International Tax and Public Finance manuscript No.
(will be inserted by the editor)

The choice of commodity tax base in the presence of horizontal foreign direct investment

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Received: date / Accepted: date

Abstract We analyse the choice of commodity tax base when countries set their taxes non-cooperatively in a reciprocal dumping model of homogeneous goods trade with horizontal foreign direct investment (FDI). We show that the consumption base (destination principle) weakly welfare-dominates the production base (origin principle) for a large range of plant fixed costs. When integration is complete, the destination principle dominates the origin principle for all levels of plant fixed costs below which FDI occurs under the origin principle. This contrasts with much of the existing literature which has tended to support the origin principle under imperfect competition with a *fixed* market structure.

Keywords Commodity taxation · Trade · Imperfect competition · Foreign direct investment · Economic integration

JEL Classification F12 · H20

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1 Introduction

Increasing economic integration has made the choice of commodity tax base an important policy issue, especially within the European Union (EU). Generally, internationally traded commodities are taxed according to the *destination principle*, i.e. taxed in the country of consumption. Under the *origin principle* goods are taxed in the country of production. Since administration of the destination principle requires border tax adjustments — with imports being brought under domestic taxation and exports taken out of it — an increase in the movement of goods across borders leads to higher compliance costs and difficulty in enforcement of border tax adjustments. Therefore, in terms of administration costs alone, the origin principle is favourable as barriers to trade fall. Recognizing this, and with the completion of the single market in 1993, the European Commission proposed moving from a value-added tax (VAT) system based on the destination principle to one based on the origin principle. However as a result of political deadlock amongst EU Member States, the European Commission proposed in 2011 that the move to the origin principle be abandoned in favour of a reformed system based on the destination principle. A 1987 proposal on harmonization of the VAT rates also met opposition, and instead a minimum standard rate of 15 per cent was introduced in 1993. Apart from this minimum rate, Member States are free to set their own tax rates. This leads to the possibility that commodity taxation is used strategically in much the same way as tariffs and other trade restrictions could be used before their abolition within the EU.[1] Our focus is on how the resulting commodity tax competition between governments differs under the two tax principles and the implications for welfare.

The innovation of this paper is to introduce a horizontal foreign direct investment (FDI) decision into a model of tax competition with imperfectly competitive firms. Since the early 1980s, the value of sales of foreign affiliates of multinational firms has been larger than that of global exports. According to the United Nations' *World Investment Report 2011*, sales of foreign affiliates in 2008 were US$33.3 trillion whereas exports of goods and non-factor services in the same year were only US$19.8 trillion. Given the significance of FDI in the world economy, it is important to understand how the presence of FDI affects the nature of tax competition and hence welfare. We demonstrate that consumption-based taxation welfare-dominates production-based

[1] There is a large literature on the strategic use of tariffs (e.g. Brander and Spencer 1984), export subsidies (e.g. Brander and Spencer 1985), and other trade policy instruments in oligopolistic industries.

taxation for a large range of investment costs. This finding is in contrast to much of the existing literature which has tended to support the origin principle under imperfect competition with a *fixed* market structure.

A number of papers have used models of imperfect competition to look at the choice of commodity tax base when countries set their taxes noncooperatively.[2] Keen and Lahiri (1998) employ a duopoly model with integrated markets, a homogeneous good, and no transport costs, and show that taxation under the origin principle leads to the first-best outcome when taxes are set non-cooperatively and the firms and countries are symmetric. Haufler et al (2005) focus on the role of trade costs. Using a two-country symmetric reciprocal dumping model of international trade in identical commodities, they find that that the origin principle is Pareto efficient for any level of trade costs when demand is linear. Furthermore, for nonlinear demand and high trade costs the destination principle dominates, while for low trade costs the origin principle dominates, lending some support to the use of the origin principle in more integrated economies. Hashimzade et al (2005) show that the results of Haufler et al (2005) are robust to some degree of product differentiation, and also to differentiated Bertrand competition. Hashimzade et al (2011) introduce country asymmetry in the same model, by allowing for differences in country size and production efficiency. The presence of asymmetries can lead to disagreement between countries over the best tax principle: large countries and inefficient countries prefer the origin principle whereas small countries and efficient countries tend to prefer the destination principle.

Despite the increasing importance of international capital flows, few papers have considered the effects of the choice of tax base on location or entry decisions. Haufler and Pflüger (2004) investigate the welfare implications of the two tax principles in a model with free entry. Using a symmetric two-country model of monopolistic competition with transport costs and international mobility of capital and firms, they find that tax competition under the destination principle will lead to the first-best outcome, while the tax rate under the origin principle deviates from the Pareto efficient level. Behrens et al (2007, 2009) compare the tax principles in a model of monopolistic competition with endogenous location choices and asymmetric country sizes, and find that although tax competition tends to decrease tax revenues under the origin principle compared to the destination principle, the spatial distribution

[2] Under perfect competition, the destination principle is favorable because it warrants production efficiency when countries set different tax rates (see Mintz and Tulkens 1986; Kanbur and Keen 1993) unless terms of trade effects become dominant (Lockwood 1993). See Lockwood (2001) for a detailed survey of cooperative and non-cooperative commodity taxation.

of industry is more equal under the former. Such models lack strategic interaction between firms, and are hard to compare directly to those with Cournot competition. Accordingly, McCracken and Stähler (2010) extend the model of Haufler et al (2005) to allow for free entry. Under the destination principle with a fixed market structure and segmented markets, the two markets are independent (i.e. a tax in one market has no effect on activity in the other market). Free entry creates a link between the markets in the form of entry and exit of firms, leading to quite different results. With free entry, the destination principle dominates the origin principle when trade costs are high or demand is linear. For lower levels of trade costs and non-linear demand, the welfare ranking of the two tax bases is ambiguous.

Given the importance of FDI in serving foreign markets, we extend the model of Haufler et al (2005) in another direction. We allow for the possibility that firms want to engage in trade-cost jumping horizontal FDI by introducing a preliminary location decision to the game. This decision takes the form of whether to build a new plant in the firm's export market at some fixed cost. Firms make their investment decisions *before* the governments set their tax rates. In this respect our model differs from much of the literature on competition for FDI (e.g. Motta and Thisse 1994; Markusen et al 1995; Haufler and Wooton 1999; Beladi et al 1999) where it is most common to assume that the governments make their policy choices before the firms choose their locations. Because of the discrete nature of location choices, there can be an incentive in such models for governments to undercut each other in order to attract FDI. Comparatively few papers (e.g. Hoel 1997; Ulph and Valentini 2001) consider the timing we adopt here where the firms make their location choices first and so take into account the effect their decisions will have on the governments' tax rates. Although the model is symmetric, there is the possibility that the equilibrium distribution of plants is asymmetric with only one firm undertaking FDI. Just as the exogenous asymmetry in countries did in Hashimzade et al (2011), this endogenous asymmetry in plant distribution can lead to disagreements (ex post) about which is the best tax principle. Such disagreements cannot occur in the absence of potential FDI in symmetric models. In contrast to Behrens et al (2009), we find that asymmetry of plant location in equilibrium can only occur under the origin principle because, under the destination principle, the firms' investment decisions are independent.

The paper is organized as follows. Section 2 sets out the basic structure of the model. Sections 3 and 4 analyse the optimal non-cooperative tax rates under the destination principle and origin principle and determine the subgame-perfect equilibria. Section 5 compares the subgame-perfect equilibrium outcomes under the two tax regimes. Section 6 concludes the paper. For expositional clarity, we have relegated most of the mathematical derivations and proofs to the appendix.

2 The model

The model is adapted from De Santis and Stähler (2009). Building on the reciprocal dumping model of Brander (1981) and Brander and Krugman (1983) by adding a preliminary plant location decision, it is similar in structure to Horstmann and Markusen's (1992) model of endogenous market structures. There are two countries, domestic and foreign, with variables for the latter country denoted by an asterisk. There are two goods, X and Z, in each country. The two countries have the same endowment E of the homogeneous good Z, which acts as the numeraire in our model.[3] Countries are identical in size and have the same quasilinear preferences

$$U(X,Z) = u(X) + Z = aX - \frac{bX^2}{2} + Z, \tag{1}$$

where X is the consumption of the oligopolistically produced good. This simple form of preferences allow us to solve the model explicitly. Located in each country is the headquarters of one firm producing good X and earning profits Π. The goods produced by these firms are subject to taxes. Tax revenue is denoted by T and is returned as a lump sum to the representative consumer, whose budget constraint is therefore

$$pX + Z = \Pi + T + E.$$

Maximization of utility (1) subject to the budget constraint gives the domestic inverse demand curve

$$p(X) = a - bX. \tag{2}$$

The appropriate measure of welfare, W, is the indirect utility of the representative consumer. Using (1), (2) and the budget constraint, welfare is the sum of profits, consumer surplus CS, tax revenues and the endowment

$$W = \Pi + CS + T + E.$$

[3] E is large enough that consumption of X is always positive.

Stage 0: A tax principle is agreed upon.
Stage 1: Firms decide whether to be a multinational or national firm.
Stage 2: Governments simultaneously set their tax rates.
Stage 3: Firms compete in a Cournot fashion.

Fig. 1: Game structure

With the linear inverse demand function (2), domestic consumer surplus is given by $bX^2/2$. In what follows we will ignore the term E, because it plays no role in the welfare comparisons.

We will refer to a firm that has only one plant in its home country, and supplies its overseas market through exports, as a *national firm*. A firm with a plant in each country, and supplying each market through the corresponding plant will be called a *multinational firm*.

The timing of the game is described in Figure 1. In stage 0, the countries have agreed to both tax under the destination or the origin principle. Before the countries simultaneously choose their tax rates, the firms choose simultaneously whether to open a plant in the other country. Having firms make their investment decision first is intended to capture the idea that without some way of committing to a tax rate, governments may have an incentive to change the tax rate after firms have located. Firms, recognizing this possibility would then ignore any announced tax rate and make their investment choice based on what the governments would choose if they were to move second. We are assuming here that the firms are not footloose; their investments in plant give them some commitment power.

In order to solve for the subgame-perfect equilibrium of this game, we use backward induction. There are four possible configurations of plant location: one in which both firms are national, another in which both firms are multinational, and two in which one firm is national and the other multinational. We will call the subgames with initial node at stage 2, the *taxation subgames*. First, we proceed by assuming that it is profitable to be in each of the taxation subgames and solve for the subgame equilibrium outputs and tax rates. Finally, we determine the first-stage FDI decisions of the firms by comparing profits in each taxation subgame.

3 Destination principle

First we consider the equilibrium when goods are taxed in the country of consumption. All sales in the domestic market are unstarred, while all sales in the foreign market are starred. A y (starred, or unstarred) denotes sales of a firm in its home market, while an x denotes sales of a firm in its overseas market. Thus y denotes production of the domestic firm for the domestic market while x^* denotes production of the domestic firm for the foreign market. For the foreign firm, y^* denotes its production for the foreign market while x denotes its production for the domestic market. This notation is summarized in Table 1.

Table 1: Notation for domestic and foreign market sales.

	Location of sales	
Firm	Domestic	Foreign
Domestic	y	x^*
Foreign	x	y^*

Clearing of the goods markets requires $X = x + y$ and $X^* = x^* + y^*$. Production at any plant incurs the same constant marginal cost of c, where $c < a$, while exports incur the additional trade cost s per unit. The following assumption on s ensures that exporting takes place under intra-industry trade.

Assumption 1. $s < \frac{2(a-c)}{3}$.

Under the destination principle, goods are taxed in the country of their consumption and so the domestic firm faces the domestic government's choice of specific tax t on its domestic sales, and the foreign government's tax t^* on its sales in the foreign market. A firm faces a fixed cost F to set up its headquarters and home plant, and an additional cost G to open a plant abroad. Markets are segmented so that firms can treat each country as a different market. Profits of national firms under the destination principle are

$$\Pi_n^D = (p - c - t)y + (p^* - c - t^* - s)x^* - F, \tag{3}$$

$$\Pi_n^{D^*} = (p^* - c - t^*)y^* + (p - c - t - s)x - F. \tag{4}$$

When the domestic firm becomes a multinational, it avoids the trade cost for all units sold in the foreign market but must incur the fixed plant cost G. Since goods are taxed where they are consumed, the appropriate tax for the product it sells overseas remains t^*. Thus profits for multinationals are given by

$$\Pi_m^D = (p-c-t)y + (p^*-c-t^*)x^* - F - G, \tag{5}$$

$$\Pi_m^{D^*} = (p^*-c-t^*)y^* + (p-c-t)x - F - G. \tag{6}$$

The fixed cost F is assumed to be small enough such that production of the good is profitable. We will ignore this term in what follows, as it plays no role in the determination of equilibrium or the welfare comparisons. Before we discuss each of the taxation subgames, it is worth pointing out that whatever the location decisions of the firms, the tax base in the domestic (foreign) market is $x+y$ (x^*+y^*). The optimal taxes will however depend on the investment choices of the firms. When a firm becomes a multinational, it avoids the trade costs, and this ultimately affects the balance of the incentives for taxation.

3.1 The intra-industry trade taxation subgame

We begin by examining the equilibrium of the subgame in which neither firm has invested in a new plant, and there is intra-industry trade. In this case, domestic welfare is given by[4]

$$\begin{aligned} W_I^D &= \Pi_I^D + CS_I^D + T_I^D \\ &= (p-c-t)y + (p^*-c-t^*-s)x^* + u(X) - pX + tX, \end{aligned} \tag{7}$$

where the subscript I denotes equilibrium values in the intra-industry trade taxation subgame. To provide some intuition for the incentives of the domestic government when setting its tax, we differentiate the above welfare expression with respect to t:[5]

$$\begin{aligned} \frac{\partial W_I^D}{\partial t} &= (p-c)\frac{\partial y}{\partial t} - x\frac{\partial p}{\partial t} + \frac{\partial tx}{\partial t} \\ &= \frac{1}{9b}[-(a-c+2t+s) - 2(a-c-t-2s) + 3(a-c-2t-2s)], \end{aligned} \tag{8}$$

[4] Note that although this welfare is calculated given the final-stage equilibrium outputs (Appendix A) we have suppressed the tax principle superscript D, and subgame subscript I for ease of readability.

[5] This expression follows because $u'(X) = p(X)$ and under the destination principle, given our assumptions of market segmentation, the domestic tax has no effect on the foreign market.

where the second line uses the expressions for final-stage equilibrium output (see Appendix A).

Since many of the effects are just transfers between consumers and firms, we are left with just three terms. The first is the domestic production efficiency effect, which is present even in a closed economy, and measures the increase in efficiency as domestic production of goods whose price exceeds marginal cost increases; the second is the terms of trade effect which measures the rise in welfare when the price the domestic country pays for imports falls; the third is the tax revenue effect which represents the incentive to tax the foreign firm's exports.[6]

Setting (8) equal to zero yields the nationally optimal destination principle tax rate $\hat{t}_I^D$. By symmetry, the optimal tax rate for the foreign government $\hat{t}_I^{D*}$ is identical. The optimal taxes are given by

$$\hat{t}_I^D = \hat{t}_I^{D*} = \frac{1}{6}[\underbrace{-(a-c+s)}_{\text{(I),(-)}}\underbrace{-2(a-c-2s)}_{\text{(II),(-/+)}}\underbrace{+3(a-c-2s)}_{\text{(III),(+/-)}}] = -\frac{s}{2}. \tag{9}$$

We identify the three incentives: (I) is the domestic production efficiency incentive; (II) is the terms of trade incentive; (III) is the tax revenue incentive. The domestic production efficiency incentive always favours a subsidy to increase production of the good. When trade costs are zero, the three effects exactly cancel. When trade costs are small the terms of trade incentive is negative, while the tax revenue incentive is positive. Together (I) and (III) represent profits shifted from the foreign firm to the domestic country. This is the well-known profit-shifting incentive identified by Brander and Spencer (1985) when analysing export subsidies and other trade policy instruments.[7] The balance of incentives is such that for all positive levels of trade costs the optimal tax is negative.

Given the optimal tax rates, the equilibrium profits and welfare when intra-industry trade takes place under the destination tax regime are

$$\begin{aligned} \hat{\Pi}_I^D = \hat{\Pi}_I^{D*} &= \frac{4(a-c)^2+9s^2}{18b}, \\ \hat{W}_I^D = \hat{W}_I^{D*} &= \frac{8(a-c)^2-3s[2(a-c)-3s]}{18b}. \end{aligned} \tag{10}$$

[6] There is no effect on the export price, because with segmented markets and a fixed market structure the tax affects production only in the domestic market.

[7] In particular, the decomposition in (8) corresponds to the decomposition in equation (4.12) of the welfare effects of a tariff in Brander (1995).

3.2 The bilateral FDI taxation subgame

When both firms invest in a new plant and become multinationals, profits for the domestic and foreign firm are given by expressions (5) and (6) respectively. Apart from the absence of trade costs and the firms incurring an extra fixed cost, the bilateral FDI subgame equilibrium is identical to the intra-industry trade equilibrium. Modifying (9) and (10) accordingly gives the equilibrium tax rates $\hat{t}_B^D = \hat{t}_B^{D*} = 0$, and the profits and welfare in the bilateral FDI equilibrium:

$$\hat{\Pi}_B^D = \hat{\Pi}_B^{D*} = \frac{2(a-c)^2}{9b} - G, \tag{11}$$
$$\hat{W}_B^D = \hat{W}_B^{D*} = \frac{4(a-c)^2}{9b} - G.$$

3.3 The unilateral FDI taxation subgame

Finally, we examine the taxation subgame in which the first-stage choices of the domestic and foreign firm are different. In finding the equilibrium, we assume that it is only the foreign firm that has invested in a new plant. The results of the previous two sections can be used to find the optimal tax rates. The domestic market looks the same as under bilateral FDI, with it being served by two plants located in the domestic country. Since the segmented markets assumption renders the two markets independent, the domestic government's optimal tax rate is identical to that under bilateral FDI, i.e. $\hat{t}_U^D = 0$. Similarly, the foreign market looks the same as under intra-industry trade, so the foreign government's optimal tax rate is $\hat{t}_U^{D*} = -s/2$. Profits and welfare in the unilateral FDI equilibrium are

$$\hat{\Pi}_U^D = \frac{8(a-c)^2 - 3s[4(a-c)-3s]}{36b}, \tag{12}$$
$$\hat{\Pi}_U^{D*} = \frac{8(a-c)^2 + 3s[4(a-c)+3s]}{144b} - G,$$
$$\hat{W}_U^D = \frac{16(a-c)^2 - 3s[4(a-c)-3s]}{36b}, \qquad \hat{W}_U^{D*} = \frac{16(a-c)^2 + 9s^2}{36b} - G.$$

3.4 Subgame-perfect equilibrium

Having found the equilibria of the taxation subgames and calculated the equilibrium profits, we turn to the first-stage choice of firm FDI.[8] In Figure 2 we present the payoff matrix for the first-stage investment choice given the equilibrium profits in each of the taxation subgames. The profits referred to in the payoff matrix are given by expressions (10), (11), and (12).

		Foreign firm	
		No FDI	FDI
Domestic firm	No FDI	$\hat{\Pi}_I^D, \hat{\Pi}_I^{D*}$	$\hat{\Pi}_U^D, \hat{\Pi}_U^{D*}$
	FDI	$\hat{\Pi}_U^{D*}, \hat{\Pi}_U^D$	$\hat{\Pi}_B^D, \hat{\Pi}_B^{D*}$

Fig. 2: Destination principle, stage 1 payoff matrix

If the domestic firm is not conducting FDI, the foreign firm has an incentive to invest in a new plant only if its profit from doing so (12) is greater than its profit in the intra-industry trade equilibrium (10). These profits are the same when G is equal to

$$G^D = \frac{s[4(a-c)-3s]}{12b}.$$

The domestic firm will also prefer to undertake investment if profits in the bilateral FDI equilibrium (11) are higher than profits for it in the unilateral FDI equilibrium (12). Profits for the domestic firm in the two subgames are equal when $G = G^D$. This demonstrates that for plant fixed costs below G^D, FDI is the dominant strategy while for higher G, no FDI is the dominant strategy.

Proposition 1. *The subgame-perfect equilibrium plant configurations are as follows.*

(i) If $G < G^D$, then there will be bilateral FDI.
(ii) If $G > G^D$, then there will be intra-industry trade.

Although when $G < G^D$ both firms have a dominant strategy to invest — and so bilateral FDI is the unique equilibrium — both firms would be better

[8] We only consider pure strategy equilibria.

off if they could agree to refrain from investing. For such levels of plant fixed cost, the location game that the firms play in the first stage is a form of the classical prisoners' dilemma. There are three effects that the foreign firm has to take into account when it decides whether to become a multinational. First, there is a direct cost saving from avoiding s but this is counteracted somewhat by the second effect — the domestic government responds to the investment by withdrawing its subsidy of $s/2$. The net cost saving of becoming a multinational is then $s/2$ per unit. The third effect is that the domestic firm also no longer receives a subsidy. FDI has two benefits for the investor — it is cost saving and it raises the rival's costs. When trade costs are zero, these effects are no longer present and FDI cannot occur for any level of fixed cost.

Given the foreign firm has invested, the incentives for the domestic firm are exactly the same. The segmented markets assumption means that under the destination principle, the tax rate and output choices in the domestic (foreign) market are independent of the domestic (foreign) firm's investment choice. This makes the investment choices of the two firms independent. Furthermore, because of the symmetry of firms and countries, when it is profitable for one firm to investment, it is also profitable for the other. This is true for any form of inverse demand for which there is a unique symmetric equilibrium in each of the taxation subgames. This result is presented in Proposition 2, the proof of which is in Appendix A.

Proposition 2. *When countries and firms are symmetric, markets are segmented and goods are taxed under the destination principle, if one firm finds it profitable to conduct FDI, then the other will also find it profitable.*

4 Origin principle

We now turn to the case of production based taxation. Under the origin principle, production is taxed by the country in which output is produced. Thus the profits of national firms are

$$\Pi_n^O = (p-c-t)y + (p^*-c-t-s)x^* - F, \tag{13}$$

$$\Pi_n^{O*} = (p^*-c-t^*)y^* + (p-c-t^*-s)x - F, \tag{14}$$

and of multinational firms:

$$\Pi_m^O = (p-c-t)y + (p^*-c-t^*)x^* - F - G, \tag{15}$$

$$\Pi_m^{O*} = (p^*-c-t^*)y^* + (p-c-t)x - F - G. \tag{16}$$

In contrast to the destination principle, each government's tax base depends on the location decisions of the firms. If both firms are national firms, then the tax base for the domestic government is $x^* + y$; if both firms are multinationals then the tax base is $x + y$; if only the foreign firm is a multinational, then the tax base is $x + y + x^*$; and if only the domestic firm is a multinational, then the tax base is y. Note that because a multinational firm produces all its output where it is sold, the profit expressions of multinational firms under the origin principle are the same as under the destination principle, so that the bilateral FDI equilibria will be the same.

In their paper, De Santis and Stähler (2009), solve a version of this model in the context of environmental regulation. Under the origin principle, the only difference between that model and the one under consideration here is the existence of pollution. Thus the subgame-perfect equilibrium under the origin principle can be found by setting the marginal disutility of pollution to zero in their results. We present only the analysis of the unilateral FDI subgame. The equilibrium welfare and profits for the other subgames, along with all the final-stage equilibrium outputs, are provided in Appendix B.

4.1 The unilateral FDI taxation subgame

Suppose the foreign firm invests but the domestic firm does not. Under the resulting plant configuration, the foreign government's tax applies only to the foreign firm's production for the foreign market. Differentiating foreign welfare we have

$$\frac{\partial W_U^{O*}}{\partial t^*} = (p^* - c)\frac{\partial y^*}{\partial t^*} - x^* \frac{\partial p^*}{\partial t^*}. \tag{17}$$

If the domestic firm's exports are positive, the foreign government has to take account of the production efficiency and terms of trade effects, both of which call for a subsidy. When the domestic firm does not export, the foreign government has to correct only the monopoly distortion — this is achieved by a subsidy such that the monopolist prices at marginal cost. It turns out (see Appendix B) that, regardless of the export status of the domestic firm, the optimal tax rate for the foreign government is $\hat{t}_U^{O*} = -(a - c)$.

The domestic government's tax applies to all the domestic firm's production, as well as the foreign firm's production in its plant located in the domestic country. We differentiate domestic welfare to obtain

$$\frac{\partial W_U^O}{\partial t} = (p-c)\frac{\partial y}{\partial t} + (p^* - c - s)\frac{\partial x^*}{\partial t} + \left(x^*\frac{\partial p^*}{\partial t} - x\frac{\partial p}{\partial t}\right) + \frac{\partial tx}{\partial t}. \tag{18}$$

The effects from left to right are: the domestic production efficiency effect, export production efficiency effect, terms of trade effect and the tax revenue effect. The following lemma (which corresponds to Lemma 2 of De Santis and Stähler 2009) demonstrates an important difference in the effect of the noncooperative tax rates under the origin and destination principles.

Lemma 1. *Under the origin principle the national firm does not export at any level of trade costs in the equilibrium of the unilateral FDI subgame.*

The proof (see Appendix B) demonstrates that the domestic firm would need to receive a subsidy, $t < -s$, from the domestic government in order for its exports to compete with the heavily subsidized foreign firm's output. However, the domestic government has no incentive to provide this subsidy. The domestic production efficiency effect, the 'import' component of the terms of trade effect ($-x\partial p/\partial t$), and the tax revenue effect together call for a zero tax rate. Also, given the foreign government is providing a large subsidy on its firm's domestic output, the foreign price is so low that the export production efficiency effect and 'export' component of the terms of trade effect ($x^*\partial p^*/\partial t$) together are positive for any tax $t < -s$, implying that welfare would be increased by raising the tax rate and driving the domestic firm's exports to zero.

When the domestic firm does not export, the incentives for the domestic government are exactly the same as when bilateral FDI occurs under the origin or destination principles because we have two firms producing in the domestic market and being taxed by the domestic government. The optimal domestic tax rate is thus $\hat{t}_U^O = 0$. Profits and welfare in the unilateral FDI equilibrium are

$$\hat{\Pi}_U^O = \frac{(a-c)^2}{9b}, \qquad \hat{\Pi}_U^{O*} = \frac{10(a-c)^2}{9b} - G, \tag{19}$$
$$\hat{W}_U^O = \frac{(a-c)^2}{3b}, \qquad \hat{W}_U^{O*} = \frac{11(a-c)^2}{18b} - G.$$

In equilibrium, each firm has half the usual Cournot duopoly profits in the domestic market, while the foreign firm also makes a profit equal to that of a first-best subsidized monopoly in the foreign market.

4.2 Subgame-perfect equilibrium

The foreign firm has an incentive to invest in a new plant unilaterally only if profits when it does so (19) are greater than profit in the intra-industry trade equilibrium (B.1). These profits are equal when plant fixed costs are given by

$$G_1^O = \frac{[22(a-c)-15s][2(a-c)+3s]}{72b}.$$

The domestic firm would also like to invest if its profits in the bilateral FDI equilibrium (B.2) are larger than in the unilateral FDI equilibrium (19). The firm is indifferent when

$$G_2^O = \frac{(a-c)^2}{9b}.$$

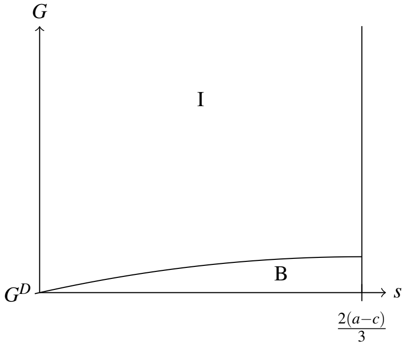
The following proposition summarizes these results and is illustrated in Figure 3b.

Proposition 3. *The subgame-perfect equilibrium plant configurations are as follows.*

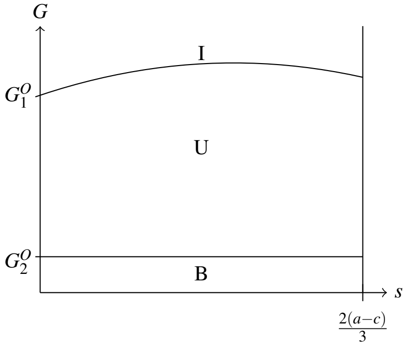
(i) If $G < G_2^O$, then there will be bilateral FDI.
(ii) If $G_2^O < G < G_1^O$, then there are two asymmetric equilibria in which one firm sets up a plant in the other country and the other firm does not.
(iii) If $G > G_1^O$, then there will be intra-industry trade.

When the foreign firm is making its investment decision, given that the rival is a national firm, there are four effects to consider. First, there is the trade cost saving of s per unit on production for its overseas market. Second, when the foreign firm invests it no longer receives a subsidy on its production for abroad. If s is large, then the net effect represents a cost saving; if s is small, then it is cost raising.[9] Third, the foreign firm knows that if it invests, the domestic government will set a tax rate which makes exporting unprofitable for the domestic firm and so enable the foreign firm to act as a monopolist in its domestic market. The size of this effect decreases as trade costs increase, because higher trade costs confer more market power on the foreign firm's production for its own market under intra-industry trade (at the extreme, when trade costs are prohibitive, the domestic firm does not export and the foreign firm is effectively a monopolist in its home market). Finally,

[9] The lost subsidy is $\hat{t}_U^O - \hat{t}_I^O = [2(a-c)-s]/4$, so that the net effect is to change per-unit costs by $[2(a-c)-5s]/4$.



(a) Destination principle



(b) Origin principle

Fig. 3: Equilibrium plant configurations (I: Intra-industry trade, U: Unilateral FDI, B: Bilateral FDI)

the domestic firm's costs are raised by the withdrawal of the domestic government's subsidy.

Now consider the incentives for the domestic firm to conduct FDI once the foreign firm has already invested. The domestic firm is not exporting in the unilateral FDI equilibrium and setting up a plant in the foreign country allows it to capture half of the total duopoly profits. In its own market, the tax rate does not change and there is no change in profits. So, when making a decision to invest, the domestic firm simply weighs the gain in profits from production in its new plant against the cost of that plant.

In contrast to the destination principle, the investment incentives depend on whether the other firm has invested or not. In particular the critical level of plant fixed cost G_1^O is a function of the trade costs, while G_2^O is not. As under the destination principle, when plant fixed costs are small ($G < G_2^O$), the firms are subject to a prisoners' dilemma — they would prefer intra-industry trade to the bilateral FDI equilibrium, but they have a dominant strategy to invest.

5 Comparison of tax principles

In this section we compare the equilibrium outcomes under the two tax principles. First we compare profits under the two tax regimes.

Proposition 4.

(i) *If $G < G^D$, then profits are the same for both firms under both tax principles.*
(ii) *If $G^D < G < G_2^O$, then profits are higher for both firms under the destination principle.*
(iii) *If $G_2^O < G < G_1^O$, then profits are higher for the national firm under the destination principle, while profits are higher for the multinational firm under the origin principle.*
(iv) *If $G_1^O < G$, then profits are higher for both firms under the origin principle.*

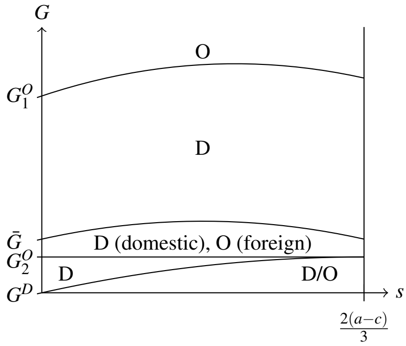
For $G^D < G < G_2^O$, because of the prisoners' dilemma facing the firms under the origin principle when making their investment choice, profits are low in comparison to those in the intra-industry trade equilibrium under the destination principle. When $G_2^O < G < G_1^O$, the firm that is a national firm in the unilateral FDI equilibrium under the origin principle does not export and earns low profits, while the multinational is a subsidized monopoly in its home market and earns high profits. For $G > G_1^O$, there is no FDI. Under the destination principle each government's tax applies to production by both the domestic and foreign headquartered firms. While the domestic government has an incentive to subsidize the domestic firm's domestic output in order to correct the inefficiently low level of output, there is a counteracting incentive to tax the foreign firm's output for the domestic market.[10] However, under the origin principle, each government's tax falls only on its own firm's production, and there is no counteracting incentive for a positive tax. Therefore, both firms receive a larger subsidy under the origin principle than under the destination principle, and so both earn higher profits.

The main difference between the two tax principles' effects on location decisions is the absence of the unilateral FDI equilibrium under consumption-based taxation. The following two propositions compare welfare under the two regimes. Before we present the next proposition we introduce the critical level of plant fixed cost,

$$\bar{G} = \frac{(a-c-s)(a-c+3s)}{6b}.$$

Proposition 5.

[10] The balance of the terms of trade and tax revenue incentives identified in (9) is positive when trade costs are not too high, i.e. $s < (a-c)/2$.



(a) Country (b) World

Fig. 4: Dominant tax principle (assuming the foreign-owned firm is the multinational under unilateral FDI)

(i) If $G < G^D$, then welfare is the same in both countries under both tax principles.
(ii) If $G^D < G < G_2^O$, then welfare is higher in both countries under the destination principle.
(iii) If $G_2^O < G < \bar{G}$, then welfare is higher in the domestic country under the destination principle, while welfare is higher in the foreign country under the origin principle.[11]
(iv) If $\bar{G} < G < G_1^O$, then welfare is higher in both countries under the destination principle.
(v) If $G_1^O < G$, then welfare is higher in both countries under the origin principle.

Proposition 5 is illustrated in Figure 4a. When plant fixed costs are sufficiently low ($G < G^D$) there is bilateral FDI in equilibrium, and both tax principles are equivalent. However, because of the prisoners' dilemma faced by the firms under the origin principle (but not under the destination principle) when G is such that there is bilateral FDI under the origin principle but intra-industry trade under the destination principle (i.e. $G^D < G < G_2^O$), welfare is higher under the latter.

[11] Assuming the foreign-owned firm is the multinational in the unilateral FDI equilibrium under the origin principle.

Part (iii) is particularly interesting, because it shows there is the potential for countries to disagree (ex post) over the best tax principle even if the countries and firms are ex ante symmetric. For trade costs $G_2^O < G < G_1^O$, there is unilateral FDI under the origin principle and intra-industry trade under the destination principle. The reason for the difference in welfare rankings in (iii) is most easily seen by considering the case where trade costs are zero. In this case the domestic market looks exactly the same under unilateral FDI as under intra-industry trade. However, when there is unilateral FDI the foreign market is served by a first-best subsidized monopolist, while under intra-industry trade there is a duopoly. This ability to implement the first-best in the foreign market under the origin principle leads to high welfare in the foreign country relative to the destination principle as long as the cost of the foreign firm's domestic plant is relatively low ($G_2^O < G < \bar{G}$). On the other hand, under the origin principle, the domestic country misses out on profits from exporting, and so always prefers the destination principle.

Finally, part (v) is a restatement of a result from Haufler et al (2005) that for the special case of linear demand, the origin principle is Pareto efficient under intra-industry trade and so dominates the destination principle. Their results show that the origin principle remains Pareto efficient for nonlinear demand if integration is complete ($s = 0$), but for intermediate levels of trade costs and nonlinear demand it may be that the destination principle dominates.

Given the difference in welfare ranking for plant fixed costs $G_2^O < G < \bar{G}$, it is natural to look at which principle leads to a higher combined welfare. Before presenting the proposition comparing combined welfare, we introduce a further critical level of plant fixed cost,

$$\breve{G} = \frac{(a-c)^2 + 6s[2(a-c) - 3s]}{18b}.$$

Proposition 6.

(i) If $G_2^O < G < \breve{G}$, then world welfare is higher under the origin principle.
(ii) If $\max\{G_2^O, \breve{G}\} < G < G_1^O$, then world welfare is higher under the destination principle.[12]

Proposition 6 is illustrated in Figure 4b. We see that for $G_2^O < G < \breve{G}$ there is the potential for the foreign country, in which the multinational is headquartered, to compensate the domestic country so that welfare is higher for both countries under the origin principle. For these relatively low plant fixed costs,

[12] Note that $G_2^O \leq (>) \breve{G}$ if $s \in (\notin) [\frac{1}{6}(a-c)(2-\sqrt{2}), \frac{1}{6}(a-c)(2+\sqrt{2})]$.

the combined welfare is relatively high because the foreign monopoly in the unilateral FDI equilibrium is producing at the first-best level. However, as plant fixed costs increase, this welfare gain is eventually outweighed so that for larger fixed costs $\max\{G_2^O, \breve{G}\} < G < G_1^O$ the destination principle leads to higher combined welfare. Notice, in particular, that when integration is complete ($s = 0$) combined welfare is higher under the destination principle for all fixed costs $G < G_1^O$. Except for a small range of intermediate and for very large plant fixed costs (for which FDI is then not an important factor), the destination principle leads to higher combined welfare levels.

6 Concluding remarks

Despite the importance of FDI, it has largely been neglected in the existing literature on the choice between origin and destination principle. The main contribution of this paper was to introduce FDI in a model of tax competition and study the consequences for welfare. In terms of overall welfare, the destination principle was found to weakly dominate the origin principle for most trade costs and plant fixed costs such that at least one firm undertakes FDI in equilibrium. Our results lend some support to the use of the destination principle when there is the potential for FDI. This is in contrast to a result of Haufler et al (2005) — whose model is identical to ours other than excluding FDI — that the origin principle is Pareto efficient for all levels of trade costs when demand is linear.

We also showed that there can be disagreement (ex post) over the preferred tax principle because of the potential for an asymmetric equilibrium distribution of plants under the origin principle but not under the destination principle. Asymmetry of plant location cannot happen under the destination principle because the incentives for a firm to invest are the same whether or not the other firm has invested. When asymmetry of plants occurs under the origin principle — with two plants in the domestic country and one in the foreign country — there is a strong incentive for the foreign country to provide a large subsidy to the firm headquartered in its country, while on the other hand the domestic country has little incentive to subsidize the foreign-headquartered firm's domestic plant production for the domestic market. This drives the domestic firm's exports to zero, so that profits and welfare in the domestic country are small compared to under the destination principle. The range of plant costs for which there is disagreement over tax principles is highest for intermediate trade costs; it is lowest when integration is complete or trade costs are near prohibitive.

The symmetry of plant location under the destination principle would not be affected if product differentiation under quantity or price competition were introduced, because the argument of Proposition 2 would still hold. The fundamental difference between the tax principles remains: given the assumption of segmented markets, the two markets and thus the firms' investment decisions are independent under the destination principle, whereas under the origin principle these decisions are interdependent. The symmetry of the model then ensures that under the destination principle both firms make the same investment decision in equilibrium. We expect that the welfare rankings under differentiated quantity competition would be qualitatively similar to those in the homogeneous good case. However it may be that the welfare rankings change under price competition. This is a subject for future research.

Acknowledgements Thanks to Frank Stähler for pointing me in the right direction in the early stages of this paper. Thanks also to Martin Richardson, Chris Jones, José Rodrigues-Neto, participants at the Brown Bag seminar in the Research School of Economics ANU, and two anonymous referees for their helpful comments and suggestions. All remaining errors are my own.

Appendix

A Destination principle (DP)

Intra-industry trade

Using (2), (3) and (4) the first order conditions for profit maximization imply that outputs in the intra-industry trade equilibrium are as follows

$$y_I^D = \frac{a-c-t+s}{3b}, \quad x_I^D = \frac{a-c-t-2s}{3b}, \quad y_I^{D*} = \frac{a-c-t^*+s}{3b}, \quad x_I^{D*} = \frac{a-c-t^*-2s}{3b}.$$

Bilateral FDI

From (2), (5) and (6), maximization of profits gives us the following equilibrium output levels

$$x_B^D = y_B^D = \frac{a-c-t}{3b}, \qquad x_B^{D*} = y_B^{D*} = \frac{a-c-t^*}{3b}.$$

Unilateral FDI

Under unilateral FDI, the domestic market is the same as under bilateral FDI, while the foreign market is the same as under intra-industry trade, so that

$$x_U^D = y_U^D = \frac{a-c-t}{3b}, \qquad y_U^{D*} = \frac{a-c-t^*+s}{3b} \qquad x_U^{D*} = \frac{a-c-t^*-2s}{3b}.$$

To check that these outputs are positive in equilibrium, note that substitution of the optimal tax rates $\hat{t}_I^{D*} = \hat{t}_U^{D*} = -s/2$ and $\hat{t}_B^{D*} = \hat{t}_U^D = 0$ into the relevant output expressions above shows that we require $s < \frac{2(a-c)}{3}$ for them all to be positive. This is Assumption 1.

Proof of Proposition 2. Consider any inverse demand function $p(X)$ for which a unique equilibrium exists in each of the taxation subgames. Suppose it is profitable for the foreign firm to undertake FDI given the domestic firm has not. Then

$$\begin{aligned}\hat{\Pi}_U^{D*} - \hat{\Pi}_I^{D*} &= (\hat{p}_U^* - c - \hat{t}_U^*)\hat{y}_U^* + (\hat{p}_U - c - \hat{t}_U)\hat{x}_U - G \\ &\quad - [(\hat{p}_I^* - c - \hat{t}_I^*)\hat{y}_I^* + (\hat{p}_I - c - \hat{t}_I - s)\hat{x}_I] \\ &= (\hat{p}_U - c - \hat{t}_U)\hat{x}_U - G - (\hat{p}_I - c - \hat{t}_I - s)\hat{x}_I > 0,\end{aligned}$$

where the second line follows from the fact that, because markets are segmented, $\hat{p}_U^* = \hat{p}_I^*$, $\hat{t}_U^* = \hat{t}_I^*$, $\hat{y}_U^* = \hat{y}_I^*$ and $\hat{x}_B^* = \hat{x}_U^*$. Now consider the domestic firm's decision. The domestic firm will also invest if

$$\begin{aligned}\hat{\Pi}_B^D - \hat{\Pi}_U^D &= (\hat{p}_B - c - \hat{t}_B)\hat{y}_B + (\hat{p}_B^* - c - \hat{t}_B^*)\hat{x}_B^* - G \\ &\quad - [(\hat{p}_U - c - \hat{t}_U)\hat{y}_U + (\hat{p}_U^* - c - \hat{t}_U^* - s)\hat{x}_U^*] \\ &= (\hat{p}_B^* - c - \hat{t}_B^*)\hat{x}_B^* - G - (\hat{p}_U^* - c - \hat{t}_U^* - s)\hat{x}_U^* > 0,\end{aligned}$$

where the second equality follows because the segmented markets assumption implies there is no change in the domestic market equilibrium price, tax or output: $\hat{p}_B = \hat{p}_U$, $\hat{t}_B = \hat{t}_U$, and $\hat{y}_B = \hat{y}_U$. Furthermore, because of symmetry, it must be that $\hat{p}_B^* = \hat{p}_B$, $\hat{t}_B^* = \hat{t}_B$, $\hat{x}_B^* = \hat{x}_B$, $\hat{p}_I^* = \hat{p}_I$, $\hat{t}_I^* = \hat{t}_I$ and $\hat{x}_I^* = \hat{x}_I$. But then symmetry together with the market segmentation assumption implies that $\hat{p}_B^* = \hat{p}_U$, $\hat{t}_B^* = \hat{t}_U$, $\hat{x}_B^* = \hat{x}_U$, $\hat{p}_U^* = \hat{p}_I$, $\hat{t}_U^* = \hat{t}_I$ and $\hat{x}_U^* = \hat{x}_I$. It then follows that

$$\hat{\Pi}_B^D - \hat{\Pi}_U^D = (\hat{p}_U - c - \hat{t}_U)\hat{x}_U - G - (\hat{p}_I - c - \hat{t}_I - s)\hat{x}_I > 0 \qquad \square$$

B Origin principle (OP)

Intra-industry trade

Using (2), (13) and (14), profit maximization gives:

$$\begin{aligned} y_I^O &= \frac{a-c-2t+t^*+s}{3b}, \quad & x_I^O &= \frac{a-c-2t^*+t-2s}{3b}, \\ y_I^{O*} &= \frac{a-c-2t^*+t+s}{3b}, \quad & x_I^{O*} &= \frac{a-c-2t+t^*-2s}{3b}. \end{aligned}$$

Equilibrium taxes are $\hat{t}_I^O = \hat{t}_I^{O*} = -(2(a-c)-s)/4 < 0$, while profit and welfare levels are

$$\hat{\Pi}_I^O = \hat{\Pi}_I^{O*} = \hat{W}_I^O = \hat{W}_I^{O*} = \frac{4(a-c)^2 - s[4(a-c)-5s]}{8b}. \tag{B.1}$$

Bilateral FDI

The equilibrium is identical to the bilateral FDI equilibrium under DP:

$$x_B^O = y_B^O = \frac{a-c-t}{3b}, \qquad x_B^{O*} = y_B^{O*} = \frac{a-c-t^*}{3b}.$$

Equilibrium taxes are $\hat{t}_B^O = \hat{t}_B^{O*} = 0$, while profit and welfare levels are

$$\hat{\Pi}_B^O = \hat{\Pi}_B^{O*} = \frac{2(a-c)^2}{9b} - G, \qquad \hat{W}_B^O = \hat{W}_B^{O*} = \frac{4(a-c)^2}{9b} - G. \tag{B.2}$$

Unilateral FDI

Using (2), (13) and (16), the equilibrium outputs in the domestic market are

$$x_U^O = y_U^O = \frac{a-c-t}{3b}. \tag{B.3}$$

If the domestic firm exports, the equilibrium output levels in the foreign market are

$$x_U^{O*} = \frac{a-c-2t+t^*-2s}{3b}, \qquad y_U^{O*} = \frac{a-c-2t^*+t+s}{3b}. \tag{B.4}$$

If the domestic firm does not export, the equilibrium output levels in the foreign market are

$$x_U^{O*} = 0, \qquad y_U^{O*} = \frac{a-c-t^*}{2b}. \tag{B.5}$$

We now solve for the foreign government's optimal tax. Using (17), (B.3), (B.4) and the starred equivalent of (2), the effect of the foreign tax rate on foreign welfare when the domestic firm exports is

$$\frac{\partial W_U^{O*}}{\partial t^*} = -\frac{2(a-c+s+t+t^*)}{9b} - \frac{a-c-2s-2t+t^*}{9b}.$$

Setting this to zero gives $t^* = -(a-c)$. Using (17), (B.3), (B.5) and the starred version of (2), when the domestic firm does not export we have

$$\frac{\partial W_U^{O*}}{\partial t^*} = -\frac{a-c+t^*}{4b}.$$

Setting this to zero gives $t^* = -(a-c)$. So, no matter the export status of the domestic firm, the optimal tax is $\hat{t}_U^{O*} = -(a-c)$.

Proof of Lemma 1. The final-stage equilibrium outputs for the domestic market are independent of whether or not the domestic (national) firm exports. Substituting them into (18) gives

$$\begin{aligned}\frac{\partial W_U^O}{\partial t} &= -\frac{(a-c+2t)}{9b}\left(\frac{-1}{3b}\right) + (p^*-c-s)\frac{\partial x^*}{\partial t} + \left(x^*\frac{\partial p^*}{\partial t} - \frac{2(a-c-t)}{9b}\right) + \frac{a-c-2t}{3b} \\ &= -\frac{2t}{3b} + (p^*-c-s)\frac{\partial x^*}{\partial t} + x^*\frac{\partial p^*}{\partial t}.\end{aligned}$$

The first term shows that the domestic production efficiency effect, the 'import' component of the terms of trade effect, and the tax revenue effect together call for a zero tax rate. Given the foreign tax rate of $-(a-c)$, $x_U^{O*} > 0$ if and only if $t < -s$. But if $t < -s$, then

$$(p^* - c - s)\frac{\partial x^*}{\partial t} + x^* \frac{\partial p^*}{\partial t} = \frac{-2(t-2s)}{9b} + \frac{2(s+t)}{9b} = \frac{2s}{3b}$$

so that

$$\frac{\partial W_U^O}{\partial t} = -\frac{2t}{3b} + \frac{2s}{3b} = \frac{2(s-t)}{3b} > \frac{4s}{3b} \geq 0.$$

It follows that $t < -s$ cannot be optimal and therefore the domestic firm does not export. □

C Comparison of tax principles

Proof of Proposition 4.

(i) This is immediate from the profit expressions (11) and (B.2).
(ii) Profits under DP (12) are larger than under OP (B.2) if and only if $G > -s^2/(2b)$.
(iii) Profits under DP (10) are larger than for the national firm under OP (19) if and only if

$$\frac{2(a-c)^2 + 9s^2}{18b} > 0.$$

Profits for the multinational under OP (19) are larger than under DP (10) if and only if

$$G < \frac{[4(a-c)+3s][4(a-c)-3s]}{18b} = G'.$$

But this holds because $G < G_1^O$ and Assumption 1 ensures that $G_1^O < G'$:

$$G' - G_1^O = \frac{[2(a-c)-3s][10(a-c)-3s]}{72b} > 0.$$

(iv) Profits under OP (B.1) are larger than under DP (10) if and only if

$$\frac{[2(a-c)-3s][10(a-c)-3s]}{72b} > 0,$$

which holds by Assumption 1. □

Proof of Proposition 5.

(i) If $G < G^D$, bilateral FDI takes place under DP and OP and the tax principles are equivalent.
(ii) If $G^D < G < G_2^O$, there is bilateral FDI in equilibrium under OP and intra-industry trade under DP. Now $W_I^D > W_B^O$ ($W_I^{D*} > W_B^{O*}$) if and only if

$$G > \frac{s[2(a-c)-3s]}{6b} = \tilde{G}.$$

But, since

$$G^D - \tilde{G} = \frac{s^2}{4b} > 0,$$

it follows that $G^D > \tilde{G}$ and so $G > \tilde{G}$. Because of Assumption 1, the range of plant costs we are considering is nonempty:

$$G_2^O - G^D = \frac{[2(a-c)-3s]^2}{36b} > 0.$$

(iii) If $G_2^O < G < \bar{G}$, there is unilateral FDI in equilibrium under OP and intra-industry trade under DP. We have $W_I^D > W_U^O$ if and only if

$$G > \frac{s[2(a-c)-3s]-2(a-c)^2}{6b} = \hat{G}.$$

But

$$G_2^O - \hat{G} = \frac{8(a-c)^2 - 3s[2(a-c)-3s]}{18b},$$

has a minimum of $7(a-c)^2/18b > 0$. It follows that $G_2^O > \hat{G}$ and so $G > \hat{G}$. Also, $W_U^{O*} > W_I^{D*}$ if and only if

$$G < \frac{(a-c-s)(a-c+3s)}{6b} = \bar{G}.$$

The range of plant costs we are considering is nonempty because of Assumption 1:

$$\bar{G} - G_2^O = \frac{(a-c)^2 + 3s[2(a-c)-3s]}{18b} > 0.$$

(iv) If $\bar{G} < G < G_1^O$, there is unilateral FDI in equilibrium under OP and intra-industry trade under DP. We showed in (iii) above that $W_I^D > W_U^O$ when $G > G_2^O$. We also showed that $W_I^{D*} > W_U^{O*}$ if and only if $G > \bar{G}$. Finally the range of plant costs is nonempty because Assumption 1 ensures that

$$G_1^O - \bar{G} = \frac{[4(a-c)+3s][8(a-c)-3s]}{72b} > 0.$$

(v) If $G_1^O < G$, there is intra-industry trade under both tax principles. We have $W_I^O > W_I^D$ (and $W_I^{O*} > W_I^{D*}$) if and only if

$$\frac{[2(a-c)-3s]^2}{72b} > 0,$$

which holds by Assumption 1. □

Proof of Proposition 6. If $G_2^O < G < G_1^O$ there is unilateral FDI in equilibrium under OP and intra-industry trade under DP. We have $W_U^O + W_U^{O*} > W_I^D + W_I^{D*}$ if and only if

$$G < \frac{(a-c)^2 + 6s[2(a-c) - 3s]}{18b} = \breve{G}.$$

Now

$$\breve{G} - G_2^O = \frac{6s[2(a-c) - 3s]^2 - (a-c)^2}{18b} \geq 0$$

if and only if

$$18s^2 - 12(a-c)s + (a-c)^2 \leq 0.$$

It follows that $\breve{G} \geq (<) G_2^O$ if $s \in (\notin)[\frac{1}{6}(a-c)(2-\sqrt{2}), \frac{1}{6}(a-c)(2+\sqrt{2})]$. □

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