstrate that Pareto improving tax coordination can only be achieved through credits or exemptions in the absence of side payments. However, tax rate coordination is not called for in the OECD model treaty. Gordon (1992) also uses uniform taxation but allows for an endogenous capital supply. In this setting, he finds an equilibrium in which the capital exporter randomizes over its tax rate. Despite this, capital flows will still be distorted without tax rate coordination, even if credits are used. This still leaves us with the question of why might the OECD model treaty reach efficient capital flows?

One fact of FDI investment patterns not considered by the above work is that most countries are

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[8] Article 24 of the OECD model treaty (1997) calls for non-discriminatory taxes. Although many countries pay lip-service to this rule, Hines (1988) and Hufbauer (1992) find evidence indicating that many tax rates are discriminatory in practice.

both home and host for FDI. As Table 1 indicates, countries both import and export capital in significant amounts. The above work on tax competition, however, assumes that countries are either pure capital exporters or importers or that governments are only concerned about net capital flows. Since inbound FDI can have different welfare impacts from outbound FDI, it seems necessary to explicitly consider inbound and outbound capital flows separately. If doing so alters incentives for taxation, it may also influence the equilibrium performance of the double tax rules. Furthermore, it is more intuitive to model the OECD model treaty in the context of two way flows, since unless countries coordinate their taxes, a single capital exporter can replicate the treaty through its unilateral choice of relief method.

Although there exist contributions to the tax competition literature which model two-way capital flows, they miss key features necessary for the current discussion. Yang (1996) examines the impact of capital flight on tax competition. In his analysis, however, it is again only the net capital flow position of a country that drives its tax policy. Additionally, by imposing symmetry Yang finds that equilibrium net capital flows are zero, a result contradicted by the data. Finally, Yang implicitly imposes exemptions and does not consider how the use of either credits or deductions affects tax competition. Mintz and Tulkens (1996) also consider two-way capital flows, but include a constant external rate of return for outbound capital flows. This removes the general equilibrium properties that the OECD recognized in its global efficiency objective. Under this assumption, Mintz and Tulkens show that when a government is unrestricted in choosing lump-sum taxes, an optimal tax policy sets the effective tax rate on outbound FDI equal to the overseas tax rate. In the terminology of Janeba and this paper, this indicates that deductions are the optimal relief method.[9] This use of deductions results from discriminatory taxes and the timing of

[9] Slemrod, Hansen, and Proctor (1997) find a similar result for a small country that not only earns a constant rate of return on outbound capital but also pays a constant cost for inbound capital. In addition, they show that optimal taxation includes exempting inbound FDI from domestic taxation. As most countries do tax inbound FDI, this implies that their model does not fully capture the role of two-

government decisions. Despite the presence of two-way flows, as detailed in Section 3.3, under discriminatory taxation the OECD model treaty still does not correct the tax distortions.

In contrast, I discuss the impact of credits, deductions, and exemptions on tax competition in the context of uniform taxes and simultaneous two-way capital flows which earn endogenous rates of return. This leads to a number of new results. First, I find that for any given combination of double taxation relief methods, an equilibrium always exists with positive capital flows in both directions. This result differs from Bond and Samuelson because I do not have the monopsonistic motives that drive capital exporter taxes in their setting. This eliminates the ratcheting effect which drives taxes to prohibitive levels under credits. Unlike Janeba, I also find that both countries set positive tax rates in equilibrium since they import capital as well as export it. This behavior leads to differing equilibrium welfare properties across the combinations of relief methods, which Janeba did not observe. Although these differences improve the performance of credits and exemptions, they do not necessarily imply their equilibrium use. When countries are symmetric in their endowments and technologies, all possible subgame perfect equilibria without a tax treaty involve either deductions by at least one country or credits by both. Which combination of relief methods arises depends on the parameters chosen. Under the OECD treaty, symmetric countries will always reach a Pareto optimum which is weakly superior to the unrestricted equilibrium. This is true even in the absence of tax rate coordination and side payments. With asymmetric countries, both countries will not always enjoy an improvement under the treaty. In particular, the OECD treaty without tax coordination does not reach Pareto optimal relative effective tax rates. In some cases, the model treaty will even fail to offer Pareto improvements over the equilibrium without a treaty. However, similar to Janeba (1995), it is shown that when deductions are eliminated, tax harmonization can always reach efficient capital flows without injuring either asymmetric country. When at least one country uses deductions, this is not the case.

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way capital flows.

The rest of this paper is structured as follows. Section 2 lays out the basic model under two restrictive assumptions: symmetry between countries and FDI levels which are convex in tax rates. Here, I derive the equilibria both with and without the OECD model treaty. Section 3 relaxes these two assumptions and discusses their impact on the results. Section 3 also extends the model to discriminatory taxes and alternative timing structures. Section 4 concludes.

2. The Model

In this section, I derive the results from tax competition with and without the OECD's model tax treaty under two assumptions: symmetric countries and FDI levels which are convex in tax rates. Under these assumptions, which are explained below, the model treaty's implications are most striking. I relax these assumptions in Section 3.

Consider a two country setting in which each government maximizes its national income through its choice of tax policy. A tax policy consists of both a method of double taxation relief and a tax rate, which are chosen independently. Specifically, governments simultaneously choose their method of double taxation relief, and after observing these choices, simultaneously set tax rates. Tax rates are constrained to the interval [0,1]. After both tax policies are set, factor markets equilibrate. In the absence of a treaty either credits, deductions, or exemptions may be chosen in the first stage.[10] Under the OECD treaty, only credits or exemptions may be chosen.[11] All factor and output markets are perfectly

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[10] Since all major capital exporters offer some form of double taxation relief, I do not explicitly model a "no relief" option. However, since no relief by home yields an effective tax $\tau = \frac{t^*}{1-t}$, governments' best responses are comparable to when home uses exemptions.

[11] I assume countries can credibly commit to the tax treaty. Alternatively, since I derive the subgame perfect equilibria, my results can be interpreted as bounds on what is self-enforcing by the standard Folk theorems as they apply to a repeated game framework.

competitive. Equilibria are required to be subgame perfect.

Each country, home and foreign, is endowed with an inelastic supply of capital, K and K^*.[12] Both countries produce a good with constant market price. For simplicity, this price is set to one. Each country produces both domestically and abroad. Home uses its capital to produce in the home country using the production function $h(K-Z)$ and in the foreign country using a subsidiary with the production function $h^s(Z)$. Z is therefore the amount of home's outbound FDI. Z may also be interpreted as foreign's inbound FDI. Analogously, foreign produces domestically using the production function $f(K^*-Z^*)$ and overseas using the production function $f(Z^*)$. All production functions are strictly concave, at least twice differentiable, and satisfy the Inada conditions.

This production structure can result from a country-specific public factor of production as suggested by Markusen (1984). In such a setting, two-way capital flows would occur as country-specific capital moves to take advantage of multi-plant economies of scale. This would occur even if each plant faces constant returns to scale in capital and the public factor of production, leading to the reduced form production structure I use here.[13] Alternatively, this production structure can emerge from a model similar Markusen and Venables (1998). In that setting, multinational production occurs in a differentiated product industry. Depending on parameter values, multinationals will produce in each country in equilibrium. Although Markusen and Venables specify constant returns to scale production, downward sloping demand for the multinational's overseas output yields decreasing marginal returns from overseas production analogous to my specification.

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[12] Throughout this paper asterisks will be used to denote values for the foreign country.

[13] Unlike Markusen (1984), I have only one exludable factor of production. Including labor in the current model would introduce the Ramaswami (1968) effects that drive taxation in models such as Bond and Samuelson (1989) or Janeba (1995). By excluding labor I can isolate the role of two-way capital flows.

For the moment, I assume that countries are symmetric, that is they have identical technologies and endowments. Note that this implies that $f^s(Z^*) = h^s(Z^*)$ for all Z and that $Z = Z^*$ wherever $\tau = \tau^*$. The asymmetric case is dealt with in Section 3.2.

2.1. Production

Profit taxes are uniform regardless of whether profits are generated locally by domestic capital, locally by inbound FDI, or overseas by outbound FDI, i.e. profit taxes are non-discriminatory. In this one-shot game, all profits are repatriated. Investors maximize their profits from production by shifting capital overseas until the after-tax marginal products of domestic and subsidiary production are equalized. This yields home and foreign capital market equilibrium conditions, which are given by:

$$h_k(K\&Z) = (1\&\tau)h_k^s(Z) \tag{1}$$

and

$$f_k(K'\&Z') = (1\&\tau')f_k^s(Z') \tag{2}$$

where τ and τ^* are the relative effective tax rates on subsidiary production, which are themselves functions of the statutory rates, t and t^*, and the method of double taxation relief chosen. Explicitly:

$$\tau = \begin{cases} t' & \textit{if home offers a deduction} \\ \max\left\{\dfrac{t'\&t}{1\&t}, 0\right\} & \textit{if home offers a credit} \\ \dfrac{t'\&t}{1\&t} & \textit{if home offers an exemption}, \end{cases} \tag{3}$$

and

$$\tau' = \begin{cases} t & \textit{if foreign offers a deduction} \\ \max\left\{\dfrac{t\&t'}{1\&t'}, 0\right\} & \textit{if foreign offers a credit} \\ \dfrac{t\&t'}{1\&t'} & \textit{if foreign offers an exemption}. \end{cases} \tag{4}$$

Note that under credits, the relative effective tax is positive if, and only if, the overseas statutory tax rate exceeds the domestic statutory tax rate. Otherwise, the relative effective tax is zero. Compare this to exemptions, where the relative effective tax rate will be negative if the domestic tax rate exceeds the overseas tax rate.

From the equilibrium conditions (1) and (2), the response in FDI levels with respect to a change in the appropriate relative effective tax rate are:

$$\frac{dZ}{d\tau} = -\frac{\varepsilon\varepsilon' Z}{(1-\tau)(\varepsilon+\varepsilon')} < 0 \tag{5}$$

and

$$\frac{dZ'}{d\tau'} = -\frac{\delta\delta' Z'}{(1-\tau')(\delta+\delta')} < 0 \tag{6}$$

where $\varepsilon = \frac{-h_k}{h_{kk}Z}$, $\varepsilon' = \frac{-h_k^s}{h_{kk}^s Z}$, $\delta = \frac{-f_k}{f_{kk}Z'}$, and $\delta' = \frac{-f_k^s}{f_{kk}^s Z'}$. I can interpret ε (δ) as the elasticity of home's (foreign's) outbound FDI supply and ε^* (δ^*) as the elasticity of home's (foreign's) outbound FDI demand. For notational convenience, I define $\alpha(\tau) = \frac{dh(K-Z)}{d\tau} = \frac{h_k^s Z\varepsilon\varepsilon'}{\varepsilon+\varepsilon'} \geq 0$ and $\beta(\tau') = \frac{df(K'-Z')}{d\tau'} = \frac{f_k^s Z'\delta\delta'}{\delta+\delta'} \geq 0$, with strict inequality when the respective effective tax is less than one. Thus α and β represent changes in the domestic output when the relevant effective tax changes.

2.2. Government Behavior

Each government chooses its tax rate and relief method to maximize its country's national income. This is done with the knowledge that tax policies influence capital flows. Home and foreign national incomes are:

$$Y = h(K-Z) + (1-t')h^s(Z) + tf^s(Z') \tag{7}$$

and

$$Y' = f(K'-Z') + (1-t)f^s(Z') + t'h^s(Z). \tag{8}$$

Both of these objective functions are assumed strictly concave in the government's own tax rate (in the case of credits, this strict concavity is piecewise above and below the 45E line).[14] Regardless of the double taxation methods being used, equations (7) and (8) can be differentiated to yield (suppressing the arguments of functions):

[14] As shown by Debreu (1952), this assumption guarantees that best response functions are continuous on either side of the 45E line.

$$dY = f^s dt + h^s dt^* + \frac{(\tau - t^*)}{(1-\tau)}\alpha d\tau + \frac{t}{(1-\tau^*)}\beta d\tau^* \quad (9)$$

and

$$dY^* = h^s dt^* + f^s dt + \frac{(\tau^* - t)}{(1-\tau^*)}\beta d\tau^* + \frac{t^*}{(1-\tau)}\alpha d\tau \quad (10)$$

Equations (9) and (10) imply that from a country's perspective, outbound capital flows are optimal when its relative effective tax rate is equal to the overseas statutory tax rate. Deductions will obtain this optimal level of outbound FDI regardless of the value of either statutory tax rate. Credits yield optimal outbound FDI only when either the overseas tax rate or the domestic tax rate is zero. Under exemptions, outbound FDI is optimal only when the domestic tax rate is zero. Note that this refers to optimality from a country's perspective. World income is maximized when both relative effective tax rates are zero. This is because taxes merely reallocate income between countries and can only distort investment decisions.

Equations (9) and (10) contain two important and countervailing effects in tax revenue from inbound FDI. The first term in both equations is the tax-capturing effect. This represents the increase in the share of inbound FDI production captured through taxation. The fourth term is the tax-shifting effect, which represents the drop in inbound FDI as the effective tax rate rises. These competing effects are crucial in determining the optimal tax rates. Let me define a tax-capturing regime for home as one in which $f^s - \frac{t}{(1-\tau^*)}\beta$ is non-decreasing in t^* for all values of t^*. One simple example satisfying this condition is when domestic and overseas production functions are both logarithmic functions of investment, i.e. $f = A\ln(K^* - Z^*)$ and $f^s = A\ln(Z^*)$. A sufficient condition for a tax-capturing regime is if $\beta(\tau)$ is non-decreasing in τ. Conversely, home is in a tax-shifting regime if $f^s - \frac{t}{(1-\tau^*)}\beta$ is decreasing in t^* for some values of t^*. A necessary condition for the tax-shifting case is that β is decreasing in τ^* for some range of effective taxes. In turn, this requires that Z^* be locally concave in τ^* in this range. Since Z^* is bounded above by K^* and below by zero, under the Inada conditions, Z^* asymptotically approaches these bounds as τ^* approaches -4 (which is only possible when foreign offers exemptions) or one. This

implies that $\beta(\tau)$ may most likely be decreasing for extreme effective tax rates.[15] In the tax-capturing regime, a rise in the foreign tax implies that, home can increase its tax revenues from inbound FDI by raising its tax. The tax-shifting regime, however, implies that, for at least some range of foreign taxes, in order to maximize tax revenues from inbound FDI home would choose to lower its tax in response to a rise in the foreign tax. Thus, in a loose sense, an increase in the foreign tax increases the size of the tax-capturing effect relative to the tax-shifting effect in the tax-capturing regime and lowers it in the tax-shifting regime, leading to respective increases or decreases in the home tax. Therefore, while the tax-capturing and tax-shifting effects are always part of home's tradeoffs, this regime terminology is intended to describe how home incentives change as t^* changes. By the same token, if h^s & $\frac{t'}{(1-\tau)}\alpha$ is non-decreasing in t for all values of t, then foreign is in a tax-capturing regime, otherwise, foreign is in a tax-shifting regime. As with home, for foreign to be in the tax-shifting regime it is necessary that α be decreasing in τ over some range of effective taxes. Note that under symmetry, since these regimes are defined across all values of the overseas tax, one country is in the tax-capturing regime if and only if the other is as well. For ease of exposition, in this section I assume that both countries are in the tax-capturing regime. I return to the tax-shifting regime in Section 3.1.

Subgame perfection requires that I first identify the equilibria of the second-stage subgames defined by the countries choice of double tax rules. This leads to my first proposition.

Proposition 1: *Regardless of the relief method chosen by either country, there exists a Nash equilibrium in the tax rate setting subgame such that positive capital flows exist in both directions.*

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[15] A wealth of literature including Grubert and Mutti (1991), Hines (1996), and Grubert and Mutti (2000) estimate the effect of taxes on FDI, however, all of them use specifications that assume that FDI is a concave function of the tax and do not consider convex functional forms.

Proof: I begin by describing the home best response correspondence. Table 3 presents home's first-order conditions across the nine subgames defined by the various combinations of double tax rules.[16] Depending on the combination of relief methods, home's optimal tax is one which balances effects on outbound FDI and tax revenues from inbound FDI. As noted above, the first of these is the impact of the home tax on tax revenues from inbound FDI, as represented by $f^s - \frac{t}{1-t}\beta$. Home must balance its share of the tax base (the first term) with changes in the level of that base (the second term). This second term is present unless the foreign firm is in an excess limit position, i.e. foreign offers credits and $t < t^*$.

When home uses deductions, its outbound FDI is invariant to its tax rate and it chooses a tax which maximizes inbound tax revenues. In the D-D subgame, home's inbound FDI is independent of the foreign tax, and home's best response is a constant as in Figure 1. The same is true for foreign. For convenience define the equilibrium home and foreign tax rates under D-D as $\hat{t}$ and $\hat{t}^*$. In the D-E subgame τ^* decreases along $t_{de}(t^*)$ because when t^* rises home finds it optimal to choose a tax that yields a larger tax base which it can tax. In the tax-capturing regime, even though τ^* is falling, a rise in the foreign tax encourages home to increase its tax as illustrated in Figure 2.[17] In the D-C subgame, as long as $t \geq t^*$ home's tradeoffs are the same as in D-E. The difference between these cases is when $t < t^*$. Here, Z^* is independent of home's tax rate, permitting home to match foreign's tax rate without affecting the tax base. Thus, home will always at least match foreign's tax rate. This is summarized in Figure 3.

When home uses exemptions, in addition to the above effect on inbound FDI, it must consider

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[16] The notation *H-F*, refers to pair of relief methods used by home (*H*) and foreign (*F*) in any particular subgame, where *H,F* $\in$ *{c,d,e}* which represent credits, deductions, and exemptions respectively. For example, *C-D* refers to the subgame where home uses credits and foreign uses deductions. This same notation in subscripts identifies the tax rates and best responses for each subgame.

[17] In the tax-shifting regime, home's best response will be negatively sloped for some portion. The implications of this alternative are discussed below.

how its tax rate influences its outbound FDI. This second effect is represented by the term $\frac{t}{1-t}(1-\tau)\alpha$. Under exemptions, a positive home tax encourages excessive outbound FDI from the home perspective. This places a damper on home's desire to tax, indicating that these home country best responses lie below those for when home used deductions. Note that as t^* approaches one, so does τ, implying that Z moves towards zero and the gap between home's best response under exemptions and under deductions disappears. In the E-E subgame, even in the tax-capturing regime, the slopes of the best response tax rates $t_{ee}(t^*)$ and $t^*_{ee}(t)$ are ambiguous at this level of generality. For example,

$$\frac{\partial^2 Y_{ee}(t(t^*,t^*),t^*)}{\partial t\,\partial t^*} = \frac{\beta}{1-t^*} + \frac{t\beta\eta}{(1-t^*)^2} + \frac{t\alpha}{(1-t)^2} - \frac{t(1-\tau)\alpha\eta}{(1-t)^2} \tag{11}$$

which due to the last term is ambiguous in sign even if α and β are increasing in τ. Note that when $t^* = 1$, $\tau = 1$, implying that home's best response $t_{ee}(t^*)$ is upward sloping at $t^* = 1$. For simplicity in my graphical analysis, I assume that both $t_{ee}(t^*)$ and $t^*_{ee}(t)$ are upward sloping everywhere. This impacts none of my results. Finally, since production functions satisfy the Inada conditions, best responses cannot be backwards bending. The E-E case is shown in Figure 4.

When home offers credits, the effect of home's tax depends on whether t is greater or less than t^*. When $t > t^*$, home's investors are in an excess limit position, implying that Z does not respond to small changes in t. Therefore home's incentives mirror those when it offers deductions. When $t < t^*$, Z responds to t and home's incentives are the same as when it offers exemptions. Although these piecewise best responses follow either the deduction or exemption best response (the shape of which depends on foreign's relief method), this switch at $t = t^*$ can cause a jump in the home best response. This occurs because although a relatively high tax rate captures more revenue from inbound investment, it simultaneously encourages excessive outbound investment. Consider the C-D case. For values of $t \geq t^*$, home's local best response is $t_{cd}(t^*) = \hat{t}$. However, as t^* approaches $\hat{t}^*$, the benefit of optimally taxing inbound FDI is outweighed by the cost of excessive outbound FDI and home prefers a tax rate lower than $\hat{t}$. These two facts implies a jump in home's best response at some $\underline{t}^*_{cd}$. For values of $t^* < \underline{t}^*_{cd}$ home will set $t_{cd}(t^*) = \hat{t}$ while for $t^* > \underline{t}^*_{cd}$, home will choose the same tax it does under

E-D. At $t^* = \underline{t}^*_{cd}$, home is indifferent between $\hat{t}$ and $t_{ed}(\underline{t}^*_{cd})$ and will randomize between them. This yields a mirror image of the foreign best response in Figure 3. A similar effect arises under C-E, yielding a comparable jump at $t_{ce}(\underline{t}^*_{ce})$ as shown in Figure 5. Despite these jumps, since $\underline{t}^*_{cd}$ and $\underline{t}^*_{ce}$ are both less than $\hat{t}^{(}$, both of the C-E and C-D equilibria will be in pure strategies. Also, note that the C-D equilibrium is equivalent to the E-D equilibrium. When both countries use credits, however, no jump occurs. Noting that $\alpha(0) = \beta(0)$ along the 45E line, home's best response for $t > t^{(}$ and $t < t^*$ intersect where the tax rates are equal. Thus, although there may be a kink in $t_{cc}(t^*)$, there is no jump in it. This C-C case is shown by Figure 6. Again, since the production functions satisfy the Inada conditions, all C-C equilibria are such that $t_{cc}(t^*) = t^*_{cc}(t)$.

Note that in all subgames, home's best response to $t^* = 0$ is always some $t > 0$ while its best response to $t^* = 1$ is something less than one. Thus, the home best response crosses the 45E line. Since a similar analysis describes foreign's best responses, this indicates the existence of a Nash equilibrium with both statutory tax rates less than one. Furthermore, this means that both effective tax rates are less than one, implying that there exists a Nash equilibrium pair of tax rates which results in positive capital flows for all combinations of relief methods. ***Q.E.D.***

It is important to contrast this result to the work utilizing one way capital flows. Without the domestic influence on the overseas capital market, I avoid the ratcheting effect that drives taxes to prohibitive levels under credits in Bond and Samuelson (1989). Additionally, under uniform taxation, an increase in a country's tax rate increases outbound FDI under credits or exemptions. This places downward pressure on tax rates and further reverses the Bond and Samuelson result. The impact of discriminatory tax rates on the current model is discussed in Section 3.3. Janeba (1995) also finds positive equilibrium FDI under credits and exemptions under uniform taxation. In his one-way capital flow setting, however, the equilibrium under each relief method is welfare equivalent. In contrast, I find that welfare levels generally differ across pairs of relief methods. This is a result of two-way capital

flows. With two-way flows, each country faces the tradeoffs of both the capital importer and the capital exporter. Due to inbound FDI, capital exporters no longer find zero taxation to be a dominant strategy. Because statutory and effective taxes vary across combinations of relief methods, equilibrium welfare properties will vary across subgames.

Before determining the subgame perfect choice of relief methods, it will prove useful to consider the relative performance of the double taxation rules for a given overseas tax rate. Regardless of the relief method chosen by its opponent, for a given overseas tax rate a country will find deductions weakly superior to credits. Furthermore, a country will find credits weakly superior to exemptions for a given overseas tax rate. To recognize this, consider the home country. Offering deductions sets $\tau = t^*$, yielding home's optimal level of Z regardless of the level of t^*. For $t > 0$, Z is too high under credits from home's point of view for any positive t^*, while under exemptions, Z is too high for all t^*. This is Musgrave's (1969) argument. In addition to superior outbound FDI under deductions, the fact that deductions make τ unresponsive to t gives home more leeway in setting its tax rate to maximize its inbound FDI tax revenues. Credits are preferred to exemptions for a similar reason, since as long as $t \$ t^*$, Z is unresponsive to t. Therefore, for a given value of t^*, home weakly prefers deductions to credits to exemptions, regardless of the relief method chosen by foreign. The size of the income difference across relief methods depends on the responsiveness of home and foreign FDI to the effective tax rate. The same ranking among relief methods holds for foreign for a given t. Note that this analysis is not dependent upon either symmetry or a tax-capturing regime. While this would seem to indicate that deductions are always a best response, a government can influence equilibrium tax rates through its chosen relief method. It is therefore necessary to consider the differences in the equilibrium tax rates across subgames, leading to my second proposition.

Proposition 2: *When countries are symmetric, the only subgame perfect Nash equilibrium in the tax-capturing regime is one in which both countries use deductions and set their tax rate equal to* $\hat{t}$.

Proof: I begin by describing home income along its best response for each of the combination of relief methods. First, suppose that foreign uses deductions. In the D-D case, $\frac{dY(t(t^{(}),t^{(})}{dt^{(}} ' \&h^{s} \# 0$. At $t^{*} = 0$, $t_{dd}(0) = t_{cd}(0) = \hat{t} > t_{ed}(0)$. In the absence of foreign taxation, home income is the same regardless of whether it offers credits or deductions. Home income is lower under exemptions because, since $\tau < 0 = t^{*}$, home's outbound FDI is too large from home's perspective. This concern over excessively high Z also leads home to set a tax rate less than its inbound FDI tax revenue maximizing choice, implying that $Y_{dd}(t(0),0) = Y_{cd}(t(0),0) > Y_{ed}(t(0),0)$. When $t^{*} = 1$, $\tau = 1$, and $Z = 0$. Home will then choose the same tax rate regardless of its relief method, i.e. $t_{dd}(1) = t_{cd}(1) = t_{ed}(1) = \hat{t}$. This indicates that $Y_{dd}(t(1),1) = Y_{cd}(t(1),1) = Y_{ed}(t(1),1)$. These comparisons are summarized in Figure 7. When home faces credits, $Y(t(t^{*}),t^{*})$ appears as in Figure 8. In this case, regardless of the relief method home chooses $\frac{dY(t(t^{(}),t^{(})}{dt^{(}} ' \frac{(1\&t)}{(1\&t^{(})} f^{s} \& h^{s}$. This term has the same sign as $t^{*} - t$. In the C-C equilibrium, where symmetry implies that $t_{cc} = t^{*}_{cc}$, $\frac{dY(t(t^{(}),t^{(})}{dt^{(}} ' f^{s} \& h^{s} ' 0$, indicating that Y_{cc} is at its minimum. Figure 9 illustrates home income along its best response when facing exemptions. Again, regardless of the relief method home uses, $\frac{dY(t(t^{(}),t^{(})}{dt^{(}} ' \frac{(1\&t)}{(1\&t^{(})} f^{s} \& h^{s}$, which has the same sign as $t^{*} - t$. Since in the E-E equilibrium for symmetric countries $t_{ee} = t^{*}_{ee}$, Y_{ee} is at its lowest in the E-E equilibrium. These results indicate that for given tax rates, home income is (weakly) highest when it offers deductions, second-highest when it offers credits, and lowest when it offers exemptions.

I can now rule out both E-C and C-E as equilibria. Since C-C and E-E are efficient while neither E-C nor C-E are, this implies that at least one country's welfare must rise by switching its relief method to match the other country's method. Thus, at least one country would deviate from the E-C and C-E combinations. I can also rule out the E-E by noting that, since home income is at its lowest point when responding to exemptions with exemptions, both credits and deductions are preferred to exemptions. Of these, deductions are the best response to exemptions. Recalling that under symmetry income is constant

along the 45E line, for fixed tax rates a country's income is highest when it offers deductions, and the definition of a best response, it must be that:

$$Y_{ee}(t_{ee},t_{ee}^{(}) \text{ ' } Y_{ee}(t_{de}^{(},t_{de}^{(}) < Y_{de}(t_{de}^{(},t_{de}^{(}) \text{ # } Y_{de}(t_{de}(t_{de}^{(}),t_{de}^{(}) \text{ ' } Y_{de}(t_{de},t_{de}^{(}). \quad (12)$$

Thus, home prefers deductions to credits to exemptions when facing exemptions. Similarly,

$$Y_{cc}(t_{cc},t_{cc}^{(}) \text{ ' } Y_{cc}(t_{dc}^{(},t_{dc}^{(}) < Y_{dc}(t_{dc}^{(},t_{dc}^{(}) \text{ # } Y_{dc}(t_{dc}(t_{dc}^{(}),t_{dc}^{(}) \text{ ' } Y_{dc}(t_{dc},t_{dc}^{(}). \quad (13)$$

As a result, C-C cannot be an equilibrium when deductions are available. If home were to switch respond to credits with exemptions, it can lower the expected value of t^* (given by the expression $E(t^*)$) to $E(t^*_{ec}) = t_{ec}$. Since $Y_{ec}(t_{ec},E(t^*_{ec})) = Y_{cc}(t_{cc},t^*_{cc}) > E(Y(t_{ec},t^*_{ec}))$, this implies that home prefers deductions to credits to exemptions when facing credits.

Finally, recall that under the tax-capturing regime best response tax rates are non-decreasing. As a result, $t^*_{dd}(t) = \hat{t}^{(} < t^*_{cd}(t) = t^*_{ed}(t)$. As a result, since $\frac{dY_{dd}(t(t^{(}),t^{(})}{dt^{(}} < 0$ for $t^{(} < 1$,

$$Y_{ed}(t_{ed},t_{ed}^{(}) < Y_{dd}(t_{ed},t_{ed}^{(}) < Y_{dd}(t_{ed},t_{dd}^{(}) \text{ # } Y_{dd}(t_{dd}(t_{dd}^{(}),t_{dd}^{(}) \text{ ' } Y_{dd}(t_{dd},t_{de}^{(}) \quad (14)$$

and home finds that deductions are preferable to either credits or exemptions when facing deductions.

Thus, home finds that deductions are a dominant double taxation rule. An analogous analysis reveals the same for foreign. As a result, deductions by both countries is the equilibrium combination of relief methods, implying that equilibrium tax rates are $t_{dd} = t^*_{dd} = \hat{t}$. ***Q.E.D.***

When facing deductions, a higher tax rate by one's opponent does not effect inbound FDI. Responding to deductions with deductions does two things. First, it increases the effective tax rate on outbound FDI, inducing optimal overseas investment and lowering the overseas tax rate. Together, these mean that less subsidiary production is lost through taxes to the other country. Second, switching to deductions removes the need to exercise restraint in taxing inbound FDI, since this no longer encourages excessive outbound FDI. This allows a country to maximize its tax revenues from inbound FDI. Combining these effects yields deductions as the best response to deductions.

In the C-C and E-E equilibrium, statutory tax rates are equal, implying that taxes are not

influencing capital allocations and world income is maximized. When facing credits, choosing credits instead of exemptions increases both world income and the income of the previously exempting country. Furthermore, by switching to deductions, a country restricts its capital outflows since the switch to deductions increases the effective tax rate on outbound FDI. Combined with a decrease in the overseas tax rate, this reduces losses from overseas taxation and outweighs decreases in inbound FDI. Therefore, it is always better to choose deductions, regardless of the relief method used overseas.

This result differs from Janeba (1995), who found that credits and exemptions are no more or less likely to occur than deductions. Here, this is not the case since home and foreign welfares differ across the subgames due to two-way capital flows. Since the welfare effects of inbound versus outbound flows differ, it is not sufficient to consider only one-way or net capital flows. After taking this difference into account, I find that symmetric countries will always be more concerned with their outbound FDI than their inbound FDI, leading to the use of deductions in the tax-capturing regime. This result does mirror those found by Bond and Samuelson (1989) and Mintz and Tulkens (1996), both of whom find that deductions are an optimal policy for a capital exporter. It is instructive to consider the differences behind these similar results. Bond and Samuelson find that a capital exporter would choose deductions over credits or exemptions since the overseas tax rate is smaller under deductions than credits or exemptions. Since in their one-way capital flow model a capital exporter's income is always decreasing in the overseas tax rate, they find that deductions are the most preferred method of double taxation relief. With two-way flows, however, a country's income can be increasing or decreasing in the overseas tax rate. This occurs because although an increase in the overseas tax decreases returns from outbound FDI, it can increase tax revenues from inbound FDI. With symmetric countries, however, the possible losses due to changes in the overseas tax rate are always outweighed by improved taxation of inbound FDI and decreases in outbound FDI. Finally, as discussed in detail in Section 3.3, the Mintz and Tulkens result arises due to discriminatory taxes and the timing of government decisions.

Also unlike Bond and Samuelson, I find that the use of deductions is welfare-reducing since both

countries are worse of in D-D than either the C-C or E-E equilibria. The availability of deductions is a prisoner's dilemma because the dominant relief method makes both countries worse off in equilibrium. Because of this, the OECD model treaty, which prohibits deductions, can improve on this outcome.

Corollary 1: *When countries are symmetric, a tax treaty which proscribes the use of deductions always yields Pareto optimal equilibrium relative effective tax rates.*

Proof: From Proposition 2, recall that credits were preferred to exemptions when facing either credits or exemptions. Therefore C-C is the only subgame perfect Nash equilibrium under a treaty which rules out the use of deductions. In this equilibrium, $t_{cc} = t^*_{cc}$, indicating that $\tau = \tau^* = 0$. Since both relative effective tax rates are zero, both home and foreign capital are efficiently allocated. This is true for both the tax-capturing and the tax-shifting regimes. ***Q.E.D.***

With symmetric countries, the OECD treaty improves the world allocation of capital, as well as the welfare of both countries, relative to the non-treaty equilibrium. This indicates that both countries would be willing to enter into such a treaty. This seems rather remarkable as the treaty does not require coordination of either tax rates or relief methods. This result, however, crucially depends on two-way capital flows. If there were a single capital exporter, the capital exporter would set a zero tax rate in all subgames since a positive tax rate will only lead to excessive capital flows. Janeba's (1995) result would then arise, where credits and exemptions do not improve over deductions. Since the relative effective tax rate would be positive and equal in all subgames, capital flows would be inefficient with or without the treaty. With two-way flows, both countries choose positive tax rates. Under symmetry they choose identical tax rates, which results in socially efficient capital allocations under treaty.

3. Extensions

The above results were determined under the assumptions of symmetry and tax-capturing. It is therefore necessary to test their sensitivity to those assumptions.

3.1. Symmetric, Tax-shifting Regime

In the tax-capturing regime, upward-sloping best responses when using deductions implied that it was always possible to lower the other country's tax rate by responding to deductions with deductions. It also implied that in the D-C and C-D subgames, the equilibrium tax rates would be in pure strategies. In the tax-shifting regime, these need not be true. This introduces complications that expand the set of possible equilibria without a treaty.

Corollary 2: *When countries are symmetric and equilibrium taxes in the D-C subgame are in pure strategies, all subgame perfect Nash equilibria in the tax-shifting regime involve at least one country using deductions. Furthermore, this equilibrium is inefficient.*

Proof: Using a proof identical to that for Proposition 2 shows, I can derive conditions identical to (12) and (13). These imply that a symmetric country will always find credits preferable to exemptions when facing either credits or exemptions. It will also find deductions preferable to credits when facing credits. Thus, all equilibria in double tax rules involve at least one country using deductions. Since τ, τ^*, or both will be non-zero in any equilibrium involving the use of deductions, equilibrium capital flows will be inefficient in at least one direction. ***Q.E.D.***

Two items differentiate this result from Proposition 2. First, since best responses can be downward sloping in the tax-shifting regime, it will now no longer be true that t^*_{dd} is less than either t^*_{ed} or t^*_{cd}. Thus, the chain of inequalities in (14) can fail, indicating that deductions need no longer be a best response to deductions. Second, it requires that equilibrium tax rates in the D-C subgame are in pure

strategies. Note that if this is true for D-C, under symmetry it must be true for C-D. If this condition fails, then home will find itself optimizing against the expected value of t^* rather than its actual value in D-C. Because of this, although similar to (13), $Y_{cc}(t_{cc},t_{cc}^{(}) < Y_{dc}(t_{dc}(E(t_{dc}^{(}),E(t_{dc}^{(})),$ $Y_{dc}(t_{dc}(E(t_{dc}^{(}),E(t_{dc}^{(})) > E(Y_{dc}(t_{dc}(E(t_{dc}^{(})),t_{dc}^{(})).$ This breaks the chain of inequalities in (13), implying that home may prefer to use credits instead of deductions when facing credits. Under symmetry, the same is true for foreign, thus C-C cannot be ruled out as a possible equilibrium even without the treaty. As such, if this added condition fails, Corollary 2 must be modified such that all subgame perfect equilibria involve either deductions by at least one country or credits by both. Note that if C-C is an equilibrium, then it is efficient since both effective tax rates would be zero.

Despite this ambiguity in the unrestricted game, the only equilibrium without the treaty is still the efficient one described by Corollary 1. Now, however, it need not be the case that both countries gain under the treaty. While this is trivially true if the equilibrium without the treaty is C-C, one country's income can fall under the treaty. Suppose for example that the equilibrium double tax rules without the treaty are D-E. In this case imposition of the treaty may benefit foreign at the expense of the home country. Side payments would then be necessary for both countries to agree to the treaty in the tax-shifting regime, despite a higher world income.

3.2. Asymmetric countries

Without loss of generality, label the countries such that when both effective tax rates are zero, $f^s(Z^*) \geq h^s(Z^*)$. This means that foreign overseas production is no less than home overseas production in the absence of tax distortions. When countries differ in either their technologies or their endowments, even in the tax-capturing regime it is difficult to narrow the set of possible equilibria, with or without the treaty. In spite of this, the following result can still be established.

Corollary 3: *Exemptions by both countries cannot be a subgame perfect Nash equilibrium in double tax rules. Furthermore, in the tax-capturing regime, the only subgame perfect Nash equilibrium involving deductions is D-D.*

Proof: In the E-E equilibrium, $\frac{dY(t_{ee}(t'),t'_{ee})}{dt'} = \frac{\beta(1-\tau')\alpha}{(1-t_{ee})(1-t'_{ee})}(t_{ee}-t'_{ee}) > 0$, i.e. home benefits from an increase in the overseas tax rate. By switching to credits, home encourages foreign to tax more aggressively as long as $t > t^*$, since home FDI is now unresponsive to taxes. This implies that in equilibrium $t^*_{ce} > t^*_{ee}$, and that home finds credits preferable to exemptions when facing exemptions. It follows that E-E cannot be a subgame perfect combination of double tax rules, regardless of whether deductions are permitted or not. This is true for both the tax-shifting and tax-capturing regimes. Note that this equilibrium is such that $t_{ee}(t^*) > t^*_{ee}(t)$. If this were not true, then $\tau = \frac{t'_{cc}(t)-t_{cc}(t')}{1-t_{cc}(t')} \geq 0$. From the governments' first-order conditions, this indicates that $(1-\tau)h^{s*}_{\tau>0} - f^{s*}_{\tau'<0} \geq 0$, which, given the assumption that $f^{s*}_{\tau'<0} \geq h^{s*}_{\tau'>0}$, cannot be true.

Similar to symmetric countries in the tax-capturing regime, deductions are always a best response to deductions in the tax-capturing regime. As in the symmetric case, $\partial Y_{dd}(t(t^*), t^*)/\partial t^* = -h^s < 0$. Combining the facts that home prefers deductions over either credits or exemptions for a given foreign tax rate and that $t^*_{dd} = \hat{t}' < min\{t^*_{cd}, t^*_{ed}\}$ reveals that home will respond to deductions with deductions. An analogous story holds for foreign. ***Q.E.D.***

In light of this result, when deductions are prohibited three potential equilibria remain: C-C, C-E, and E-C. Unfortunately, regardless of which of these arises under the treaty, fully efficient capital flows will not be reached.

Proposition 3: *When countries are asymmetric, the OECD model tax treaty will not result in Pareto optimal equilibrium effective tax rates.*

Proof: Given Corollary 3, three potential equilibrium pairs of relief methods remain under the treaty: C-C, C-E, and E-C. One important distinction between the symmetric and asymmetric cases is the equilibrium under C-C. In the symmetric case, both best responses intersected the 45E line because at that point $\tau = \tau^* = 0$, implying that $\alpha(0) = \beta(0)$ and that the country's optimal tax rate was the same from above and below the 45E line. In the asymmetric case, even if $\tau = \tau^* = 0$, it is not generally true that $\alpha(0) = \beta(0)$. This implies that one country's best response will have a jump in it, similar to that in the cases where only one country uses credits. Which reaction function, if any, jumps depends on the relative values of α and β in the absence of tax distortions. On the 45^E line, home's local best response from above is to set $f^{s*}_{\tau('0} = \frac{t}{1\&t}\beta$, while from below home will set $f^{s*}_{\tau('0} = \frac{t}{1\&t}\alpha$. If $\alpha(0) > \beta(0)$, this implies that $t_{cc}(t^*)$ will have a jump at $\underline{t}_{cc}^*$ as in Figure 10. Starting from free factor flows, foreign subsidiary output is more responsive to taxes than is home subsidiary output if $\alpha(0) > \beta(0)$. Because foreign subsidiary output is relatively sensitive to changes in tax rates, a drop in the home tax rate greatly increases inbound FDI which can then be taxed at a slightly lower tax rate. Although inbound FDI tax revenues fall by decreasing t, this decline is relatively slight. At the same time, decreasing t improves home's outbound FDI since now $\tau > 0$. Therefore, home has an incentive to drop its tax rate below foreign's before $t_{cc}(t^*)^*_{t\$*} = t^*$. This same condition implies that $t^*_{cc}(t)$ is kinked as in Figure 10. Foreign's kink occurs because the relatively unresponsive h^s encourages higher foreign taxation. If $\alpha(0) < \beta(0)$, then $t^*_{cc}(t)$ has a jump and $t_{cc}(t^*)$ is kinked. Thus, at most one country uses a mixed strategy in equilibrium. This jump leads to my inability to rule out C-E or E-C as equilibria with or without the treaty. This jump also means that regardless of whether the equilibrium is in pure or mixed strategies, it is such that statutory taxes are not equal even in C-C. Recognizing that in each of these cases the equilibrium in tax rates is such that $t \ldots t^*$, it follows that at least one relative effective tax rate differs from zero. This indicates that capital is inefficiently allocated even under the treaty, and that the equilibrium relative effective tax rates are not Pareto optimal. ***Q.E.D.***

With asymmetric countries, it is still possible to find examples in which both countries gain under the treaty. However, even with the expanded set of possibilities there does not exist an equilibrium where tax rates are equal. This implies that at least one relative effective tax rate is non-zero and world income is not maximized. Therefore there exist Pareto superior tax rate combinations. Furthermore, both countries will not always prefer the equilibrium under the treaty to the D-D equilibrium, which is the only equilibrium ruled out in the tax-capturing regime. This occurs because even if equilibrium world income rises under the treaty, there is no assurance that both countries will share in the gains. Examples where either home or foreign finds D-D preferable to the equilibrium under the treaty are readily calculated. Thus, without side payments, there is in general no reason to anticipate that both countries would be willing to enter into a tax treaty since this eliminates the D-D equilibrium. A similar result is found by Kanbur and Keen (1993), who consider commodity tax competition between a small country and a large trading partner.

Of even greater concern is the potential for world income to fall under the treaty when compared to the D-D equilibrium. Such situations require the existence of equilibria involving mixed strategies in tax rates. Consider the situation illustrated in Figure 10, where home uses a mixed strategy in the C-C equilibrium. At point A, world income is higher under C-C than under D-D since at A, $\tau = 0 < \hat{t}($ and $0 < \tau^* < \hat{t}$. At point B, foreign FDI is efficiently allocated since $\tau^* = 0$, however, home FDI is still inefficiently allocated. In fact, I am unable to rule out the possibility that at B, $\tau > \hat{t}($, implying an increase in the tax distortion for home's FDI. If this additional distortion is large enough, world welfare may be lower under C-C than under D-D. Similar dangers arise under E-C and C-E. Additionally, under the E-C or C-E equilibria the effective tax rate on the exempting country's outbound FDI can be negative yielding a potentially greater distortion than the D-D equilibrium. Combining this distortion with a potentially higher effective tax for the crediting country raises the possibility that the treaty can reduce world income, necessitating the fall in at least one country's income.

Thus, when countries differ, the OECD treaty does not reach fully efficient capital flows and may

not ensure welfare improvements for both participants. However, if I combine the guidelines of the treaty with tax harmonization, both of these difficulties can be overcome.

Proposition 4: *A tax rate harmonizing treaty that rules out the use of deductions can always reach a Pareto optimal pair of relative effective tax rates which increase the income of both asymmetric countries without the need for side payments. This is not true for a tax rate harmonizing treaty that permits the use of deductions.*

Proof: A Pareto optimum requires that both relative effective tax rates are zero. This improves world income over any possible equilibrium outcome in the unrestricted game since in the absence of tax rate coordination, at least one effective tax rate will differ from zero. Under any combination of credits and exemptions, a necessary and sufficient condition for social efficiency is that $t = t^*$. In any combination where at least one country uses deductions, social efficiency is reached if and only if both tax rates are zero. Since tax rates must be equal, Pareto optimal tax coordination is in fact tax harmonization. Denote this common tax rate t^h. The values of home and foreign income under such a treaty will then be:

$$Y^t = h + h^s + t^h(f^s - h^s) \tag{15}$$

and

$$Y^{(t} = f + f^s + t^h(h^s - f^s). \tag{16}$$

When at least one country uses deductions, which implies that t^h is zero, values of both home and foreign income are fixed. Without side payments, it is impossible to guarantee that both $Y(t^h,t^h)$ and $Y^*(t^h,t^h)$ will be greater than their equilibrium values in the unrestricted game. Examples can be calculated where this is the case.

Under any combination of credits or deductions, by increasing t^h, home income is increased (since $f^{s*}_{\tau^*=0} > h^{s*}_{\tau=0}$) and foreign income is decreased. Since both effective tax rates remain constant at

zero, shifting t^h maps out the entire Pareto frontier. This make it possible to always choose t^t such that neither country is worse off under the treaty. ***Q.E.D.***

This result stems from the workings of the various relief methods, and is similar to that found in Janeba (1995). In particular, under combinations of credits and/or exemptions both effective tax rates are zero as long as tax rates are equal. By adjusting the agreed upon tax rate, it is possible to move along the Pareto frontier and find an agreed upon tax rate such that both countries will voluntarily enter into such a treaty. When one or more countries use deductions only one point on the Pareto frontier can be reached, indicating a potential need for side-payments to ensure participation by both countries. Furthermore, by harmonizing taxes, full efficiency can be obtained. This is true for both the tax-shifting regime and the tax-capturing regime. For symmetric countries, although the prohibition of deductions combined with tax harmonization also implies Pareto optimal relative effective tax rates, it is not possible to map out the entire Pareto frontier. With symmetric countries $h^s = f^s$ when $\tau = \tau^* = 0$, eliminating the ability to shift income between home and foreign by altering the harmonized tax rate. In the tax-shifting regime, side payments may still be necessary to ensure mutual acceptance of the treaty by both symmetric countries, even with tax harmonization. It is instructive to contrast this result with Kanbur and Keen (1993), who consider commodity tax competition between a large and a small country. They find that the small country is always made worse off by tax harmonization, however both countries gain by the imposition of an appropriate minimum tax condition. I, on the other hand, find that the small home country as well as the large foreign country can gain by appropriate tax harmonization. Also, although I find that the imposition of an appropriate minimum tax rate can lead to efficient capital allocations, this reduces the flexibility in taxes necessary to ensure improvement in the welfare of both countries, creating the same participation difficulties noted above.

Despite the promise of harmonization, it is not seen in practice. While tax treaties typically do harmonize withholding tax rates, they do not harmonize corporate income taxes, a major component of

effective tax rates. As a result, my findings are perhaps best understood as relating to changes in these non-negotiated tax rates from the OECD model treaty. This suggests tensions or institutional constraints to treaty formation not modeled here. I leave the nature and implications of these constraints for future research.

3.3. Alternative Timing Structures and Discriminatory Taxation

Here, I consider two final variants of the above model. First, if the timing of government decisions is such that countries choose their relief method and tax rates at the same time, D-D is the only equilibrium without the treaty.[18] This is true for both symmetric and asymmetric countries as well as for the tax-shifting and tax-capturing regimes. This occurs because a country will no longer be able to affect its opponent's tax rate through the choice of its own relief method. Therefore it is optimal to choose deductions, which offer superior capital outflows and an increased ability to tax capital inflows. This indicates that equilibrium tax rates will be as they are in D-D. Under the treaty, since credits do at least as well as exemptions given the overseas tax rate, credits are a weakly dominant double tax rule. This leaves C-C as the equilibrium under the treaty. This however does not alter the results of Proposition 3, implying that asymmetric countries may still be reluctant to enter into a treaty lacking tax harmonization.

The second variant of the model alters the assumption of non-discriminatory tax rates. This can be done in three ways, all of which yield the same result. The first allows for a different tax rate based on the location of production. Thus, a country may set one tax rate for domestic and inbound FDI profits and a potentially different tax rate for outbound FDI profits. Alternatively, a country may set a tax rate based on the nationality of capital ownership. Here, a country would set one tax rate for domestically owned capital, regardless of whether it is used at home or abroad, and a separate tax rate for inbound FDI. Finally, the sort of tax flexibility considered in Mintz and Tulkens (1996) may be considered, where a country can set differing tax rates for all three types of production under its tax jurisdiction. In any case,

[18] This is the timing used by Mintz and Tulkens (1996).

such a change would make the debate over credits, deductions, and exemptions irrelevant, since the equilibrium in each case is identical, mirroring Janeba (1995). This result obtains because a country will use one tax rate to maximize tax revenues from inbound FDI while using the other tax rates to set the effective tax on its outbound FDI equal to the overseas tax rate. This is also the result found in Mintz and Tulkens. When both countries do this, the effective and statutory tax rates on inbound FDI are the same as in the D-D case, regardless of the actual double taxation conventions chosen. When countries have this richer tax rate strategy space, they are essentially setting their method of double taxation relief and tax rate on inbound FDI at the same time. Therefore, the D-D result is the only equilibrium for both the tax-capturing and tax-shifting regimes. Furthermore, the OECD treaty would not be able to improve on this situation in the absence of tax rate coordination, for symmetric and asymmetric countries. Since prohibiting deductions will only lead countries to choose tax rates which keep the same effective tax rates as D-D, the welfare of both countries will remain unchanged. This may help to explain the OECD stipulation that tax rates on multinational investment should be non-discriminatory as contained in Article 24 of the model tax treaty (OECD, 1997).

4. Conclusion

In summary, I have found that the consideration of two-way capital flows offers new insights for the performance of the OECD model tax treaty. In particular, with symmetric countries, the treaty always obtains efficient capital flows. Additionally, the treaty always improves the welfare of both participants over a situation in which they both use deductions. When countries differ, it is impossible to guarantee that the OECD model treaty will improve the welfare of both. Of particular concern is the possibility that tax distortions may increase under the treaty. However, if countries can harmonize their tax rates while ruling out deductions, not only can efficient capital flows be reached, but it is possible to do so without injuring either participant. This is not always the case if one or more countries use deductions.

Therefore, the inclusion of the fact that countries act as both home and host for multinational investment provides useful insights for the theory of tax competition as well as for the development of international tax treaties.

Table 1: Inbound and Outbound Capital Positions

Country	Foreign Direct Investment Positions			
	Inbound (billions of $)		Outbound (billions of $)	
	1995	1985	1995	1985
Austria	15.048	3.762	11.142	1.343
Canada	122.684	64.657	103.903	40.947
France	143.670	-	184.380	-
Germany	189.545	22.181	252.928	36.441
Japan	19.848	4.743	296.207	43.974
Korea	-	-	10.500	.484
Netherlands	122.399	24.952	177.766	47.772
United Kingdom	233.077	64.027	331.354	100.313
United States	560.086	184.616	711.621	230.287

Unavailable data is indicated by -.

Source: OECD (1998)

Table 2: List of U.S. Tax Treaties.

Aruba (1986-1996)[1]	India (1990-)	Phillippines (1977-)
Australia (1953-)	Indonesia (1989-)	Poland (1976-)
Austria (1956-)	Ireland (1952-)	Portugal (1994-)
Barbados (1984-)	Israel (1993-)	Romania (1976-)
Belgium (1948-)	Italy (1955-)	Russia (1993-)
Canada (1941-)	Jamaica (1981-)	Trinidad and Tobago (1971-)
China (1985-)	Japan (1954-)	Slovakia (1994-)
Cyprus (1988-)	Kazakstan (1993-)	South Africa (1953-1987, 1997-)[4]
Czech Republic (1995-)	Korea, Republic of (1977-)	Spain (1991-)
Denmark (1948-)	Luxembourg (1963-)	Sweden (1940-)
Egypt (1981-)	Malta (1981-1997)[1]	Switzerland (1951-)
Finland (1952-)	Mexico (1993-)	Tunisia (1986-)
France (1940-)	Morocco (1978-)	Turkey (1997-)
Germany (1954-)[2]	Netherlands (1949-)	Ukraine (1994-)
Greece (1965-)	Netherlands Antilles (1948-1987)[1]	United Kingdom (1945-)
Honduras (1956-1966)[3]	New Zealand (1948-)	U.S.S.R. (1977-1992)[5]
Hungary (1980-)	Norway (1951-)	
Iceland (1976-)	Pakistan (1958-)	

[1] Terminated by the U.S. due to partner's inability to prevent treaty shopping. Treaty shopping is the practice where investment from a third, non-treaty nation is funneled through a treaty partner in order to obtain the preferential tax treatment.

[2] Extended to cover the unified Germany in 1990.

[3] Terminated by Honduras due to its opinion that all treaty benefits were accruing to the U.S. as a result of the almost unilateral nature of capital flows.

[4] Terminated in 1987 as part of the Comprehensive Anti-Apartheid Act of 1987. It was reinstated in 1997.

[5] Treaty provisions extended to former members until individual treaties can be negotiated.

Source: Diamond and Diamond (1998).

Table 3: Home's First-order Condition Under the Various Subgames

		Home uses:		
		deductions	credits	exemptions
Foreign uses:	deductions	$\frac{dY_{dd}}{dt} = f^s - \frac{t}{1-t}\beta$	$\frac{dY_{cd}}{dt} = \begin{cases} f^s - \frac{t}{1-t}\beta & if\ t \geq t^* \\ f^s - \frac{t}{1-t}\beta - \frac{t}{1-t}(1-\tau)\alpha & if\ t < t^* \end{cases}$	$\frac{dY_{ed}}{dt} = f^s - \frac{t}{1-t}\beta - \frac{t}{1-t}(1-\tau)\alpha$
	credits	$\frac{dY_{dc}}{dt} = \begin{cases} f^s - \frac{t}{1-t}\beta & if\ t \geq t^* \\ f^s & if\ t < t^* \end{cases}$	$\frac{dY_{cc}}{dt} = \begin{cases} f^s - \frac{t}{1-t}\beta & if\ t \geq t^* \\ f^s - \frac{t}{1-t}(1-\tau)\alpha & if\ t < t^* \end{cases}$	$\frac{dY_{ec}}{dt} = \begin{cases} f^s - \frac{t}{1-t}\beta - \frac{t}{1-t}(1-\tau)\alpha & if\ t \geq t^* \\ f^s - \frac{t}{1-t}(1-\tau)\alpha & if\ t < t^* \end{cases}$
	exemptions	$\frac{dY_{de}}{dt} = f^s - \frac{t}{1-t}\beta$	$\frac{dY_{ce}}{dt} = \begin{cases} f^s - \frac{t}{1-t}\beta & if\ t \geq t^* \\ f^s - \frac{t}{1-t}\beta - \frac{t}{1-t}(1-\tau)\alpha & if\ t < t^* \end{cases}$	$\frac{dY_{ee}}{dt} = f^s - \frac{t}{1-t}\beta - \frac{t}{1-t}(1-\tau)\alpha$

Figure 1

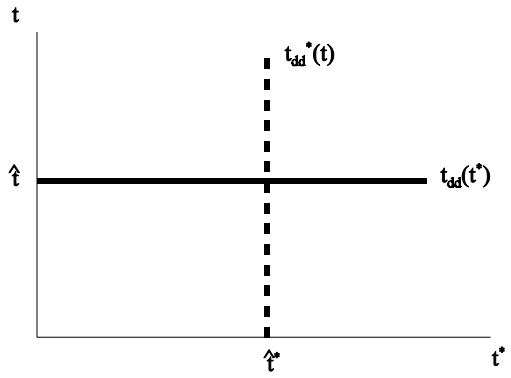


Figure 2

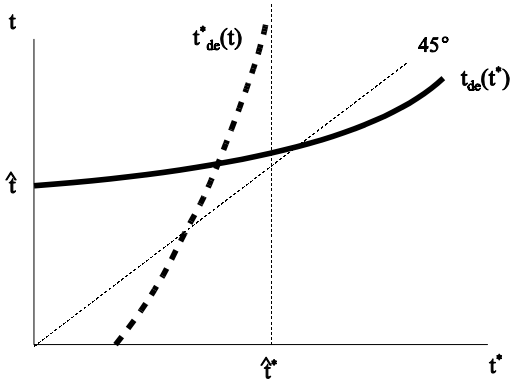


Figure 3

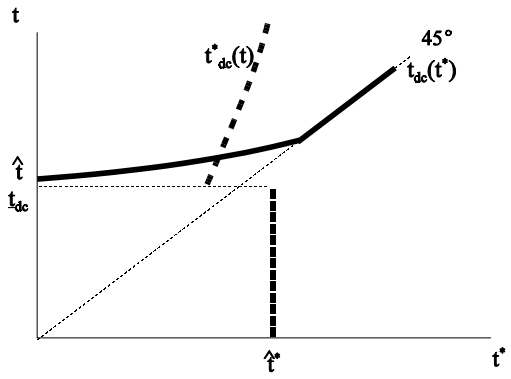


Figure 4

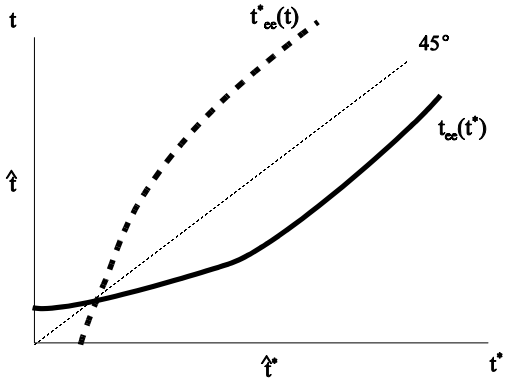


Figure 5

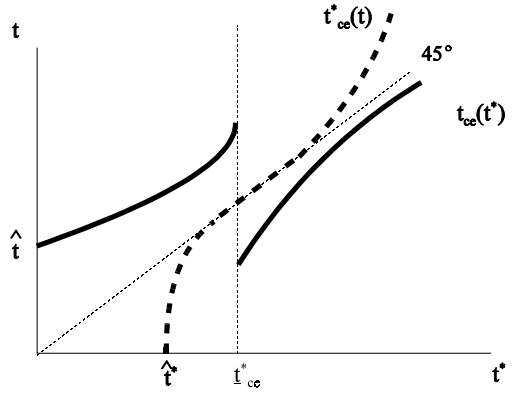


Figure 6 (symmetry)

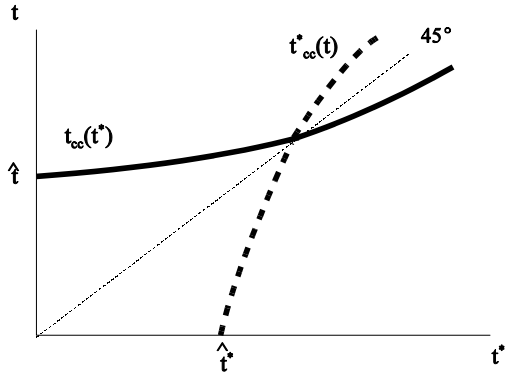


Figure 7

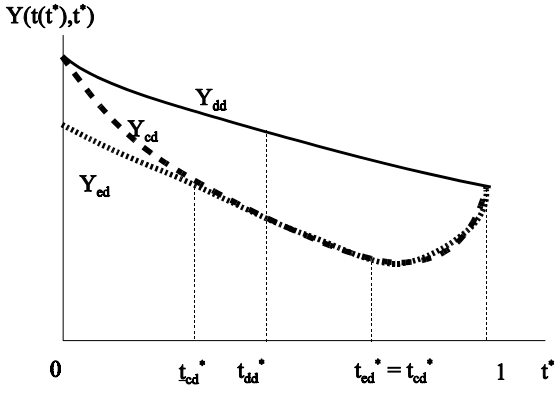


Figure 8

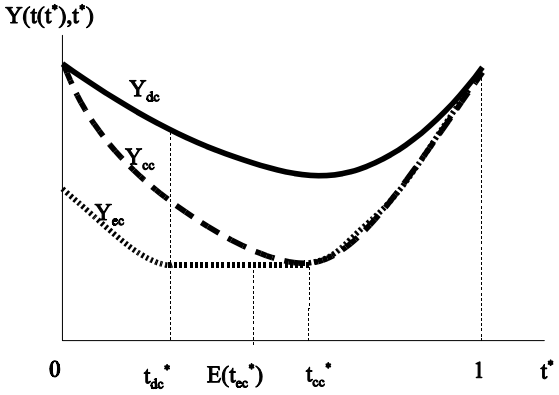


Figure 9

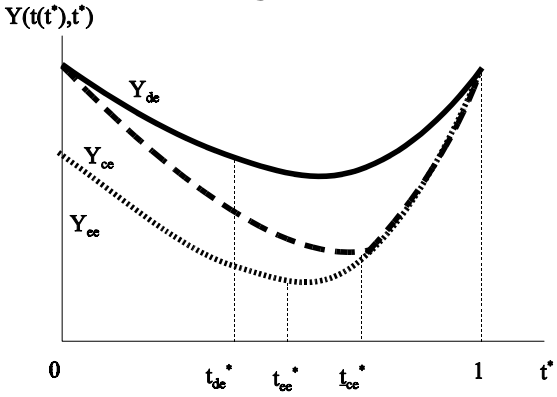
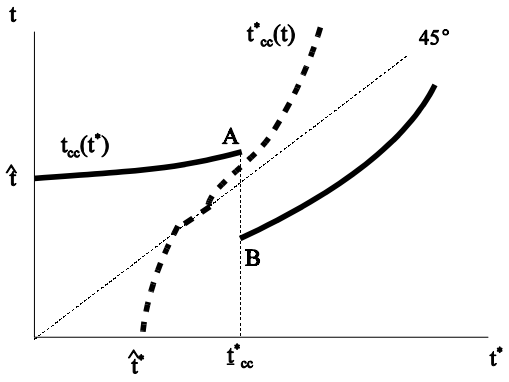


Figure 10 (α > β)



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