International Tax and Public Finance, 12, 281–300, 2005

Barriers to Trade and Imperfect Competition: The Choice of Commodity Tax Base

ANDREAS HAUFLER Andreas.Haufler@lrz.uni-muenchen.de
Department of Economics, University of Munich, Munich, Germany

GUTTORM SCHJELDERUP Guttorm.Schjelderup@nhh.no
Department of Economics, Norwegian School of Economics and Business Administration and CESifo, Bergen, Norway

FRANK STÄHLER fstaehler@business.otago.ac.nz
Department of Economics, University of Otago, Dunedin, New Zealand

Abstract

Recent work has started to analyze the choice of international commodity tax base under conditions of imperfect competition. This paper focuses on the effects of changing levels of trade barriers in a model where firms engage in duopoly competition and governments set commodity taxes non-cooperatively. It is shown that the consumption base (destination principle) dominates the production base (origin principle) when trade costs are high, but the ranking of the two tax bases is reversed for low levels of trade costs. We conclude that the case for origin-based commodity taxes becomes stronger when barriers to trade fall.

Keywords: commodity taxation, imperfect competition, strategic trade policy

JEL Code: F12, H20

1. Introduction

An important and long-standing policy issue has been whether traded commodities should be taxed in the country of consumption (destination principle) or in the country of production (origin principle). Traditionally, world trade has been based on the destination principle. In settings with perfectly competitive commodity markets, there is also theoretical support for this choice, as the destination principle will avoid that countries compete over tax bases in the presence of cross-border shopping.[1] However, the destination principle relies on border tax adjustments and is therefore difficult to administer in integrated markets. Thus, from a perspective of tax administration the choice of international tax principle depends in an important way on the degree of economic integration between the trading countries, and there is therefore a presumption in favor of origin-based taxation as integration proceeds. In this paper we ask whether a reduction in barriers to trade also affects the relative merits of the destination and origin regimes from a *theoretical* perspective when competition is imperfect.

Interestingly, despite the wealth of literature dealing with international commodity taxation and the obvious policy relevance of the subject, this issue seems to have received little attention so far.

Recently, a few papers have begun to analyze the choice of commodity tax principle under imperfect competition. In a duopoly model with integrated markets, Keen and Lahiri (1998) obtain a number of strong results that favor the origin principle over the destination principle and thus contradict the results that are obtained in the perfectly competitive case. When taxes are set cooperatively and the unit costs of production differ between the firms located in different countries, then only origin-based taxes (subsidies) can achieve a first-best outcome, as they can be targeted directly at the underlying production distortion. A similarly strong result arises under non-cooperative tax setting when the two countries and firms are fully symmetric. A first-best outcome will then be obtained under the origin principle, despite the presence of tax competition, whereas the same is not true with destination-based taxes. However, these results do not seem to be robust with respect to the precise model of imperfect competition underlying the analysis. Lockwood (2001, Sections 4 and 6) sets up a model of imperfect competition that combines imperfect substitutability of goods with profit-maximizing firms. In this model taxes levied under either the destination or the origin principle create international spillovers on the profits of foreign firms, leading to ambiguous results for the comparison of Nash equilibria under the two international tax regimes. Haufler and Pflüger (2004) employ a symmetric two-country model with monopolistic competition and internationally mobile firms and show that commodity tax competition under the destination regime, but not under the origin regime will yield a first-best outcome.[2]

A weakness of these studies is that none of them focuses on the role of trade costs, even though the latter constitute an important administrative argument for the choice between the different international tax regimes. In the present paper we analyze the effects of a reduction in trade costs on the choice between destination- and origin-based commodity tax regimes in the symmetric two-country 'reciprocal dumping' model of Brander (1981) and Brander and Krugman (1983).[3] Similar to Keen and Lahiri (1998), we find that in the absence of trade costs the origin principle dominates the destination principle when taxes are set non-cooperatively. This finding results from the interplay of two motives for tax policy in the reciprocal dumping model; to increase domestic consumption and to shift rents to the home economy. These two motives add up to the Pareto efficient tax rate under the origin principle, but not under the destination regime. With positive trade costs, however, the trade-off for national tax policy changes qualitatively as the resource costs of trade also enter the analysis. For sufficiently high trade costs strategic motives become negligible and the task for tax policy is to weigh domestic inefficiencies from imperfect competition against international inefficiencies that arise from wasteful trade costs. This trade-off is optimally solved by the destination principle, but not by the origin principle. Hence there are distinct qualitative advantages of each tax principle in our framework. Interestingly, our theoretical results have the same implications as the above-mentioned administrative concerns: the destination principle is to be preferred for relatively low levels of integration, whereas the origin principle dominates as integration proceeds.

In the remainder of the paper we proceed as follows. Section 2 describes the basic model and analyzes optimal tax policy with destination- and origin-based commodity taxes. Section 3 compares global welfare under the destination and origin principles when taxes are set non-cooperatively. Section 4 discusses the robustness of our results under several model extensions. Section 5 concludes.

2. The Model

The basic structure of our model is adopted from the reciprocal dumping model of Brander (1981) and Brander and Krugman (1983). We consider two countries, home and foreign, which are identical in all respects. The basic setup of the model is explained from the viewpoint of the domestic country only; all foreign variables—denoted by an asterisk—are derived analogously. There are two goods, X and Z, where goods produced in different countries are perfect substitutes. Good X is produced in an oligopolistic industry whereas the numeraire good Z is produced in a perfectly competitive sector. The preferences of the representative consumer are given by the quasi-linear utility function

$$U(X, Z) = u(X) + Z, \tag{1}$$

where $u(X)$ is three times differentiable with $u' > 0$ and $u'' < 0$.

The consumer is endowed with a fixed amount of labor (L). Labor is the only factor of production and is intersectorally mobile, but internationally immobile. One unit of labor produces one unit of good Z; hence, the wage rate equals unity. In addition to wage income the representative consumer receives all profits (Π) earned by the domestic firm in the oligopolistic market. Finally, tax revenue (T) is obtained from a unit tax levied at rate t on either the consumption or the production of good X, whereas the numeraire good Z remains untaxed. Hence the commodity tax that we introduce is *selective*, ensuring that destination- and origin-based commodity taxes have different real effects.[4] Tax revenue is returned to the consumer as a lump sum so that the social valuation of one dollar of tax revenues is equal to the marginal utility of the numeraire good Z. This last assumption must be emphasized because it implies that commodity tax rates can be negative in our analysis. Eliminating a revenue objective in the main part of the paper allows us to focus on efficiency and rent shifting motives of taxation, and to analyze the principal trade-off inherent in these two effects.[5]

Denoting the consumer price of good X by p, the consumer's budget constraint is

$$L + \Pi + T = pX + Z. \tag{2}$$

Utility maximization subject to the budget constraint (2) yields the demand function for good X which, under the chosen utility function, depends only on relative prices. The inverse demand function and its derivative are

$$p(X) = u'(X), \quad p'(X) = u''(X) < 0. \tag{3}$$

Production in the oligopolistic industry X requires c units of labor per unit of output and fixed costs of $F > 0$ to set up a production plant. We assume that the level of fixed costs F is such that exactly one firm in each country is able to make positive profits. The latter assumption implies that demand for good X must be sufficiently high so that a positive $\bar{X}$ exists for which the mark-up earned on the sales, $[p(\bar{X}) - c - t]\bar{X}$, exceeds the fixed costs F for any tax rate t we derive. Given this assumption, there will be two identical firms in our model, each located in one market. The two firms engage in Cournot quantity competition in each of the two national markets. A distinguishing feature of our analysis is that exports from either firm to the other market carry trade costs of s per unit. These trade costs are to be interpreted in a broad sense, including all barriers to the exchange of goods between the two countries.

Following standard notation in the trade literature, x describes the sales of the domestic firm in the home country and y are the home country's imports from the foreign firm. Aggregate consumption in the home market is thus $X = x + y$, and the inverse demand function is $p(x + y)$. Analogously, aggregate demand in the foreign market is $X^* = x^* + y^*$, where x^* are the foreign firm's sales in the foreign country (its domestic market) and y^* are the home firm's exports to the foreign market.

2.1. Consumption Taxes

Under the *destination principle*, the home tax rate t is levied on domestic and foreign goods sold in the home market (x and y), whereas the foreign tax rate t^* applies to all sales in the foreign country (x^* and y^*). The profit equations for the domestic and the foreign firm under the destination regime (superscript D) are

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

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

Throughout the paper, we assume that the firms perceive the two markets as segmented. Since marginal costs are assumed constant, the profit maximizing production decisions for the home and the foreign market can be completely separated (cf. Brander and Krugman, 1983). Furthermore, under the destination principle the domestic tax rate affects only the domestic market. We can thus focus on the optimal levels of x and y chosen by the domestic and the foreign firm, respectively, for sale in the home market. The analysis for the foreign market will be completely symmetric. The first-order conditions, describing the firms' reaction functions, are

$$\Pi_x^D = p - c - t + p'x = 0, \tag{5a}$$

$$\Pi_y^{*D} = p - c - s - t + p'y = 0, \tag{5b}$$

where subscript letters here and in the following denote partial derivatives.[6] We also impose the condition that goods are *strategic substitutes* (Bulow, Geanakoplos and Klemperer, 1985):

$$\Pi_{xy} = p' + p''x < 0, \quad \Pi_{yx}^* = p' + p''y < 0. \tag{6}$$

Assumption (6) implies that reaction functions are negatively sloped, as an increase in the foreign firm's output reduces the marginal revenue that the home firm can earn by increasing its output. This is a standard assumption in models of Cournot competition, which also ensures that profits functions are strictly concave in output.[7]

To determine social welfare in the home country we use the budget constraint (2) to substitute out for Z in the individual's utility function (1). Domestic welfare under the destination principle is then given by

$$W^D = u(.) - p(.)(x+y) + t(x+y) + L + \Pi^D. \tag{7}$$

The first two terms in (7) give the consumer surplus in the oligopolistic industry, which is an exact welfare measure under the quasi-linear utility function assumed. We assume for all tax regimes that W is continuous and quasi-concave in t so that the second-order conditions for a national welfare maximum are fulfilled. Then, from the symmetry of our model, a symmetric Nash equilibrium in tax rates must exist. Note that maximizing (7) with respect to the nationally optimal consumption tax rate $\hat{t}^D$ yields a continuous trade-off in the reciprocal dumping model, because production levels are always positive in both countries.[8] The home country's optimal tax rate (best response function) is derived in the Appendix and given by:

$$\hat{t}^D = \frac{1}{\left(x_t^D + y_t^D\right)} \left[\underbrace{p'y\left(x_t^D + y_t^D\right) - s\, x_t^D}_{\text{(I)}\,(-,+)} + \underbrace{p'y\, x_t^D - y}_{\text{(II)}\,(+)} \right], \tag{8}$$

where x_t^D and y_t^D are the general equilibrium responses of domestic sales and imports with respect to a change in the destination-based tax

$$x_t^D = \frac{p' + p''(y-x)}{|J|} \gtrless 0, \quad y_t^D = \frac{p' + p''(x-y)}{|J|} < 0, \quad x_t^D + y_t^D = \frac{2p'}{|J|} < 0. \tag{9}$$

The Jacobian is $|J| > 0$ [see (A.2) in the Appendix] and the last two terms in (9) can be unambiguously signed from (3) and (6).

Equation (8) identifies two effects, which we label the *efficiency effect* (I) and the *rent shifting effect* (II). *The efficiency effect* describes the familiar incentive to increase the suboptimally low consumption of the oligopolistically produced good X by means of a subsidy (the first part of the effect, which is unambiguously negative), but this is adjusted here to account for the efficiency cost of international trade (the term sx_t^D). Overall, the efficiency effect is not unambiguous under the destination principle, as the incentive to curtail inefficient trade may counteract the incentive to subsidize domestic consumption. In most cases, however, a negative sign can be expected for the efficiency effect.

The first term in the *rent shifting effect* (II) reflects the incentive to increase the market share of the domestic firm, while the second term gives the incentive to shift some of the burden of taxation onto foreigners. The latter effect always dominates when strategic substitutability holds, thus making the rent shifting effect unambiguously positive under the destination principle.

Having discussed the isolated effects, we can now simplify (8) using (9). This gives

$$\hat{t}^D = -yp''x - \frac{s[p' + p''(y-x)]}{2p'}. \tag{10}$$

From (10) it is immediately seen that the balance between the efficiency effect and the rent shifting effect depends critically on the curvature of the demand function.[9] The results for the optimal non-cooperative tax rate under the destination principle can be summarized as follows:

Proposition 1. (a) *Under the destination principle, the nationally optimal tax rate is negative for all levels of trade costs, if the inverse demand function is convex* ($p'' > 0$). (b) *If inverse demand is concave* ($p'' < 0$), *then the optimal tax rate is positive at* $s = 0$ *and it is positive at higher levels of* s *iff* $x_t^D > 0$.

Proof: Part (a) of the Proposition follows immediately from substituting $p'' > 0$ into (10) and noting from $y \leq x$ that the second term in (10) is unambiguously negative in this case. For (b) we use $p'' < 0$ and either substitute $s = 0$ or use the expression for x_t^D in (9). □

The reason for the ambiguous sign of the destination-based tax rate lies in the conflicting incentives to increase domestic consumption (by means of a subsidy) and to shift profits to the home country (by means of a tax). Which of these counteracting effects dominates depends critically on the curvature of the demand function, which determines how effective a subsidy is in raising domestic output. If the inverse demand function is convex ($p'' > 0$), the increase in demand following a subsidy is large and the incentive to raise domestic consumption by means of a subsidy is strong. In contrast, if $p'' < 0$, a tax increase causes only a moderate fall in domestic consumption and this effect is relatively weak. The nationally optimal tax will then be positive if trade costs are zero and the rent shifting term (II) is accordingly strong (because trade levels and thus foreign profits in the domestic market are high). In addition, the destination-based tax will also be positive if inverse demand is concave and $x_t^D > 0$, so that a positive tax raises domestic production and reduces inefficient trade costs. Finally, note that in the special case of a linear inverse demand function ($p'' = 0$) and zero trade costs, the counteracting incentives just offset each other and the non-cooperative consumption tax is zero.

Our results in this section can be compared to previous findings in the literature on strategic trade policy. In Brander and Spencer (1984, Propositions 1 and 2) the sign of the nationally optimal import tariff also depends on the curvature of demand. However, in their analysis the borderline case of a linear demand function involves a positive tariff at $s = 0$, whereas this demand function implies a zero consumption tax in the present analysis. This difference is explained from the fact that the tariff affects only the imports of good X and thus can be directly targeted at the rents that accrue to foreign producers in the home market. In contrast, a consumption tax simultaneously raises the price of domestically produced goods and thus implies a more severe underconsumption of good X for any given level of rent shifting.

2.2. Production Taxes

Under the *origin principle*, commodity taxes are levied in the country of production rather than in the country of final consumption. Hence the home country's tax rate t now applies to the domestic sales of the home firm (x) and to its exports to the foreign country (y^*). Analogously, the foreign tax rate (t^*) applies to the foreign firm's sales in each of the two countries (x^* and y). The profits of the domestic and the foreign firm under the origin principle (superscript O) are

$$\Pi^O = (p - c - t)\,x + (p^* - c - s - t)\,y^* - F, \tag{11a}$$

$$\Pi^{*O} = (p^* - c - t^*)\,x^* + (p - c - s - t^*)\,y - F. \tag{11b}$$

Welfare in the home country under the origin principle is given by

$$W^O = u(.) - p(.)(x + y) + t\,(x + y^*) + L + \Pi^O, \tag{12}$$

where the tax base now includes the home country's exports of good X, rather than its imports. The home government's nationally optimal tax rate $\hat{t}^O$ is derived in the Appendix and given by

$$\hat{t}^O = \frac{1}{\left(x_t^O + y_t^{*O}\right)}\left[\underbrace{p'y\left(x_t^O + y_t^O\right) - s\,x_t^O}_{\text{(I)}\,(-)} + \underbrace{p'yx_t^O - p^{*\prime}y^*x_t^{*O}}_{\text{(II)}\,(-)}\right], \tag{13}$$

where the general equilibrium quantity changes are

$$x_t^O = \frac{2p' + p''y}{|J|} < 0, \qquad y_t^O = -\frac{(p' + p''y)}{|J|} > 0, \qquad x_t^O + y_t^O = \frac{p'}{|J|} < 0,$$

$$x_t^{*O} = -\frac{(p^{*\prime} + p^{*\prime\prime}x^*)}{|J^*|} > 0, \qquad y_t^{*O} = \frac{2p^{*\prime} + p^{*\prime\prime}x^*}{|J^*|} < 0, \tag{14}$$

$$x_t^{*O} + y_t^{*O} = \frac{p^{*\prime}}{|J^*|} < 0,$$

and $|J|, |J^*| > 0$.

Similar to the destination principle the optimal tax rate consists of an *efficiency effect* (I) and a *rent shifting effect* (II). The *efficiency effect* (I) is unambiguously negative under the origin principle, and the first term in (I) again captures the motive to correct for the domestic consumption inefficiency by means of a subsidy. Note, however, that this term will, ceteris paribus, be less strong than the corresponding effect under the destination principle because a production subsidy is only an imperfect instrument to raise domestic consumption in an open-economy setting. The second term in (I) is also unambiguously negative under the origin principle since a positive tax will reduce domestic production and increase imports, thus raising the excess trade costs borne by domestic consumers.

The *rent shifting effect* (II) differs qualitatively from that under the destination principle, since the incentive is now to allow the domestic firm to capture a larger market share both at home (first term) and abroad (second term). Thus, the rent shifting effect is unambiguously negative under the origin principle, and a subsidy will increase the profit share of the domestic firm in both national markets.

Using (15) in (13), the optimal tax formula can be simplified to

$$\hat{t}^O = p'y - \frac{s(2p' + p''y)}{4p' + p''(x + y)}. \tag{15}$$

Thus we get:

Proposition 2. *Under the origin principle, the nationally optimal tax rate is negative for all levels of trade costs.*

Proof: This follows directly from (15) and strategic substitutability [equation (6)]. □

Proposition 2 shows that commodity taxes levied under the origin principle lead to results that resemble the case for strategic export subsidies, aimed at increasing the domestic firm's market share in a foreign market (Brander and Spencer, 1985). Together, our Propositions 1 and 2 thus encompass two of the main beggar-thy-neighbor strategies analyzed in the literature on strategic trade policy: (i) the incentive to shift profits from the foreign firm to the home treasury through an import tariff; and (ii) the incentive to shift profits from the foreign to the domestic firm through an export subsidy. Which of these two strategic incentives is at work in a commodity tax setting depends only on the international tax principle in operation.

Based on Propositions 1 and 2, we can now compare the non-cooperative tax rates under the destination and origin principles:

Proposition 3. (a) *The nationally optimal tax rate is higher under the destination principle, if the inverse demand function is concave ($p'' < 0$) or if trade costs are zero.* (b) *The optimal tax rate is higher under the origin principle, if the inverse demand function is convex ($p'' > 0$) and trade costs are sufficiently high.*

Proof: See the Appendix. □

The comparison of Nash equilibrium tax rates under the two tax principles depends on two counteracting forces. On the one hand, the negative efficiency effect in the home market [the first term in (I)] is stronger under the destination principle, since the subsidy can be directly targeted at domestic consumption. On the other hand, the rent shifting effect (II) tends to raise the optimal tax rate under the destination principle, but lowers it under the origin principle. Hence, $\hat{t}^D > \hat{t}^O$ holds when trade costs are zero (or very low). When trade costs are high, $\hat{t}^D > \hat{t}^O$ will also hold if $p'' < 0$, as the incentive to subsidize domestic consumption is then relatively weak. However, when the domestic efficiency effect is strong ($p'' > 0$) and the rent shifting terms are negligible (trade costs are high), then the failure of the origin principle to fully correct for imperfect competition implies that $\hat{t}^D < \hat{t}^O$.

3. Trade Costs and the Choice of Tax Principle

The analysis in the preceding section has pointed out the different strategic incentives that exist for national tax policy under consumption- and production-based commodity taxation, leading to different equilibrium tax levels. The final objective of our paper is to compare the welfare levels that each country can obtain under the two alternative tax principles when tax rates are set non-cooperatively. The policy idea that underlies our analysis is that an international agreement on tax principles is far easier to reach than an agreement on tax rates. The relevance of this scenario is clearly demonstrated by the strong resistance of many member states of the European Union towards a further harmonization of value-added tax rates.

The core result in this section will be that the welfare comparison of the destination and origin regimes depends critically on the level of trade costs. As a first step in the analysis, we derive the optimal tax formula that would result under aggregate welfare maximization and use it as a benchmark for the comparison of the two commodity tax regimes. In our symmetric setting, the optimal tax policy is equivalent to a coordinated tax policy under either the destination or the origin principle; hence, it does not matter whether we maximize joint utility under the first or the latter. There is, however, a clear expository advantage in determining the optimal tax rate under the destination principle. Under this tax scheme the national markets for good X are independent and consumer surplus in each national market is affected only by the domestic commodity tax rate. Therefore, it is sufficient to consider the spillovers of domestic tax policy on the foreign firm's profits and thus choose the domestic tax rate so as to maximize the sum of domestic consumer surplus and the profits of *both* firms. By the symmetry of the model the foreign tax rate will be identical and the solution represents an aggregate global welfare optimum. Denoting all values that obtain under global welfare maximization by a tilde, the objective function is

$$\tilde{W} = u(\cdot) - p(.)(x + y) + t\,(x + y) + L + \Pi^D + \Pi^{*D}, \tag{16}$$

where the difference to (7) lies in the additional term for the profits of the foreign firm (Π^*). Differentiating (16) and solving for the optimal coordinated tax rate $\tilde{t}$ yields (see the Appendix)

$$\tilde{t} = \frac{1}{\left(x_t^D + y_t^D\right)}\left[p'y\,\left(x_t^D + y_t^D\right) - s\,x_t^D\right] = p'y - \frac{s[p' + p''(y - x)]}{2p'}\,. \tag{17}$$

In general, the optimal coordinated tax rate balances the competing considerations to (i) correct the domestic underconsumption of good X in both countries and (ii) ensure an efficient level of trade. In the special case of zero trade costs, two-way trade yields no efficiency loss and only the domestic correction motive is operating. In this case the second term in (17) is zero and the optimal tax is unambiguously negative. When s is increased, the market power of each national firm rises in its home market, increasing the need for a consumption subsidy. At the same time, however, two-way trade involves rising levels of trade costs. For sufficiently high levels of s, the latter effect dominates and a positive *trade* tax would increase global welfare by eliminating wasteful trade (Brander and Krugman, 1983). The sign of the optimal *commodity* tax is ambiguous, however, since a positive tax also aggravates the domestic underconsumption of good X.

The next step is to compare (17) with the nationally optimal tax rate under the destination and the origin principle, respectively. Since the second-order conditions for national welfare maximization are assumed to hold, and $W(t)$ is continuous and quasi-concave under both tax principles, it is possible to link tax rates and welfare levels in an unambiguous way. In particular, if one of the non-cooperative tax rates ($\hat{t}^D$, $\hat{t}^O$) coincides with the optimal coordinated tax rate $\tilde{t}$ for a specific level of transport costs s, then the corresponding tax principle must (at least weakly) dominate the other in this point.

3.1. Prohibitively High Trade Costs

We first turn to the limiting case where trade costs are so high that the optimal policy is to eliminate all trade. Let $\tilde{s}, \bar{s}^D, \bar{s}^O$ denote the minimal level of trade costs for which the *coordinated* tax rate $\tilde{t}$ and the non-cooperative tax rates $\hat{t}^D$ and $\hat{t}^O$ respectively imply $y = y^* = 0$. Substituting $y = y^* = 0$ in (10), (15) and (17) shows that

$$\tilde{s} = \bar{s}^D \Rightarrow \hat{t}^D|_{s=\tilde{s}} = \tilde{t}|_{s=\tilde{s}} = \frac{-s[p' - p''x]}{2p'}; \qquad \hat{t}^O|_{s=\bar{s}^O} = \frac{-2sp'}{4p' + p''x}\,. \tag{18}$$

Equation (18) shows that the non-cooperative tax rate under the destination principle coincides with the Pareto efficient tax rate when trade costs approach prohibitively high levels, whereas the same is not true for non-cooperative taxation under the origin principle. Intuitively, the rent shifting effects (II) in (8) and (13) disappear under both tax principles when trade costs approach prohibitively high levels, and only the efficiency effects remain. Non-cooperative taxation under the destination principle fully internalizes the Pareto optimal trade-off between an efficient level of domestic consumption and an efficient level of international trade.[10] The reason is that, in each country, the destination-based tax can be targeted directly at the domestic underconsumption of good X, and it also incorporates all trade costs that must be borne by domestic consumers.

In contrast, the non-cooperative production tax deviates from global efficiency considerations in two respects. On the one hand, the non-cooperative tax $\hat{t}^O$ neglects the import component of domestic demand, implying that the subsidy for domestic consumption is too low. On the other hand, it also neglects the trade costs borne by *foreign* consumers, leading to excessive subsidization of domestic exports. The net effect of these two deviations from the optimal tax rate at high levels of trade costs depends again on the curvature of the domestic demand function. In the special case of a linear inverse demand function ($p'' = 0$) the deviations from the globally optimal tax rate $\tilde{t}$ are just offsetting so that non-cooperative taxation under the origin principle implies $\bar{s}^O = \tilde{s}$ and is Pareto efficient.

3.2. Zero Trade Costs

We now turn to the other limiting case of zero trade costs. As discussed above, the Pareto optimal tax rate is then unambiguously negative, as two-way trade causes no efficiency losses and tax policy serves the sole purpose of correcting the domestic distortions in the two national markets for good X. Setting $s = 0$ in (10), (15) and (17) gives

$$\hat{t}^O|_{s=0} = \tilde{t}|_{s=0} = p'y\,; \qquad \hat{t}^D|_{s=0} = -p''xy\,. \tag{19}$$

Equation (19) shows that the non-cooperative tax rate $\hat{t}^O$ always coincides with $\tilde{t}$ at $s = 0$, whereas the same is not true under the destination principle. To understand this result, it is helpful to return to the detailed optimal tax formulae developed in Section 2. The efficiency term (I) is the same under the destination-based tax (8) and the Pareto optimal tax (17), if both are evaluated at $s = 0$. This reflects that the consumption-based tax in each country fully internalizes the optimal subsidy to correct for the domestic distortion. Hence, the non-cooperative tax rate under the destination principle will deviate from the optimal tax rate by the rent shifting effect (II). Since this effect is unambiguously positive under the destination principle, the nationally optimal tax rate $\hat{t}^D$ will always be 'too high' (i.e., subsidies are 'too low') from the perspective of global welfare maximization.

Under the origin principle [Equation (13)], the efficiency effect (I) falls short of the optimal subsidy in (17) at $s = 0$, since the tax affects only that part of domestic consumption which is also domestically produced. However, the rent shifting effect (II) also works in the direction of a subsidy. In a symmetric model, and in the absence of trade costs, both firms share both markets equally and the strategic rent shifting effect just makes up for the incomplete incentive to subsidize domestic consumption. Hence, even though governments set tax rates non-cooperatively, the *sum* of all effects is just as large as in the aggregate welfare optimum.

3.3. The Effects of Changes in Trade Costs

From the above results it is straightforward to show that, starting from a situation of prohibitively high trade costs and a higher welfare level under the destination principle, a continuous reduction in trade costs must lead to a point where the preference for the destination principle is reversed. Our results are summarized in the following proposition (where $\hat{W}^D$, $\hat{W}^O$ are the welfare levels in the non-cooperative tax equilibria):

Proposition 4.

(a) *At prohibitively high levels of trade costs* ($s = \tilde{s}$), *the non-cooperative tax equilibrium under the destination principle is Pareto efficient. In the neighborhood of* $\tilde{s}$, *it weakly dominates the non-cooperative equilibrium under the origin principle.*
(b) *In the absence of trade costs* ($s = 0$), *the non-cooperative tax equilibrium under the origin principle is Pareto efficient and dominates the non-cooperative equilibrium under the destination principle.*
(c) *There is at least one critical level of trade costs* s^c, *where the welfare ranking of the non-cooperative tax equilibria under the destination and origin principles is reversed*, i.e., $\hat{W}^D|_{s\geq s^c} \geq \hat{W}^O|_{s\geq s^c}$ *and* $\hat{W}^D|_{s<s^c} < \hat{W}^O|_{s<s^c}$.

Proof: See the Appendix. □

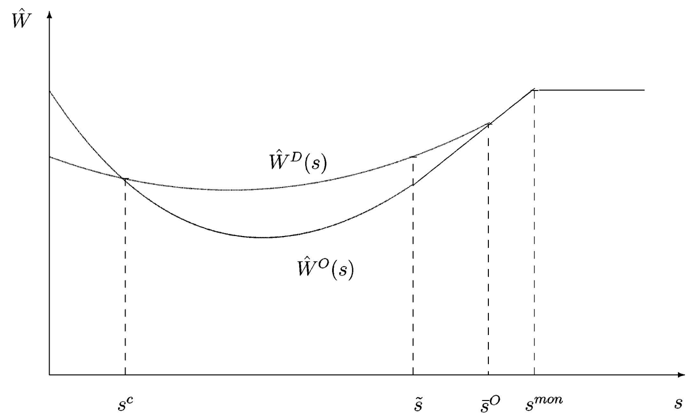

Figure 1. Welfare levels in the non-cooperative tax equilibrium: destination regime ($\hat{W}^D$) vs. origin regime ($\hat{W}^O$).

The intuition for Proposition 4 follows from our earlier discussion. At very high trade costs, the destination principle optimally trades off domestic consumption efficiency and international trade efficiency. As trade costs decrease, rent shifting effects become important, turning the non-cooperative consumption tax away from the Pareto efficient level while the non-cooperative production tax approaches the globally optimal tax. Since all optimal tax rates are continuous functions of s, there must be a critical level of trade costs where the welfare comparison turns in favor of the origin principle. Our results are illustrated in Figure 1.[11]

Note first that the welfare plot exhibits a U-shape because aggregate trade costs are largest for intermediate values of s. Figure 1 shows that non-cooperative taxation under the destination principle leads to a higher welfare level at $\tilde{s}$ (Proposition 4a), whereas the origin principle yields the higher welfare level at $s = 0$ (Proposition 4b). Since the curves $\hat{W}^D(s)$ and $\hat{W}^O(s)$ are continuous functions of s, they must intersect at a critical level of trade costs s^c (Proposition 4c). To get an idea on s^c, we have carried out simulations for the class of isoelastic utility functions $u(X) = X^a$. For a relatively broad range of parameter specifications ($0.3 < a < 0.7$), the critical level of trade costs lies between 10% and 20% of the unit production costs c. These values are close to the levels of trade costs assumed, for example, by Markusen and Venables (1998) in their simulation model of trade and foreign direct investment.

4. Discussion

We first compare our results with those of Keen and Lahiri (1998), who do not incorporate trade costs into their analysis. Their Proposition 6 states that if countries are identical, non-cooperative taxation under the origin principle yields the first best, and dominates the non-cooperative tax equilibrium under the destination principle. This corresponds to our

Proposition 4b, even though Keen and Lahiri assume markets to be integrated, whereas our analysis is based on segmented national markets. It can be argued, however, that similar effects as the ones outlined above are present in the Keen/Lahiri model. Under the *origin principle*, each government has an incentive to subsidize domestic production in order to increase domestic consumer surplus and profits. While each government does not take into account that foreign consumers also benefit from a lower price in the common market, there is an additional incentive to subsidize domestic output in order to shift profits to the home firm. Together, these effects add up to the optimal subsidy and the first best is attained. Under the *destination principle*, each government internalizes all benefits to consumers. However, in an integrated market, it cannot prevent the other country's firm to profit from a domestic subsidy. Since a subsidization policy is associated with a positive externality for the foreign country, each government will choose a tax rate that is too high from a global efficiency perspective.

Next, we discuss the robustness of our results with respect to some of the basic assumptions made. A first extension is to incorporate an exogenous excess burden of taxation by assigning an exogenous weight $\lambda > 1$ to each dollar of tax revenue collected. Note that this does not ensure that tax rates will actually be positive for any particular specification, but $\lambda > 1$ does capture the general notion that subsidies are a costly instrument for governments to use. The only change that arises for the welfare expressions under the destination and origin regimes [equations (7) and (12)] is that the tax revenue terms are multiplied by λ. This leads to an additional *revenue effect* in the optimal tax expressions (8) and (13). This revenue effect is always positive and therefore tends to shift tax rates upward under both tax principles.[12] A first result is that the destination-based tax rate still approaches the Pareto efficient tax rate as trade costs become prohibitively high. This is explained from our above argument that nationally optimal tax rates levied under the destination principle fully internalize the trade-off between an efficient level of domestic consumption and an efficient level of international trade, once rent-shifting effects become negligible. On the other hand, the origin-based tax rate and the Pareto optimal tax rate no longer coincide for $s = 0$, and the equilibrium tax rate under the origin principle will now be 'too low' at $s = 0$. As the excess burden increases, the comparison of the tax regimes in the absence of trade costs is thus no longer unambiguous.[13]

A second possible extension is to relax the symmetry assumption made throughout our analysis. Allowing for differences in country characteristics should not change the superiority of the destination principle for very high levels of trade costs. Intuitively, when rent shifting effects disappear the destination principle will still internalize the Pareto optimal trade-off with respect to the efficiency terms, irrespective of whether the domestic and foreign markets are symmetric or not. In contrast, this extension is likely to affect our results in the other special case where trade costs are zero. Suppose, for example, that the absolute size of the foreign market falls. This reduces the rent shifting effect under the origin principle and it is then no longer clear that the strategic motive to shift rents to the home firm will just compensate for the imperfect incentive to subsidize domestic production. Therefore, the non-cooperative tax rate under the origin principle may not be equal to the Pareto-efficient tax rate at zero trade costs, and the strict dominance of the origin principle at this point may not carry over to a setting of asymmetric countries.

The third and final extension considered here is a reduction in the fixed cost of production so that each national market will support more than one profit-making firm. With free entry and exit, rent shifting effects will disappear, but additional efficiency considerations enter the analysis. First, too many firms will be active in equilibrium, with each firm producing an inefficiently low level of output. Second, international trade continues to introduce inefficiencies in this framework.[14] Whether consumption- or production-based taxation comes closer to solving this trade-off in a Pareto efficient way is a question that needs to be studied in a separate analysis.

5. Conclusions

The debate among economists and policymakers over the choice of commodity tax principle under economic integration has largely revolved around administrative costs. In contrast, the focal point of this paper has been to ask how economic integration affects the relative merits of the two main principles of commodity taxation from a theoretical perspective. We have done so by using a symmetric two-country model with trade costs where firms and governments behave non-cooperatively. In this framework, national tax policy faces three simultaneous tasks: (i) to counteract the domestic underconsumption in the oligopolistic market; (ii) to shift rents from the foreign firm to the home country; and (iii) to minimize the pure waste that arises from international trade in identical products.

The main result from our analysis is that the welfare comparison of the non-cooperative outcomes under destination and origin taxation depends critically on the level of trade costs, as they change the relative importance of the three above-mentioned effects. Under zero trade costs, the trade-off for tax policy is between improving domestic efficiency and shifting rents to the home country. In this case, the origin principle yields a Pareto optimal outcome, as an imperfect incentive to correct the domestic distortion in the goods market is just compensated by the strategic rent shifting effect. This is the result of Keen and Lahiri (1998), which is reproduced in our framework, but we have also argued that it may not carry over to extensions of the basic model. In the opposite polar case of prohibitively high trade costs the rent shifting effect disappears. This tilts the welfare comparison in favor of the destination principle, which is able to trade off domestic consumption efficiency and international trade efficiency in a Pareto optimal way. Thus our framework identifies a new argument in favor of the destination principle in an imperfectly competitive setting, and it features distinct qualitative advantages of each tax principle, depending on the level of trade costs.

From a policy perspective, our findings indicate that the optimal choice of commodity tax principle for a group of trading countries depends on the level of—broadly defined—barriers to trade between them. The importance of these theoretical findings derives from the fact that they support the administrative argument that the destination principle becomes more costly to enforce as integration proceeds. Hence, the destination principle is the preferred alternative as long as trade barriers between countries are high. Instead there may be both theoretical and administrative arguments to switch to the origin principle when the costs of trading goods between the countries fall.

Appendix

Derivation of Equation (8)

The second-order conditions for a profit maximum are

$$\Pi_{xx} = 2p' + p''x < 0, \quad \Pi^*_{yy} = 2p' + p''y < 0. \tag{A.1}$$

It follows from (A.1) and (6) that the determinant of the Jacobian matrix of the two first-order conditions (5a) and (5b) is positive:

$$|J| \equiv \Pi_{xx}\Pi^*_{yy} - \Pi_{xy}\Pi^*_{yx} = p'[3p' + p''(x + y)] > 0. \tag{A.2}$$

Maximizing (7) with respect to t, recalling that both u and p are functions of $X = x + y$ and using $u' = p$ from (3) yields in a first step

$$W^D_t = -p'\left(x^D_t + y^D_t\right)(x + y) + (x + y) + t\,\left(x^D_t + y^D_t\right) + \Pi^D_t = 0. \tag{A.3}$$

Differentiating the domestic firm's profits [equation (4a)] yields

$$\Pi^D_t = \left[p'\left(x^D_t + y^D_t\right) - 1\right] x + (p - c - t)\, x^D_t. \tag{A.4}$$

Finally we use $p - c - t = s - p'y$ from (5b). Rearranging and solving for the home government's nationally optimal tax rate $\hat{t}^D$ yields equation (8).

Derivation of Equation (9)

Totally differentiating the firms' first-order conditions for profit maximization $\Pi_x(x, y, t)$ and $\Pi^*_y(x, y, t)$ [equations (5a) and (5b)] yields

$$\begin{aligned} \Pi_{xx}dx + \Pi_{xy}dy + \Pi_{xt}dt &= 0,\\ \Pi^*_{yx}dx + \Pi^*_{yy}dy + \Pi^*_{yt}dt &= 0. \end{aligned} \tag{A.5}$$

Substituting the second-order derivatives [equations (A.1) and (6)] and $\Pi_{xt} = \Pi^*_{yt} = -1$ into (A.5) yields the simultaneous equation system

$$\begin{bmatrix} 2p' + p''x & p' + p''x \\ p' + p''y & 2p' + p''y \end{bmatrix} \begin{bmatrix} dx \\ dy \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \end{bmatrix} dt. \tag{A.6}$$

Applying Cramer's rule to (A.6) gives the expressions for $dx/dt \equiv x_t$ and $dy/dt \equiv y_t$ in equation (9) of the main text.

Derivation of Equation (13)

Under the origin principle we need to determine the optimal levels of output that both firms produce for each market. The first-order conditions are

$$\Pi^O_x = p - c - t + p'x = 0, \qquad \Pi^{*O}_y = p - c - s - t^* + p'y = 0, \tag{A.7}$$

$$\Pi^{*O}_{x^*} = p^* - c - t^* + p^{*\prime}x^* = 0, \qquad \Pi^O_{y^*} = p^* - c - s - t + p^{*\prime}y^* = 0. \tag{A.8}$$

Maximizing (12) yields in a first step

$$W_t^O = -p'\left(x_t^O + y_t^O\right)(x+y) + (x+y^*) + t\left(x_t^O + y_t^{*O}\right) + \Pi_t^O = 0.$$

Differentiating (11a) gives

$$\begin{aligned}\Pi_t^O &= \left[p'\left(x_t^O + y_t^O\right) - 1\right]x + (p-c-t)x_t^O + \left[p^{*\prime}\left(x_t^{*O} + y_t^{*O}\right) - 1\right]y^* \\ &\quad +(p^* - c - s - t)y_t^{*O}.\end{aligned}$$

Using the firms' optimality conditions (A.7) and (A.8) and the fact that $t = t^*$ in the symmetric equilibrium yields equation (13).

Derivation of Equation (14)

To obtain the effects of a domestic tax increase in the home market we totally differentiate the first-order conditions $\Pi_x(x, y, t) = 0$ and $\Pi_y^*(x, y) = 0$. This gives

$$\begin{bmatrix} \Pi_{xx} & \Pi_{xy} \\ \Pi_{yx}^* & \Pi_{yy}^* \end{bmatrix} \begin{bmatrix} dx \\ dy \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \end{bmatrix} dt. \tag{A.9}$$

Analogously, the effects of a domestic tax increase in the foreign market are obtained by totally differentiating $\Pi_{x^*}^*(x^*, y^*) = 0$ and $\Pi_{y^*}(x^*, y^*, t) = 0$. Applying Cramer's rule to (A.9) and its equivalent in the foreign market gives

$$x_t = \frac{\Pi_{yy}^*}{|J|}, \quad y_t = -\frac{\Pi_{yx}^*}{|J|}, \quad x_t^* = -\frac{\Pi_{x^*y^*}^*}{|J^*|}, \quad y_t^* = \frac{\Pi_{x^*x^*}^*}{|J^*|}, \tag{A.10}$$

where $|J|$ is given in (A.2) and $|J^*|$ is the Jacobian for the foreign market.

The second-order derivatives of the profit functions Π and Π^* are obtained from (A.7)–(A.8). From strategic substitutability, these can be signed as

$$\begin{aligned} \Pi_{yx}^* &= p' + p''y < 0, & \Pi_{yy}^* &= 2p' + p''y < 0, \\ \Pi_{x^*y^*}^* &= p^{*\prime} + p^{*\prime\prime}x^* < 0, & \Pi_{x^*x^*}^* &= 2p^{*\prime} + p^{*\prime\prime}x^* < 0. \end{aligned} \tag{A.11}$$

Substituting (A.11) in (A.10) yields the results summarized in Equation (14).

Derivation of Equation (17)

Differentiating (16), substituting (A.4) and the equivalent expression for Π_t^{*D} gives

$$\begin{aligned}\tilde{W}_t &= -p'\left(x_t^D + y_t^D\right)(x+y) + (x+y) + t\,\left(x_t^D + y_t^D\right) + \Pi_t^D + \Pi_t^{*D} \\ &= t\,\left(x_t^D + y_t^D\right) - p'y\,\left(x_t^D + y_t^D\right) + s x_t^D = 0. \end{aligned} \tag{A.12}$$

Solving for the optimal coordinated tax rate $\tilde{t}$ and using (9) gives (17).

Proof of Proposition 3: The proof is based on the first-order condition for national welfare maximization under the destination principle. From (A.3) and (A.4) this is given by

$$W_t^D = -p'(2x_t + y_t)y + y + t\,(x_t + y_t) + sx_t.$$

We evaluate this expression at the equilibrium tax rate under the *origin principle*. Since the second-order conditions of the government's maximization problem are assumed to hold under both tax principles, W_t^D must be continuous and quasi-concave in t. We can then infer that $\hat{t}^D > \hat{t}^O$ when $W_t^D|_{t=\hat{t}^O} > 0$ and $\hat{t}^D < \hat{t}^O$ when $W_t^D|_{t=\hat{t}^O} < 0$. Setting t equal to $\hat{t}^O$ in (13), using the comparative static results (9) and expanding by $|J|$ as given in (A.2) yields

$$W_t^D(t = t^* = \hat{t}^O) = \frac{1}{|J|}\left[2p'y(p' + p''x) + sp''(y - x)\,\frac{3p' + p''(x + y)}{4p' + p''(x + y)}\right]. \quad \text{(A.13)}$$

From strategic substitutability [equation (6)] the first term is unambiguously positive for $y > 0$. The second term has the opposite sign as p'', since $y < x$ for $s > 0$. Hence $W_t^D|_{t=\hat{t}^O} > 0$ if $s = 0$ or if $p'' \le 0$. This demonstrates part (a) of the proposition. For part (b), note that a large level of s implies that y is small and hence the first positive term becomes small. Furthermore, the second term (which is negative if $p'' > 0$) increases with s and decreases with y in absolute terms. Hence, a sufficiently large s exists such that the second term dominates the first for all levels of trade costs above this value, giving $W_t^D|_{t=\hat{t}^O} < 0$. □

Proof of Proposition 4:

Proposition 4(a). Two cases must be distinguished:

1. When inverse demand is concave ($p'' < 0$), Proposition 3(a) states $\hat{t}^D > \hat{t}^O$. Furthermore, from equations (5b) and (A.8) (with $t = t^*$ in the symmetric equilibrium) y is monotonously falling in t under both tax principles. Hence $\bar{s}^O > \tilde{s}$ must hold, where $\bar{s}^O$ is the level of trade costs that eliminates trade in the non-cooperative tax equilibrium under the origin principle. Hence equation (15) describes the optimal non-cooperative tax rate under the origin principle at $s = \tilde{s}$. This deviates from the Pareto optimal tax rate $\tilde{t}$ at $s = \tilde{s}$, implying $\hat{W}^D|_{s=\tilde{s}} > \hat{W}^O|_{s=\tilde{s}}$.
2. When inverse demand is convex ($p'' > 0$), Proposition 3(b) states that $\hat{t}^D < \hat{t}^O$ for low levels of y. Using the property that y is monotonously falling in t implies $\bar{s}^O < \tilde{s}$. In this case, the origin principle no longer supports trade at $s = \tilde{s}$ and equation (15) cannot be used to describe the optimal non-cooperative tax rate at $s = \tilde{s}$. To show that the destination principle dominates the origin principle at $\bar{s}^O$, we evaluate $\tilde{W}_t$ at $t = \hat{t}^D$ by substituting (10) into (A.12). This yields, for any level of $s < \tilde{s}$

$$\tilde{W}_t|_{t=\hat{t}^D} = \frac{-yp''x\;2p' - 2(p')^2 y}{|J|} = \frac{-2p'\,y}{|J|}\,(p' + p''x) < 0$$

from strategic substitutability [equation (6)]. It then follows from the quasi-concavity of $\tilde{W}(t)$ that $\hat{t}^O > \hat{t}^D > \tilde{t}$ holds at $\bar{s}^O$. Hence, $\hat{W}^D|_{s=\bar{s}^O} > \hat{W}^O|_{s=\bar{s}^O}$, showing that the non-cooperative equilibrium under the destination principle dominates in the neighbourhood of $\tilde{s}$.

Proposition 4(b). This part immediately follows from (19), which shows that $\hat{t}^O$ and $\tilde{t}$ always coincide at $s = 0$. In contrast, $\hat{t}^D$ and $\tilde{t}$ coincide if and only if $p' = -p''x \Longleftrightarrow p' + p''x = 0$, which violates the assumption that the commodities are strategic substitutes [equation (6)].

Proposition 4(c). All variables are continuous functions of s so that the maximized functions $\hat{W}^D(s)$ and $\hat{W}^O(s)$ are also continuous in s. Part (c) then follows directly from parts (a) and (b) of the proposition and the Intermediate Value Theorem. □

Acknowledgement

Revised version of a paper presented at the Congress of the International Institute of Public Finance (IIPF) in Seville, at the Annual Congress of the German Economic Association in Berlin, and at seminars in Berlin, Freiburg and Kiel. We are indebted to Thorsten Bayindir-Upmann, Kai Konrad, Michael Pflüger, Horst Raff, Ian Wooton and especially Agnar Sandmo for comments and discussions. We also thank two anonymous referees for their helpful and constructive remarks. This paper was started while Schjelderup and Stähler visited the University of Konstanz and continued while Haufler and Stähler were at the Norwegian School of Economics and Business Administration in Bergen. We wish to thank both institutions for their hospitality. Financial support from the Center of Finance and Econometrics (CoFE) at the University of Konstanz and the Norwegian Research Council, grant number 137114/510, is gratefully acknowledged.

Notes

1. Core references are Mintz and Tulkens (1986) and Kanbur and Keen (1993). Lockwood (1993) shows that the result in favor of the destination principles must be qualified, even under perfect competition, when terms of trade effects are important. For a thorough and systematic survey of the literature, see Lockwood (2001).
2. A still different approach is taken by Haufler and Schjelderup (2004) who use a model of dynamic price competition to study how international commodity taxation levied under either the destination or the origin principle affects the stability of collusive agreements when producers in an international duopoly agree not to export into each other's home market.
3. Recent work on international trade patterns has given empirical support for the reciprocal dumping model; see Rauch (1999) and Feenstra, Markusen and Rose (2001).
4. If taxes fall on all goods at the same rate, then the destination and origin regimes are equivalent under rather general conditions, including some cases of imperfect competition. See Lockwood, de Meza and Myles (1994). For analytical simplicity, and in order to facilitate comparison with the modeling of specific tariffs in most of the trade literature, we model trade taxes to be specific rather than ad valorem.
5. In Section 4, we extend the model by incorporating a positive excess burden of taxation.
6. Note that (5a) and (5b) imply $x > y$ for $s > 0$. As both firms face identical marginal costs and taxes under the destination principle, each firm will have a larger market share in its home market since it does not incur trade costs.
7. See equation (A.1) in the Appendix. The Appendix also shows that the Jacobian determinant is unambiguously positive under both tax regimes [see equations (A.2) and (A.11)], ensuring that a unique commodity market equilibrium exists. See Corollary 3.2 in Kolstad and Mathiesen (1987).

8. This is different in the well-known model of Mintz and Tulkens (1986), where the trade-off for national tax policy changes discretely at the switch between the autarky and importing regimes, leading to a 'jump' in the best response function.
9. It is well known from closed-economy textbook models that the optimal corrective subsidy in imperfectly competitive markets depends on the curvature of demand. See Myles (1995, Ch. 11).
10. Note that the sign of $\tilde{t}$ is generally ambiguous at $\tilde{s}$, as the tax trades off the competing incentives to correct the domestic distortion and to cut off inefficient levels of trade.
11. Figure 1 is drawn for the case of a concave inverse demand function, implying that the non-cooperative production tax still supports positive trade levels at $s = \tilde{s}$ (see the proof of Proposition 4(a) in the appendix). Note further that once trade is eliminated under the origin *and* destination principles, then welfare must also be equalized under both regimes. This occurs at $\bar{s}^O$. At this level of trade costs, no imports occur but the *potential* entry of the foreign firm still limits the optimal subsidy granted to domestic producers in each country. Only in s^{mon} are trade costs so high that the first-best monopoly subsidy can be set without inducing entry of the foreign firm.
12. We do not provide the calculations for this extension here, but merely state the results. The detailed calculations are available from the authors upon request.
13. This ambiguity is also derived in Proposition 7 of Keen and Lahiri (1998), who adopt an analogous procedure in one part of their analysis.
14. Venables (1985) shows that any measure which increases the relative size of domestic vis-a-vis foreign firms will increase domestic welfare, at the expense of foreigners, by reducing the aggregate trade costs borne by domestic consumers.

References

Brander, J. A. (1981). "Intra-industry Trade in Identical Commodities," *Journal of International Economics* 11, 1–14.

Brander, J. A. and P. R. Krugman. (1983). "A 'Reciprocal Dumping' Model of International Trade," *Journal of International Economics* 15, 313–323.

Brander, J. A. and B. Spencer. (1984). "Tariff Protection and Imperfect Competition." In H. Kierzkowski (ed.), *Monopolistic Competition and International Trade*. Oxford University Press, pp. 194–206.

Brander, J. A. and B. Spencer. (1985). "Export Subsidies and International Market Share Rivalry," *Journal of International Economics* 18, 83–100.

Bulow, J., J. Geanakoplos and P. Klemperer. (1985). "Multimarket Oligopoly: Strategic Substitutes and Complements," *Journal of Political Economy* 93, 488–511.

Feenstra, R. C., J. R. Markusen and A. K. Rose. (2001). "Using the Gravity Equation to Differentiate Among Alternative Theories of Trade," *Canadian Journal of Economics 34*, 430–447.

Haufler, A. and M. Pflüger. (2004). "International Commodity Taxation Under Monopolistic Competition," *Journal of Public Economic Theory* 6, 445–470.

Haufler, A. and G. Schjelderup. (2004). "Tacit Collusion and International Commodity Taxation," *Journal of Public Economics* 88, 577–600.

Kanbur, R. and M. Keen. (1993). "Jeux Sans Frontières: Tax Competition and Tax Coordination when Countries Differ in Size," *American Economic Review* 83, 877–892.

Keen, M. and S. Lahiri. (1998), "The Comparison Between Destination and Origin Principles Under Imperfect Competition," *Journal of International Economics* 45, 323–350.

Kolstad, C. D. and L. Mathiesen. (1987). "Necessary and Sufficient Conditions for Uniqueness of a Cournot Equilibrium," *Review of Economic Studies* 54, 681–690.

Lockwood, B. (1993). "Commodity Tax Competition Under Destination and Origin Principles," *Journal of Public Economics* 53, 141–162.

Lockwood, B. (2001). "Tax Competition and Tax Co-ordination Under Destination and Origin Principles: A Synthesis," *Journal of Public Economics* 81, 279–319.

Lockwood, B., D. de Meza and G. Myles. (1994). "When are Origin and Destination Regimes Equivalent?" *International Tax and Public Finance* 1, 5–24.

Markusen, J. R. and A. J. Venables. (1998). "Multinational Firms and the New Trade Theory," *Journal of International Economics* 46, 183–203.

Mintz, J. and H. Tulkens. (1986). "Commodity Tax Competition Between Member States of a Federation: Equilibrium and Efficiency," *Journal of Public Economics* 29, 133–172.

Myles, G. D. (1995). *Public Economics*. Cambridge University Press.

Rauch, J. R. (1999). "Networks Versus Markets in International Trade," *Journal of International Economics* 48, 7–37.

Venables, A. J. (1985). "Trade and Trade Policy with Imperfect Competition: The Case of Identical Products and Free Entry," *Journal of International Economics* 19, 1–19.