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Abstract

This paper considers the implications of the abolition of border controls for the design of commodity taxes when governments choose taxes non–cooperatively, in the context of a competitive 2–country, 2–good model of international trade where cross–border shopping by consumers (consumer imports) and firm exports are both costly. It is shown that that abolition has two basic effects. First, it introduces an incentive for each country to raise taxes, as the burden of taxation is then partly borne by foreign residents. Second, countries face new constraints, or ceilings, on the tax they can set on their exports; at any tax above the ceiling, foreign consumers will no longer import the good, and the home country's tax base will fall discontinuously. The effect of abolition on taxes depends on the interaction of these two effects , and may result in an increase in taxes, in contrast to the conventional wisdom. A modified version of this result holds when countries also use taxes to manipulate the terms of trade. With a fixed terms of trade, abolition of controls always leads to a welfare loss for both countries; if the terms of trade are (perceived to be) flexible, it is also possible that abolition of controls can raise welfare.

JEL Classification numbers: 321, 423

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1. Introduction

This paper considers the question of the design of tax policies within countries that are trading partners in a free trade area or customs union, e.g. the EEC or EFTA. I consider the tax design problem where in each country, a public good must be financed from distortionary commodity taxes, and how this problem is affected by the presence or absence of border controls. One motivation for pursuing this line of inquiry is that among the proposals of the European Commission for "completing the internal market" , there are plans for the abolition or reduction of border controls, and also corresponding changes to the VAT and excise tax systems so that they can continue to function in the absence of border controls[1].

Many economists argue that such abolition of border controls, in an environment where cross–border shopping by consumers is not too costly, implies strong pressures towards reduction of commodity tax rates below their pre–abolition equilibrium levels across different countries , if these countries are unable to coordinate their tax policies. For example, Lee, Pearson, and Smith (1988), commenting on the likely effects of the reduction or abolition of controls in the EEC after 1992, comment; "*where countries are left free to make their own decisions about whether to move their tax rates more closely into line with their neighbours, ..it is clear that the outcome of such an uncoordinated process would be a tendency for tax rates to move downward.*" Sinn(1989) says; "*Unless the VAT rates are sufficiently harmonised, massive waves of cross–border purchases must be reckoned with....The only way to ensure that, despite the direct purchases, net of tax prices continue to be equated across borders seems to be a harmonisation of tax rates.*". There also seems to be a presumption that such "tax competition" is necessarily bad; for example, Lee, Pearson, and Smith(1989) describe the post–abolition situation as a "fiscal free–for–all" and argue that the countries concerned have strong incentives to cooperate to avoid tax undercutting.

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[1]The principal changes are the following. Goods liable for VAT will no longewr be zero–rated for export, but will be taxable at the exporting country's rate before crossing the border. The importer then reclaims the VAT paid in the usual way. Goods bearing excise taxes would travel under seal, tax free, until they reached a bonded warehouse in the country of retail. When the goods left this warehouse for retail sale, tax would become due. See Lee, Preason and Smith(1988) for more details of the Commission's plans.

The argument usually proposed to support this conclusion is what might be called the consumer/producer arbitrage argument. Suppose there are only two countries, a and b , in the customs union, and taxes are initially at their pre–abolition non–cooperative equilibrium levels. Now suppose that controls are abolished, and country a lowers its commodity tax rates. Then ,two things will happen. Initially, consumer prices in a will fall, and some consumers in b (those with low enough transport/transactions costs) cross the border to shop in a. This increases a's tax base. If consumer transport costs are low, consumer arbitrage will eventually tend to equalise consumer prices, which means that the producer price in a will be somewhat higher than in b. If producer transport costs are low, producers in b will export more to a, again increasing a's tax base at the expense of b's. Both these effects thus give a an increased tax base which may be enough to offset the cut in tax rate. In the extreme case where there are no transport costs on either side of the market, taxes will be driven down to zero.

On reflection, however, this consumer/producer arbitrage argument seems to be both misleading and partial. Most importantly, it confuses the changes in objectives and constraints that occur when border controls are abolished. Suppose for concreteness that each of the countries a and b can produce both goods 1 and 2 , but that a (b) has a cost advantage in the production of 1 (2). Suppose also that the pattern of production is initially efficient, and that cross–border shopping is costless. What happens when border controls are abolished? First, abolition means that residents of b will buy good 1 directly from a at a price equal to the cost of production in a plus a's tax on good 1, and vice versa. So, part of a's tax on good 1 is levied on foreign consumers, which means that other things being equal, the a's government would prefer higher, not lower, taxes than in the case with border controls. Another way of thinking about this is to observe that abolition introduces negative externalities between countries: when any country raises its' tax rate on the good that it exports, it raises the price that residents of the other country pays for imports, which has a negative external effect on welfare. Following Mintz and Tulkens (1986), I call this the *private consumption externality*.

The second effect of abolition is that countries face new constraints on tax–setting, arising from consumer and producer arbitrage, as in the conventional story. Specifically, if country a raises its' tax rate on good 1 too high, at some point the consumer price of this good will rise either (i) above the cost of production in a plus the cost at which firms in a can ship the good to country b, or (ii) the cost of of production in country b. At this point, it will be profitable for country b to "undercut" a by setting a positive tax on the good which is small enough to induce the residents of country b to buy good 1 at home, thus attracting customers away from country a and eroding its' tax base. I call this the *undercutting constraint*. The severity of the undercutting constraint will depend inversely on both firm's costs of exporting, and country a's cost advantage in producing good 1. If a is relatively very efficient at exporting and producing it, it can levy a high tax on the good while keeping the consumer price of the good below the ceiling. Thus, the effect of abolition on tax rates depends on how the incentives for higher taxes and the undercutting constraint interact: in particular, if the domestic country's cost advantage in a good is large, or the costs of firms exporting are high, the tax on that good may actually rise.

There is also a further effect of abolition. The above argument has assumed (as does the existing literature) that the terms of trade are fixed. However, in the above story, country b's trade balance with a deteriorates by the additional value of shopping that b's residents do in a; thus, abolition of controls may lead to trade imbalances. Then, – at least in the long run – the terms of trade will move in response to this imbalance, and countries may choose taxes strategically to manipulate the terms of trade. Abolition of controls changes the way that the terms of trade depend on taxes, and so changes the incentives to strategically manipulate the terms of trade, although it is not clear a priori whether this will tend to raise or lower taxes.

In this paper, I formalise these arguments using[2] a Ricardian two–country, two–commodity model[3]. I make a more general assumption than the one discussed above, namely that cross–border shopping (consumer importing) and firm exporting are both costly[4], and look at effects of abolition of border controls on the taxes set in non–cooperative fiscal equilibrium by the two countries for both the cases of fixed and flexible real exchange rates. In particular, I am interested in how the private consumption externality and undercutting constraint interact.

The main results are as follows. First, I show that taxes may be higher or lower following abolition, for reasons outlined above. Second, the severity of the undercutting constraint is shown to depend on the difference between firm's and consumer's transportation costs: the smaller this difference is, the lower the tax ceiling and so the lower the equilibrium taxes. Thus, costless consumer arbitrage on its own is insufficient to compel countries to bid taxes down to zero; costless producer arbitrage is also required. I also consider the welfare properties of the tax equilibria. With a fixed terms of trade, the equilibrium with controls is constrained Pareto–efficient and thus Pareto–dominates the equilibrium without controls. Indeed, autarky may be preferable to trade without border controls; the traditional gains from trade may be more than outweighed by the new constraints that countries face in tax–setting. However, this need not be the case with a flexible terms of trade: here, abolition may be welfare improving. The argument is a standard second–best one; pre–abolition, tax rates are

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There is a small literature on cooperative and non–cooperative tax design by interdependent tax jurisdictions in a federal state (Mintz and Tulkens(1986), Wilson(1986), (1987), Kerlove (1988)), and some work on tax design in a customs union (Keen(198)). However, the models used by these authors do not compare different regimes. The models of Mintz–Tulkens, Wilson and Kerlove assume that factors of production are costlessly mobile and that cross–border shopping by consumers is possible, whereas Keen assumes the opposite. The difference in choice of assumptions is that the former class of models are mainly addressed to the problem of state or provincial tax design in the U.S. or Canada, where Keen's paper is explicitly concerned with the issue of tax harmonisation within the EEC.

3 A single representative consumer in each country, one immobile factor of production and constant returns to scale.

4 However, I assume that both consumer import costs and firm export costs per unit of the good are small relative to the cost advantage enjoyed by each country in one of the goods (assumption (A1) below). This

not generally at their Pareto–efficient levels as each country uses its tax instruments to try and manipulate the terms of trade to its' advantage – in fact, on average, they are too high. Abolition of controls has two effects. First, it introduces the negative externality outlined above. Second, it changes the strategic incentive to manipulate the terms of trade. It turns out that this second effect may be dominant, which leads to a fall in the average of the two tax rates on the two commodities – although one of the tax rates rises – hence increasing welfare.

The layout of the paper is as follows. Section 1 relates the origin and destination principles of taxation to the effects of abolition of border controls. In section 2, I present the Ricardian model. Sections 3 and 4 consider the cases of fixed and flexible terms of trade respectively. Section 5 describes related literature, especially Mintz and Tulkens (1986), the work of Grossman(1980), Whalley(1979) and Berglas(1981) on the relationship between the origin and destination principles, and the recent work by Razin and Sadka (1989) comparing the residence and origin principles for capital taxation.

1. What Happens when Border Controls Are Abolished?

Here, I briefly outline the implications of abolition of border controls for the levying of commodity taxes on imports and exports. By commodity taxes , I mean not only sales taxes on final commodities (such as excise taxes on tobacco and alcohol), but also VAT. It is useful at this point to introduce the concepts of origin and destination tax regimes (Whalley(1979), Grossman(1980), Berglas(1981), Sinn(1989)). In the former regime, goods that cross national are taxed at the rate of the country from where they are exported, whereas under the latter, exports are tax–exempt, and are subsequently taxed at the importing country's rate. Clearly, if there are physical controls on goods crossing national borders, either regime is feasible, irrespective of whther it is firms or consumers who are importing the good[5]. On the other

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assumption ensures that in equilibrium, each country produces only the good in which it has a comparative advantage, which greatly simplifies the analysis.

[5]The exception to this is services that are consumed in the "exporting" country e.g. by tourists. If a British tourist eats a meal on holiday in France, she must pay the French rate of VAT on the meal.

hand, if there are no border controls, the feasibility of the regime depends crucially on whether goods are imported by firms (intermediaries) for eventual resale, or by private individuals for final consumption. If the former is the case, it is clear that the final commodity can be taxed at the rate of the country to which it is imported, as long as the sale of the imports is honestly reported to – or can be verified by – the tax authorities[6]. On the other hand, if the good is imported by an individual for private consumption (*cross–border shopping)*, the importing country has no way of imposing its tax on the good. The feasible regimes in all these contingencies are shown below.

Table 1

	border controls:	
	yes	*no*
import by:		
consumers	D,O	O
firms	D,O	D,O

where D denotes destination regime, and O , origin regime.

The current system of commodity taxation in the EC is a mixture of destination and origin regimes, at least for importation by private individuals. For example, Danish residents can (and do) cross the border to Germany, where excise taxes are lower, to buy beer, without declaring it at the border[7]. On the other hand, a Dane who bought a car in Germany and transported it back to Denmark would buy it free of German VAT, and then be liable for Danish VAT upon importing it into Denmark. However, in this paper I take the abolition of controls to imply *a shift from the destination to origin regime for cross–border shopping, with the destination regime still in force for imports by intermediaries:* this seems a reasonable approximation to reality.

[6]While this is clear for sales taxes, it is less clear how the destination regime could continue to function for VAT without border controls. Howver, the EC has devised such a system, the so–called "clearing house approach" , which will allow this (see Lee, Pearson, and Smith(1989) or Sinn(1989) for more details).

[7]I am indebted to Morton Hvid for this interesting nugget of information.

3 The Model

There are two countries, i=a,b in a free trade area or customs union, so there are no tariffs on trade between the two countries. There is no trade with the rest of the world. I suppose that there is free trade in two homogeneous produced goods, produced by one factor of production (labour) in each country with a constant returns to scale technology, and that there are no intermediate goods. Labour is immobile between countries. Let c_j^i be the amount of labour in needed to produce one unit of good j in country i. I assume that without loss of generality, that country a has a comparative advantage in the production of good 1 i.e. $c_1^a/c_2^a < c_1^b/c_2^b$. I choose units so that $c_2^a = c_1^b = c$, $c_1^a = c_2^b = 1$, $c > 1$.

Each country has a "market" for each good . Consumers in any country can buy on the domestic market at no transport or transactions cost, but incur a cost of σ labour units per unit of the good bought if they purchase on the foreign market and import the good. Similarly, producers can sell their good on the domestic market without incurring transport or transactions costs, but incur a cost of τ labour units for every unit of the good they export and sell on the foreign market. This cost structure embodies some strong assumptions. First, it supposes constant returns to scale in the activities of consumer import and firm export, whereas there are clearly fixed costs in both these activities. However, allowing for more general cost structures would lead to considerable complications (see Mintz and Tulkens(1986)). Second, it supposes that costs are identical for all consumers and firms, whereas in practice, there are likely to be wide spatial variations, with σ and τ being lower for those who live, or produce, close to the border.

I assume that σ, τ are low relative to comparative advantage , or more precisely:

(A1) $\sigma, \tau < c-1$.

This assumption plays an important role in the ensuing analysis: it ensures that in any tax equilibrium, production is efficient in the sense that each country only produces the good for which it has a comparative advantage. Note that efficient production rules out autarky as a tax equilibrium.

Finally, it is worth commenting on the role of these transportation costs. If $\sigma,\tau = 0$ then producer and consumer arbitrage will drive taxes down to zero, so we need at least one of these costs to be positive. However, from Section 1, it is clear that the central case of interest is when σ is low relative to τ; then, there will be cross–border shopping, and so abolition of controls will have real effects. A simple – but misleading – way of modeling this would be to set $\sigma = 0$, $\tau = \infty$, as done in an earlier version of this paper (Lockwood(1990)). This would be misleading both on theoretical and practical grounds. First, in practice, firms export costs are often low relative to consumer's import costs. Second, it turns out that the tax "ceiling" referred to in the introduction is essentially the <u>minimum</u> of $1-c$ and $\tau-\sigma$; setting $\tau = \infty$, $\sigma = 0$ would obscure this fact.

The prices in the model are as follows. First, w^i is the wage in country i. Also, p_j^i and q_j^i denote the producer and consumer price of good j on the market in country i, <u>net</u> of any transport and transactions costs. Also, t_j^i is the ad valorem tax levied on a value–added basis on commodity j in country i. As there are four goods in the model, I normalise by setting $w^a = 1$, so $w^b = w$. The main contribution of the paper (Section 3) is analysis of the case where the terms of trade are fixed, or are perceived to be fixed, so I set $w = 1$ where appropriate in what follows. This is relaxed in Section 4 where w is endogenised.

(i) *<u>Price Determination</u>*

In this section, I take the vector of taxes $(t_1^a,t_2^a,t_1^b,t_2^b)$ as given , and describe how market prices are determined as functions of this tax vector. First, by constant returns to scale producers will be willing to supply wherever price net of tax exceeds cost, which is 1 or c if supplying the domestic market and $1+\tau$ or $c + \tau$ if exporting. Then, the market prices will be the minimum of the cost of supply of the domestic and foreign producers, including the tax:

$$q_a^1 = \min\{ 1+t_1^a, (c+\tau).(1+t_1^a)\} \quad = 1+t_1^a \qquad (1)$$

$$q_b^1 = \min \{ c(1+t_1^b), (1+\tau).(1+t_1^b)\} \quad = (1+\tau).(1+t_1^b) \qquad \textit{(by (A1))}$$

$$q_2^b = \min\{\ 1+t_2^b, (c+\tau).(1+t_2^b)\} \qquad = 1+t_2^b \qquad (2)$$

$$q_2^a = \min\ \{\ c(1+t_2^a), (1+\tau).(1+t_2^a)\} \qquad = (1+\tau).(1+t_2^a) \qquad \textit{(by (A1))}$$

Next, producer prices are simply consumer prices deflated by taxes i.e. the revenue per unit that a firm makes by selling good j on the market in country i is $p_j^i = q_j^i/(1+t_j^i)$. Finally, let d_j^i be the cost per unit to the consumer resident in country i (including import costs) of buying good j from the cheapest source. This is

$$d_j^i = \min\{\ q_j^i, b_j^{ik}.q_j^k+\sigma\} \qquad (3)$$

where b_j^{ik} is a border tax adjustment that is equal to 1 without border controls, and $(1+t_j^i)/(1+t_j^k)$ with controls. The inclusion of this term reflects the fact that with border controls, the consumer pays the tax of the country where the good is purchased, but with controls, the consumer pays the tax of the country to where the good is imported.

(ii) _Government Preferences and Budget Constraints_

First, assume that in each country there is a representative consumer with preferences over leisure, the two private goods, and a public good. To bring out the essential points, I make the assumption that there are no income or cross–price effects[8], and demand elasticities are constant and equal i.e. preferences are of the following quasi–linear form:

$$u^i = \frac{(x_1^i)^{1-1/\epsilon}}{1-1/\epsilon} + \frac{(x_2^i)^{1-1/\epsilon}}{1-1/\epsilon} + l^i + \lambda.G^i \qquad i = a,b \qquad (4)$$

where x_j^i is consumption of good j by country i's residents, l^i is consumption of leisure, and G^i the level of consumption of the public good, where one unit of G^i is produced from one unit of labour in country i. The consumer in country i faces a budget constraint

[8]The assumption of no cross—price effects is a strong one, but the model becomes notationally very complex if it is relaxed. An informal discussion of the effects of relaxing it can be found in Section 5 below.

$$d_1^i.x_1^i + d_2^i.x_2^i + w^i.l^i = w^i, \qquad i = a,b \qquad (5)$$

where d_1^i, d_2^i are as in (3). I have also assumed in (5) a time endowment of unity. Then (4) is maximised subject to (5) which results in commodity demands $x_j^i = (d_j^i/w^i)^{-\epsilon}$, i = a,b , j =1,2 and indirect utility functions of the form;

$$v^i = \frac{(d_1^i/w^i)^{1-\epsilon}}{1 - \epsilon} + \frac{(d_2^i/w^i)^{1-\epsilon}}{1 - \epsilon} + \lambda.G^i, i = a,b \qquad (6)$$

I now turn to equilibrium conditions in product and labour markets. As output supply is perfectly elastic, I only need to specify how demand is divided between domestic and foreign markets when the consumer is indifferent between them i.e. when the two unit costs in the min{.} operator in (3) are equal. In this case, I suppose the consumers resident in country i chooses to buy in the market that their government most prefers they buy in[9]. Now, let y_j^i be the output of good j by firms in country i. Then the labour market clearing conditions in both regimes simply require that the labour needed for production and transportation of both the public and the private goods in any country sums to unity, the labour endowment. (The exact form of these conditions depends on the type of equilibrium, and so it is rather tedious and unenlightening to write them down formally.)

Governments are assumed to be welfare–maximising so their objectives are given by the indirect utility functions in (6). The precieved government budget constraints in this set–up are as follows. I suppose that both governments <u>expect</u> trade to balance at all configurations of taxes and expenditure levels. Unless w moves endogenously to ensure trade balance, this expectation is non–rational away from tax equilibrium, but correct in equilibrium. Then, the budget constraints (5), goods and labour market clearing conditions, and the balance of trade give rise to the following perceived government budget constraints.

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[9]This tie—breaking rule is chosen for technical reasons, to ensure existence of a strict Nash equilibrium in taxes. With alternative rules, e.g. purchase in the home country in the case of indifference, an ϵ—Nash equilibrium can be shown to exist for any $\epsilon > 0$.

In the case where the destination (origin) regime is in operation, the tax base for each tax is the value of domestic consumption (production) calculated at prices ruling in the market where the good is purchased. Explicit formulae for the constraints are specific to the different types of equilibria, and are given in (7)–(9) below.

3.Tax Equilibrium with a Fixed Terms of Trade

A *tax equilibrium with a fixed terms of trade* is a pair of tax–expenditure vectors $((t_1^a, t_2^a, G^a), (t_1^b, t_2^b, G^b))$ such that for each country i, (t_1^i, t_2^i, G_i) maximises v^i in (6) subject to its budget constraint, and the pricing equations (1)–(3), taking the other country's tax/expenditure vector, (t_1^j, t_2^j, G^j) as given, but taking into account the reactions of the private sector to (t_1^i, t_2^i, G^i), and in particular, the decisions of consumers and firms as whether to import or export respectively. (Technically, the two countries act as Stackleberg leaders with respect to the private sector.). In this paper, I only analyse symmetric tax equilibria i.e. equilibria with $t_1^a = t_2^b$, $t_2^a = t_1^b$, and $G^a = G^b$.

I can begin with two observations that simplify the analysis of these symmetric tax equilibria. First, say that a (symmetric) equilibrium has efficient production if good 1 is only produced in country a, and good 2 in country b. Then, from (A1) and (1), (2) it is clear that any equilibrium must have efficient production. For example, consider the market for good 1 in country b, and suppose to the contrary that firms in b supplied this market in equilibrium: as $1+\tau < c$, firms from country a can always supply this market (and a fortiori, the market for good 1 in country a) more cheaply than firms from b, a contradiction.

This implies in turn that in any equilibrium, good 1 must either be imported into country b by residents of b (*consumers import*), or exported to b by firms in a (*firms export*), and similarly for good 2. This implies that there can be just three types of equilibrium:

(C) – *consumers in a (b) import good 2 (1);*

(F) – *firms in a (b) export good 1 (2);*

(FC) – *as in (F), except that consumers in a (b) re–import good 1 (2).*

It turns out that the (FC) equilibrium cannot exist either with or without border controls. In what follows, I characterise (C) and (F) equilibrium both with and without border controls. This then allows me to be precise about what may happens when controls are abolished.

We are now in a position to write down the government budget constraints for the different equilibria. First, in the case <u>with</u> border controls, they are:

$$t_1^a.x_1^a + t_2^a.(1+\tau).x_2^a = G^a,$$
$$t_2^b.x_2^b + t_1^b.(1+\tau).x_1^b = G^b \qquad \textit{((F) equilibrium)} \qquad (7)$$

$$t_1^a.x_1^a + t_2^a.x_2^a = G^a,$$
$$t_2^b.x_2^b + t_1^b.x_1^b = G^b \qquad \textit{((C) equilibrium)} \qquad (8)$$

The difference between the two is that in the (C) equilibrium, good 2 is bought in country b, where the producer price is 1 rather than $1+\tau$. In the case <u>without</u> border controls, the constraints are obviously the same in the (F) equilibrium, but they become

$$t_1^a.(x_1^a + x_1^b) = G^a,$$
$$t_2^b.(x_2^b + x_2^a) = G^b \qquad \textit{((C) equilibrium)} \qquad (9)$$

Here, the tax base is the value of production of the good the country produces efficiently.

(a) <u>*Tax Equilibrium with Border Controls*</u>

First, I establish that a (FC) equilibrium can never exist. Suppose to the contrary that one did exist. Then consumers in country a would be re–importing good 1 from b at cost $(1+\tau).(1+t_1^a) + \sigma$ per unit. But by buying on the domestic market, they can obtain the good at $1+t_1^a$ per unit, which is a strictly cheaper, a contradiction.

The first step in analysing the (C) or (F) equilibrium is to determine for which tax rates consumers can be induced to import or firms to export. As a (FC) equilibrium does not exist, if consumers import in equilibrium, residents of a (b) will only import good 2 (1). So, when will residents of a choose to import good 2 from b? This will be when the cost of doing so, $q_2^b.(1+t_2^a)/(1+t_2^b) + \sigma$, is less than the cost at which it is available on the domestic market, q_2^a. Rearranging this inequality gives $\sigma \leqq \tau.(1+t_2^a)$. A similar argument shows that residents of b will import 1 if $\sigma \leqq \tau.(1+t_1^b)$. So:

consumers in a import good 2 (firms in b export good 2) as $\sigma \leqq (\geqq)\ \tau.(1+t_2^a)$
consumers in b import good 1 (firms in a export good 1) as $\sigma \leqq (\geqq)\ \tau.(1+t_1^b)$ (10)

So, the governments of country a and b can induce its residents to "cross–border shop" or not by setting t_2^a and t_1^b consistent with these inequalities.

Now note from (10) that the revenue available to country a for the public good depends only on domestic tax rates t_1^a, t_2^a, and domestic consumption of the two goods (the tax bases). In turn, from (4) and (5), the tax bases depend only on d_1^a, d_2^a, which from (1)–(3), depend only on domestic tax rates. Finally, I have just established that the decision of domestic consumers as to whether to import good 2 or "let" foreign firms do it depends only on domestic tax rates. Hence, welfare in a, v^a, does not depend on foreign tax rates, and so there is no interaction in decision–making between countries: each country faces a single–agent decision problem. This makes the equilibrium very simple to analyse.

Now define the function

$$\Gamma(t;\sigma,\tau) = \frac{[(1+\tau).(1+t+\sigma)]^{1-\epsilon}}{\epsilon - 1} + \lambda.(1+\tau).t.[(1+\tau).(1+t+\sigma)]^{-\epsilon} \qquad (11)$$

and assume:

(A2) Γ is quasi–concave in t, all $\sigma,\tau \geqq 0$, and $t(\sigma,\tau) \equiv \underset{t}{\operatorname{argmax}}\, \Gamma > 0$.

Assumption (A2) is very weak : all it requires[10] is that $\epsilon > \theta > 0$, $\theta = (\lambda-1)/\lambda$.

Then, from (10) and (11), (8), and the commodity demands arising from maximisation of (4) subject to (5), the maximum welfare that (say) country a can achieve while inducing domestic consumers to import good 2 is:

$$v_b^c(\sigma,\tau) = \max_{t_2^a} \Gamma(t_2^a\colon \sigma,0) + \max_{t_1^a} \Gamma(t_1^a\colon 0,0) \qquad \text{s.t. } t_2^a \geqq \sigma/\tau - 1 \qquad (12)$$

where the "b" subscript denotes the equilibrium with border controls. By a similar argument (but using (7) instead of (8)) the maximum welfare that it can achieve while inducing domestic consumers to buy good 2 on the home market is

$$v_b^f(\sigma,\tau) = \max_{t_2^a} \Gamma(t_2^a\colon 0,\tau) + \max_{t_1^a} \Gamma(t_1^a\colon 0,0) \qquad \text{s.t. } t_2^a \leqq \sigma/\tau - 1. \qquad (13)$$

Then, country a will wish to induce consumer imports (firm exports) as long as $v_b^c \geqq (\leqq)\ W^f$. We thus have the following result:

<u>Proposition 1</u>

Assume (A1) and (A2). If $v_b^c \geqq (\leqq)\ v_b^f$, there exists a (C) or (F) equilibrium respectively. In the (C) equilibrium,

$$t_1^a = t_2^b = t(0,0) = \theta/\epsilon,\ t_2^a = t_1^b = \max\{t(\sigma,0),\ \sigma/\tau - 1\}. \qquad (14)$$

In the (F) equilibrium,

$$t_1^a = t_2^b = t(0,0) = \theta/\epsilon,\ t_2^a = t_1^b = \min\{t(0,\tau),\ \sigma/\tau - 1\}. \qquad (15)$$

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[10]To see this, note that $\partial\Gamma/\partial t = \lambda.\epsilon.(1+\tau)^{-\epsilon}.(1+t+\sigma)^{-\epsilon}.[\theta/\epsilon - t/(1+t+\sigma)]$, which has a unique stationary point where the term in the square brackets is sero. this stationary point is is positive iff $0 < \theta < \epsilon$. So, quasi–concavity requires that $\partial^2\Gamma/\partial t^2 < 0$ evaluated at $\theta/\epsilon = t/(1+t+\sigma)$. But the sign of the latter is the sign of $\partial[\theta/\epsilon - t/(1+t+\sigma)]/\partial t = (1+t+\sigma)^{-1}.[-1 + t/(1+t+\sigma)] = (1+t+\sigma)^{-1}.[-1 + \theta/\epsilon]$, so $\theta < \epsilon$ is sufficient for quasi–concavity.

The final question of interest is for which parameter values the two equilibria exist. Note that when $\sigma = \tau = x$, $v_b^c > v_b^f$. To see this, note that if $\sigma = \tau$, $t_2^a \leqq 0$ in (13). Then, from (11) and (A2), $\underset{t \leqq 0}{\text{argmax}}\ \Gamma(t: 0, x) = \Gamma(0: 0, x) = \Gamma(0: x,0) < \underset{t \geqq 0}{\text{argmax}}\ \Gamma(t: x,0)$. This means that (σ,τ) space is divided as shown in Figure 1 below, into two regions, (C) and (F), where the two different equilibria prevail.

Figure 1 in here

A useful "base case" to bear in mind for what follows is when σ is small relative to τ. Then, a (C) equilibrium will exist, and the taxes in this equilibrium will all be close to the Ramsey taxes $t(0,0) = \theta/\epsilon \equiv t^r$; the latter are the taxes that would be optimal in the closed economy where both goods can be produced efficiently i.e. at unit labour cost.

(b) *Tax Equilibrium Without Border Controls*

As before, I begin with the conditions under which consumers from a (b) will import good 2 (1). These conditions are $q_2^b + \sigma \leqq q_2^a$, $q_1^a + \sigma \leqq q_1^b$ respectively, and reduce to :

$$\begin{aligned} &\textit{consumers in a import (firms in b export) good 2 as } \sigma \leqq (\geqq)\ (1+\tau).(1+t_2^a) - (1+t_2^b), \\ &\textit{consumers in b import (firms in a export) good 1 as } \sigma \leqq (\geqq)\ (1+\tau).(1+t_1^b) - (1+t_1^a) \end{aligned} \tag{16}$$

Without border controls, we also have to allow for the possibility that consumers in a (b) will also re–import good 1 (2) , after it has been exported by firms in a (b). The conditions that rules this out is :

$$\begin{aligned} &(1+t_1^a) \leqq (1+\tau).(1+t_1^b) + \sigma \qquad \textit{(no re–importing of good 1 by a's consumers)} \\ &(1+t_2^b) \leqq (1+\tau).(1+t_2^a) + \sigma \qquad \textit{(no re–importing of good 2 by b's consumers)} \end{aligned} \tag{17}$$

Note that consumer importation as in (16) implies that <u>re</u>–importation is never profitable. It is again possible[11] to establish that there exists no (FC) equilibrium.

We are therefore left with (C) and (F) equilibria. I now establish conditions under which the (C) equilibrium exists. (The analysis of the (F) equilibrium is omitted, as abolition of border controls only has any effect if there is cross–border shopping – recall Section 1). First, in a (C) equilibrium, country a (b) raises no revenue from t_2^a ($t^b{}_1$). So, I hypothesize that both these taxes are zero in equilibrium. Now, from (16) and (17), country a has two options in setting t_1^a. To see what these are, consider what happens to the tax base of t_1^a as t_1^a rises, other things being fixed. From (16) and $t_1^b = 0$, as long as $t_1^a \leqq \sigma - \tau$, b's residents continue to buy good 1 in a, so the tax base consists of the value of purchases of both domestic and foreign residents. What happens in t_1^a exceeds $\sigma - \tau$? Then, a loses from the tax base all of b's residents who switch to buying good 1 domestically. Eventually, from (17), when t_1^a rises above $\tau + \sigma$, it will also lose from the tax base of t_1^a its <u>domestic</u> residents, who will go to b to re–import good 1 back into a; when t_1^a is above this level, the tax base shrinks to zero.

The two options are then as follows. One, it can choose t_1^a to maximise welfare subject to the $t_1^a \leqq \tau - \sigma$, retaining the larger tax base. Two, it can maximise welfare subject to $t_1^a \leqq \tau + \sigma$, retaining the smaller tax base. The two constraints are *undercutting constraints*: that is, if country a sets a tax higher than (say) $\tau - \sigma$, country b can "undercut" a by setting t_1^b at a level which will attract some of a's tax base and raise positive revenue for b.

Using (11), the government budget constraint (9), and commodity demands, the payoffs from these two options are :

[11]Suppose to the contrary there is one, with $t_1^a = t_2^b = t^0$, $t_2^a = t_1^b = t^{00}$. Then (17) must be violated at these tax rates. But then from (16), residents in country b must also buy good 1 domestically , from the market in country b. Thus, the tax base for t_1^a is zero and it raises zero revenue. But then, by lowering t_1^a from t^0 to the point where (17) holds with equality, country a can induce its residents to buy good 1 in a, thus raising positive revenue from t_1^a , without affecting the revenue raised from t_2^a (this last fact follows from zero cross–price effects in demand). This change in a's tax rates thus unambiguously raises revenue and lowers the price a's residents pay for good 1, so raising v^a. So, the hypothesised equilibrium cannot be an equilibrium after all.

$$v^c_{nb}(\sigma,\tau) = \max_{t^a_1} \Gamma(t^a_1\colon 0,0) + \lambda.t^a_1.(1+t^a_1+\sigma)^{-\epsilon} \qquad \text{s.t. } t^a_1 \leqq \tau-\sigma \tag{18}$$

$$v'_{nb}(\sigma,\tau) = \max_{t^a_1} \Gamma(t^a_1\colon 0,0) \qquad \text{s.t. } t^a_1 \leqq \tau+\sigma \tag{19}$$

where the subscript "nb" denotes the equilibrium with no border controls. Let $t^*(\sigma)$ be the tax that maximises the expression in (18), ignoring the constraint. This is the tax that a would like to impose on its production of good 1 *in the absence of any tax undercutting threat from b*. Note that if σ is not too large, $t^*(\sigma) > t(0,0)$,so in the absence of the undercutting constraint, country a (b) would like to set a higher tax on good 1 (2) than it does in the equilibrium with border controls. This is because, as explained above, part of the tax falls on exports so part of the burden if the tax is exported i.e. the *private consumption externality*.

Clearly, for equilibrium, we need $v^c_{nb} \geqq v'_{nb}$, and this is also sufficient. I have therefore shown that given this, there exists an equilibrium with $t^a_1 = t^b_2 = \min\{t^*(\sigma), \tau-\sigma\}$, $t^a_2 = t^b_1 = 0$. Furthermore, it can be shown[12] that symmetric equilibrium is unique if $t^*(\sigma) \geqq \tau-\sigma$, and even if $t^*(\sigma) < \tau-\sigma$, the equilibrium payoffs are unique. Formally,

[12]The proof of this is as follows. Suppose there were an equilibrium with $t^a_2 = t^b_1 = s > 0$. Then, from (16), the upper bounds in (18) would be $(\tau-\sigma) + (1+\tau).s \equiv \eta$. Then, $t^a_1 = t^b_2 = \min\{t^*(\sigma),\tau-\sigma\}$, and in equilibrium, t^a_2, t^b_1 generate no revenue. Suppose first that $t^*(\sigma) \geqq \eta$. But Then, by setting $t^b_1 = s-\epsilon$, $\epsilon > 0$, a (b) can induce its domestic residents to buy good 2 (1) at home, thus raising positive revenue from t^a_2 (t^b_1) , a contradiction. Next, suppose that $\tau-\sigma < t^*(\sigma) < \eta$; then by setting $t^b_1 = \epsilon > 0$ for ϵ small enough, a (b) can again induce its domestic residents to shop at home, again a contradiction. Finally, if $t^*(\sigma) \leqq \tau-\sigma$, country a (b) can never generate any revenue from t^a_2 (t^b_1), so <u>any</u> levels of these tax variables are consistent with tax equilibrium.

Proposition 2

Assume (A1) and (A2). Then, there exists a (C) equilibrium if and only if $v^c_{nb} \geqq v'_{nb}$. Furthermore if $t^*(\sigma) > \tau-\sigma$ the equilibrium is unique, with taxes

$$t^a_1 = t^b_2 = \min\{t^*(\sigma), \tau-\sigma\},\ t^a_2 = t^b_1 = 0 \tag{20}$$

If $t^*(\sigma) \leqq \tau-\sigma$, there exist a family of equilibria with $t^a_1 = t^b_2 = t^*$, $t^a_2 = t^b_1 = z$, $z\epsilon[0,\infty)$, where consumers in a (b) cross–border shop for 2 (1) for all z, so all equilibria yield the two countries identical payoffs.

Clearly, when $\sigma = \tau > 0$, $v^c_{nb} < v'_{nb}$, but for $\tau - \sigma$ large enough, $v^c_{nb} > v'_{nb}$. So, there exists a set of parameter values for which the (C) equilibrium exists, which is a subset of the parameter values for which a (C) equilibrium exists with border controls, as shown in Figure 2. Note that the border of this regime passes though the origin in σ,τ space.

Figure 2 in here

So, for some parameter values, abolition of controls means a switch from a (C) equilibrium with taxes given in (14) to a (C) equilibrium with taxes given in (20). The taxes on the goods that the countries export (namely t^a_1, t^b_2) change from the Ramsey taxes t^r to $\min\{t^*(\sigma), \tau-\sigma\}$, and the taxes on the goods that the two countries import (namely t^a_2, t^b_1) fall from positive values to zero. In the latter case, the undercutting effect dominates ; if they were positive, the other country could "steal" the tax base by setting a lower tax. The former case is more subtle and interesting, as there are two opposing effects at work. First, countries have an incentive to raise the taxes on the goods they produce efficiently above t^r, the level with border controls (i.e. $t^*(\sigma) > t^r$), as the tax is now levied partly on foreign residents – this is the private consumption externality at work. Second, the possibility of tax undercutting by the other country imposes ceilings $\sigma-\tau$ on these taxes which may force them below the levels with border controls. In particular, as $\sigma,\tau\to 1$ (consumer and producer arbitrage becomes more and more effective) , the undercutting effect dominates and taxes are driven down to zero. Note that <u>both</u> costless consumer and producer arbitrage are required to drive taxes down to zero; costless consumer arbitrage on its own ($\sigma = 0$) is <u>not</u> sufficient.

Finally, in the central case of interest, where (C) equilibria prevail both with and without border controls, the equilibria may be welfare–ranked. With controls, there are no externalities between countries , and so equilibrium is constrained Pareto–efficient; the taxes in (14) or (15) maximise $v^a + v^b$ subject to (1)–(3) and (9). Thus, the equilibrium without border controls is Pareto–dominated. At first sight, this seems a surprising result: after all, with cross–border shopping, consumers can buy at least as cheaply as they could before, so one would expect consumer welfare to <u>rise</u>, not fall. However, this is the wrong intuition: the correct one is that the abolition of controls introduces tax externalities which countries fail to internalise. Indeed, it is possible to show that this efficiency loss may exceed the gains from trade so that *it may be better to prohibit trade altogether rather than allow cross–border shopping*[13]. To see this, let c go to 1, and $\tau - \sigma$ go to zero, while satisfying (A1) and $v^c_{nb} \geq v'_{nb}$ (this is always possible from Figure 2). For c close enough to 1, the gains from trade become negligible, but as $\tau - \sigma \to 0$, taxes are forced down to zero, strictly below their efficient level of t^r.

4. <u>Tax Equilibrium With a Flexible Terms of Trade</u>

The welfare result of the previous section is rather disturbing, as it suggest that in a second–best environment with distortionary taxes, "completing the single market" will <u>reduce</u>, rather than improve, welfare[14]. In this section, I show how the analysis above may be affected by an endogenous terms of trade, and in particular, that the welfare result may be reversed. To concentrate on the welfare effects, I make the simplifying assumption that:

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[13]This result one of a class of results which show that free trade may be inferior to autarky when there is an initial distortion in the economy. Newbery and Stiglitz (1981) have established this in the case where insurance markets are incomplete; there, the argument is that increased income variability associated with trade can outweigh the traditional gains from trade. It can also arise with imperfect competition in product markets (Venables and Smith(1986)) if there are transport costs.

[14]In practice there are, of course, other costs associated with border controls, such as paperwork, increased journey times, etc. which will be reduced or eliminated by the completion of the internal market. These costs are not modelled here.

(A3) $c = \tau = +\infty$, $\sigma = 0$

i.e. cross–border shopping is costless , but that firms in each country can only produce one good (1 in a, 2 in b), and find it infinitely costly to export it directly. Thus all trade is conducted by consumers i.e. the (C) equilibrium always prevails.

How is w determined? It is given by the trade–balance conditions , which can be written as follows. Let country i's export of good j be $e_j^i = y_j^i - x_j^i$. Then,

$$p_1^a . e_1^a + p_2^a . e_2^a = 0 \qquad (origin) \qquad (21)$$

$$q_1^a . e_1^a + q_2^a . e_2^a = 0 \qquad (destination) \qquad (22)$$

This says that in the origin (destination) regime, the value of net exports at producer (consumer) prices must be zero. The difference between the origin and destination cases is due to the fact that in the origin regime, the tax is imposed on the producer, and so is in effect when the good crosses the border. A *tax equilibrium with with a flexible terms of trade* is defined exactly as a tax equilibrium with a fixed terms of trade as above, eaxept that each country takes account of the effect of its tax variables on w though (21) or (22).

(a) *Tax Equilibrium with Border Controls*

In this case, the destination regime prevails. Thus, the government budget constraint is as in (8) with the obvious modification due to the endogeneity of w. Substituting the government budget constraint into (6) yields an objective

$$v^a = \frac{(1+t_1^a)^{1-\epsilon}}{\epsilon - 1} + \frac{[w.(1+t_2^a)]^{1-\epsilon}}{\epsilon - 1} + \lambda.[t_1^a.(1+t_1^a)^{-\epsilon} + w^{1-\epsilon}.t_2^a.(1+t_2^a)^{-\epsilon}] \qquad (23)$$

and v^b is similar, except for the substitutions of t_2^b for t_1^a, t_1^b for t_2^a, and $w^{\epsilon-1}$ for $w^{1-\epsilon}$. Also, from the trade balance condition (22) and consumer demands arising from maximisation of (4) subject to (5), the equilibrium terms of trade is

$$w = [(1+t_2^a)/(1+t_1^b)]^{\epsilon/(1-2.\epsilon)} \tag{24}$$

Note from (24) that from country a's point of view, a devaluation i.e. an increase in w will improve the trade balance only if $1-2.\epsilon > 0$, which is simply the Marshall–Lerner condition.

Then, country a chooses t_1^a, t_2^a to maximise (23) subject to (24) and country b behaves similarly. Evaluating the first–order conditions[15] to this problem at the symmetric tax equilibrium with $t_1^a = t_2^b = z$, $t_2^a = t_1^b = t$, I obtain:

$$\frac{(\lambda-1)}{\lambda} - \epsilon.\frac{z}{1+z} = 0 \tag{25}$$

$$\underbrace{\left[\frac{(\lambda-1)}{\lambda} - \epsilon.\frac{t}{1+t}\right]}_{(domestic\ welfare)} + \underbrace{\left[\frac{(1+t_2^a)}{w}.\frac{dw}{dt_2^a}\right]}_{(strategic)}.\left\{(1-\epsilon).\frac{t}{1+t} - \frac{1}{\lambda}\right\} = 0 \tag{26}$$

The left–hand side of Equation (26) is made up of two effects. The first is the marginal impact of an increment in t_1^a on domestic welfare (the domestic welfare effect), given that the terms of trade is fixed. The second is the indirect effect of an increment of t_2^a on a's welfare, via the induced effect on the terms of trade. This second term measures the strategic incentive for country a to manipulate the terms of trade to its advantage, and so I refer to it in what follows as the strategic effect. Equation (26) therefore says that at the optimal t_2^a, the sum of the two effects is zero. (Note that there is no strategic effect in (25), as t_1^a has no effect on w,

[15] For t,s as defined in (25) and (26) to be equilibrium taxes, it is also that case that they must be global maxima of v^a given $t_1^b = t$, $t_2^b = s$. As there is a unique solution to the first–order conditions, it suffices to check that the second–order conditions to the problem are satisfied at $t_1^a = t_2^b = s$, $t_2^a = t_1^b = t$. The conditions required for this are derived in the Appendix, and are $\epsilon > \theta$ and (A7).

from (24)).

Looking at the strategic effect in more detail, it is made up of the elasticity of w with respect to $1+t_2^a$ times the term in the curly brackets, which is the effect of an increment in w on domestic welfare. Following Mintz and Tulkens(1986), I can split this latter effect into two parts. First, there is the "private consumption effect" of an increase in w, $-1/\lambda$, which measures the direct utility loss to consumers in a from the higher price of good 2 (recall equation (3)). This is always negative. Second, there is the "tax base effect" $(1-\epsilon).\frac{t}{1+t}$, which measures the effect on country a's tax base of an increment in w. Recall from (14) that the tax raised from the imported good is $t_2^a.w.x_2^a = t_2^a.w^{1-\epsilon}(1+t_2^a)^{-\epsilon}$, so the impact of w on this source of revenue is clearly positive as long as demand for the imported good is is inelastic i.e. $\epsilon < 1$ and negative otherwise.

Solving (25) and (26), I get

$$\frac{z}{1+z} = \frac{\theta}{\epsilon}, \qquad \frac{t}{1+t} = \frac{\theta.(2.\epsilon-1) + \epsilon/\lambda}{\epsilon^2} \tag{27}$$

It is easily checked that $t \gtreqless z$ as $\epsilon \gtreqless \theta$. But the second-order conditions to a's problem require $\epsilon > \theta$. So, $t > z$ i.e. the strategic effect is always positive in equilibrium.

(b) *Tax Equilibrium without Border Controls*

In this case, as cross-border shopping is costless from (A3), the origin regime is in operation. As $c = \tau = \infty$, both consumer prices and government revenue are independent of (t_2^a, t_1^b). These tax instruments are then "redundant" in the case without border controls and so we may set them to zero in the discussion of the origin regime that follows[16]. Given that (t_2^a, t_1^b) are "redundant", I can set $t_1^a = t^a$, $t_2^b = t^b$. Substitution of the government budget constraint (9) into (6), using (1)–(3) and modifying (9) in the obvious way due to an endogenous terms of trade, gives a formula for domestic welfare of

[16]More precisely, this is saying that it is not feasible for country a (b) to tax good 2 (1).

$$v^a = \frac{(1+t^a)^{1-\epsilon}}{\epsilon - 1} + \frac{[w.(1+t^b)]^{1-\epsilon}}{\epsilon - 1} + \lambda.t^a[(1+t^a)^{-\epsilon} + w^{\epsilon}.(1+t^a)^{-\epsilon}] \qquad (28)$$

Also, solving for the equilibrium terms of trade from (21), I get:

$$w = [(1+t^a)/(1+t^b)]^{(1-\epsilon)/(1-2\epsilon)} \qquad (29)$$

The problem facing country a is to choose t^a to maximise (28) subject to the terms of trade in (29), taking t^b as given. This differs from the problem in the destination case in two respects. First, (as discussed above) the choice of t^b has a direct external effect on v^a (and vice versa) by changing the price that a's residents pay for the imported good b. Second, the strategic effect will be different, both because the terms of trade is determined differently as a function of the taxes, and because w enters differently in v^a, due to the different tax base in the origin case. (Note that the undercutting constraint is now absent as $c = \tau = \infty$).

Evaluating the first–order condition[17] to a's maximisation problem at the symmetric equilibrium $t^a = t^b = \tau$, I obtain;

$$\underbrace{\left[\frac{(\lambda-0.5)}{\lambda} - \epsilon.\frac{\tau}{1+\tau}\right]}_{\textit{(domestic welfare)}} + \underbrace{\frac{1}{2}.\left[\frac{(1+t^a)}{w}.\frac{dw}{dt^a}\right].\left\{\epsilon.\frac{\tau}{1+\tau} - \frac{1}{\lambda}\right\}}_{\textit{(strategic)}} = 0 \qquad (30)$$

Again, this is made up of the sum of a domestic welfare effect and a strategic effect.

To compare this to the destination case, recall first that when the terms of trade are fixed, taxes in the origin case are always higher than in the destination case in the absence of any undercutting threat, due to the private consumption externality. This is apparent in (30), where if the strategic effect is zero, the domestic welfare effect yields $\tau = t^*(0) = (\lambda-0.5)/\lambda.\epsilon > t^r$. However, when w adjusts to bring about trade balance, and the countries

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[17] Again, as there is only one solution to the first–order conditions, it is only necessary that the SOC should hold at the equilibrium $t^a = t^b = \tau$. This requires (A11) in the Appendix to hold.

foresee this, the strategic effect comes into play, which generally differs between origin and destination regimes. Note that the private consumption effect, $-1/\lambda$, is the same as in the destination case, but the tax base effect is now unambiguously positive at $\epsilon \frac{\tau}{1+\tau}$. The reason for this is that from (18), a's tax base depends positively on w as long as $\epsilon > 0$. Intuitively, this is because when the switch from destination to origin takes place, imports of good 2 (which depend negatively on w) are replaced by exports of good 1 (which depend positively on w) in the tax base.

Solving (30) for the tax rate, I get:

$$\frac{\tau}{1 + \tau} = \frac{2\theta'.(2\epsilon-1)+(1-\epsilon)/\lambda}{\epsilon(3.\epsilon-1)} \qquad (31)$$

where $\theta' = (\lambda-0.5)/\lambda$. It can be checked that as long as $\epsilon > 1/3$, $\tau \gtreqless t^*(0)$ if either $\epsilon \gtreqless 1$ and $\lambda > 1.5$, or if $\epsilon \lesseqgtr 1$ and $\lambda < 1.5$. So, the strategic effect may give either an upward or downward bias to the tax. Thus, there are parameter configurations (e.g. $\epsilon > 1 > \theta$ and $\lambda < 1.5$) where the strategic bias changes sign from positive to negative following abolition.

(c)*Comparing Solutions*

Equations (27) and (31) say that in the case with controls, the consumers of each country face a tax vector (z,t) whereas without controls, they face a tax vector (τ,τ). It is easy to show that as $\epsilon > 0$, $t > \tau > z$ as long as $\epsilon > 1/3$. So, as long as $\epsilon > 1/3$, one of the taxes – namely the tax on the exported good – will be higher in the origin regime than in the destination regime. Thus, the insight that (some) taxes can rise following abolition of border controls carries over to the case where the real exchange rate is flexible. The intuition for this result is simply the additional negative externality introduced by abolition of controls, which tends to raise equilibrium taxes, may dominate (or be complemented by) the strategic effect. However, if $\epsilon > 1/3$, one tax – namely the tax on the imported good – must also fall following abolition. This is illustrated in Figure 3 below, where t,z,τ are shown for $\lambda = 1.1$, $2.0 < \epsilon < 5.0$.

Figure 3 in here

Now recall that as cross–border shopping is costless, the constrained Pareto–efficient level of all the t_j^i is t^r. So, in country a, as $\epsilon > \theta$ from second–order conditions, abolition has the effect of moving the tax on one good (good 2) closer to $z = t^r$, and the tax on the other good (good 1) further away. A priori, the effect of this change on welfare is ambiguous. However, some numerical simulations illustrated in Figure 4 below, indicate that welfare may actually rise following abolition.

Figure 4 in here

The intuition is a standard second–best one. The equilibrium with border controls is not a Pareto–efficient equilibrium relative to the tax instruments available (i.e. not constrained Pareto–efficient), as the external effects through shifts in the terms of trade,w, are not internalised when countries choose tax rates. Thus, introducing an additional externality by abolishing border controls does not necessarily reduce welfare, _if_ it offsets the original distortion. In this example, the efficient taxes $z = t^r$ are rather low, whereas t is very high; abolition of controls replaces the two tax rates (z,t) on goods 1 and 2 respectively by the tax vector (τ,τ) where τ is much lower than t, and so (τ,τ) is "on average" closer to (z,z) than (z,t) is. It is important to note that the force pushing (τ,τ) down and thus improving welfare is not the new externality, but the reversal in sign of the strategic effect from positive to negative (note that the parameter values in the simulation satisfy $\epsilon > 1 > \theta$ and $\lambda < 1.5$).

5 Related literature and Conclusions

There are several literatures related to the analysis of this paper. The first is the literature, largely initiated by Mintz and Tulkens (1986), on tax competition between jurisdictions. They consider a model with costly cross–border shopping and two tax authorities. The main differences between M–T and this model are the following. First and foremost, firms cannot export directly, and there are assumed to be no border controls, so that an origin regime is _assumed_, rather than determined endogenously within the model. This means that the effects of abolition cannot be directly deduced from their results. Second, trade is balanced not by a flexible terms of trade, but by labour mobility. Third, there is only one taxable good, but strictly convex transport costs mean that the residents of any country may buy the good from more than one country simultaneously.

They identify two kinds of external effect of an increase in the tax levied by country/jurisdiction i on country j, the "public consumption effect", and the "private consumption effect". The latter is precisely the negative externality I identified above, whereby an increase in i's taxes increases the price residents on j pay for (some proportion of their purchases), which tends to bias the tax rates upwards. The former is the impact of a change in i's tax on j's tax base, and is related to the undercutting constraint.

The second literature is that comparing origin and destination regimes (Whalley(1979), Grossman(1980), Berglas(1981), Sinn(1989)). Recall that when cross–border shopping is costless, we have identified the former and latter with the cases with and without border controls (see Section 2 above). From (1) – (3) above it is clear that the real allocation of resources is in general, changed when a switch from the origin to the destination regime, or vice versa, occurs, given tax rates fixed.

However, Grossman(1980), Berglas (1981) and Whalley(1979) among others have showed that there are conditions under which a switch has no real effects[18]. These conditions are: first, that commodity taxes are uniform <u>within</u> each country, second that all factors are inelastically supplied, and third, that all tax revenues are returned in a lump–sum form to domestic consumers. The intuition for the result is simple; following a switch from origin to destination, the relative wage adjusts to ensure that relative consumer prices in (2) are the same as in (3) when commodity taxation is at the uniform rates $t_1^a = t_2^a = t^a$ and $t_1^b = t_2^b = t^b$ respectively. More precisely, if w^o, w^d are the relative producer wages in the two regimes, they need to satisfy $w^d = w^o.(1+t^a)/(1+t^b)$. As labour supplies are inelastic, this change in

[18]Sinn(1989) has shown that when consumption goods are taxed, but investment goods are not, then a change of regime will have real effects. This shows that the results of Grossman, Whalley, and Berglas require uniformity of taxes.

the relative wage has no[19] real allocative effects (see Whalley(1980) for more detail of this argument). So, the results of this paper extend this literature by considering the effects of a regime switch when taxes are chosen optimally by each country and without cooperation between countries, and labour is supplied elastically, so that the tax design problem is non–trivial. I have shown that in general, abolition of border controls leading to a switch in regimes does make a difference.

The final literature is that comparing the residence and origin principles in the taxation of income from capital, and in particular, the paper of Razin and Sadka (1989). For the taxation of income from capital, there are two polar principles of taxation: the residence and origin principles. Under the former, residents of any country are taxed on their world–wide income equally, regardless of whether the source of income is domestic or foreign. Under the latter, residents of a country are not taxed on their income from foreign sources and foreigners are taxed equally as residents on income from domestic sources. Under the reasonable assumption that tax rates on capital income vary across countries, it is clear that under the residence principle, returns to savers vary across countries (savings inefficiency), whereas the returns to investment across countries are equalised (investment efficiency), whereas the opposite is true under the origin principle. Sadka and Razin show that if terms of trade manipulation is ignored (i.e. each country believes it cannot alter the terms of trade), tax competition leads each country to choose the residence principle of taxation and equilibrium is constrained Pareto–efficient. This result is comparable to the results in this paper if the term "residence" is replaced by "destination". In particular, with a fixed terms of trade, the taxes chosen in the destination regime are the constrained Pareto–efficient Ramsey

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[19]Note that when tax rates are fixed following the switch, and labour is supplied inelastically, but where taxes are non–uniform, the regimes can be welfare–ranked. In the case with border controls, from (1) and (2) there is production efficiency, but consumption inefficiency (i.e. $q^a \neq q^b$). Comparing (3) and (4), however, there is consumption efficiency across countries (i.e. $q^a = q^b$), and also production efficiency as long as taxes are such that $p_2^a < c_2^a$ and $p_1^b < w.c_1^a$. Therefore, under these conditions, the abolition of border controls makes at least one country better off.

taxes.

Finally, it is worth mentioning some limitations of the analysis in this paper. One important extension would be to consider a less special demand structure, and allow for cross–price elasticities. In this case, the externality created by abolition would be more complex: an increase in (say) t_1^a would not only increase the price that country b's residents pay for good 1, but would also change b's tax base $x_2^b + x_2^a$. If the two goods were substitutes, b's tax base may in principle rise by enough to offset the negative price effect. A final extension is to consider models of intra–industry trade with imperfect competition, such as Krugman (1979) or Dixit(1984). This was done in an earlier version of this paper (Lockwood(1990)), where it was shown that an increase in the tax set by country a on the (single) traded good could again have a positive effect on b's tax base, and vice versa, in addition to the negative price effect.

Appendix

In this appendix, I show that the welfare functions (23) and (28) are have unique stationary points and are quasi–concave i.e. the second–order conditions for a maximum hold at the stationary point.

(a) *Tax Equilibrium with Border Controls*

The first–order conditions to the problem of choosing t_1^a, t_2^a to maximise (23), given (24) can be written

$$\lambda.(1+t_1^a)^{-\epsilon}.\Phi^1(t_1^a) = 0 \qquad \text{(A1)}$$

$$\lambda.(1+t_2^a)^{-\epsilon}.\Phi^2(t_2^a, w(t_2^a, t_1^b)) = 0 \qquad \text{(A2)}$$

where

$$\Phi^1 = \theta - \epsilon.\frac{t_1^a}{1+t_1^a} \qquad \text{(A3)}$$

$$\Phi^2 = w^{1-\epsilon}.\{[\theta-\epsilon.\frac{t_2^a}{1+t_2^a}] + \eta.[-\frac{1}{\lambda} + (1-\epsilon).\frac{t_2^a}{1+t_2^a}]\} \qquad \text{(A4)}$$

with $\eta = \dfrac{\epsilon}{1-2.\epsilon}$. These have unique solutions. For quasi–concavity of v^a, we need the Jacobian of the left–hand sides of (A1) and (A2) with respect to (t_1^a, t_2^a) be negative definite when evaluated at the unique solution of (A1)–(A2). As Φ^1 is independent of t_2^a, the cross–partials are zero. Therefore, negative definiteness requires simply:

$$\partial\Phi^1/\partial t_1^a < 0 \qquad \text{(A5)}$$

$$\partial\Phi^4/\partial t_2^a + (\partial\Phi^4/\partial w).\frac{dw}{dt_2^a} < 0 \qquad \text{(A6)}$$

From (A5) and (A3), It is clear that (A5) holds if and only if $\epsilon > \theta$. From (A6) and (A4), and given that $t_2^a = t_1^b > -1$ in symmetric equilibrium, (A6) holds if and only if;

$$\eta/\lambda - (1-\frac{1}{\lambda}) < 0 \tag{A7}$$

(b) *Tax Equilibrium without Border Controls*

The first–order condition to the problem of choosing t_a to maximise (28) subject to (29) can be written;

$$\lambda.(1+t_a)^{-\epsilon}.\Phi^2(t_a, w(t_a, t_b)) = 0 \tag{A8}$$

where

$$\Phi^3 = \quad [1+w^{1-\epsilon}-\frac{1}{\lambda}-(1+w^{1-\epsilon}).\epsilon.\frac{t_a}{1+t_a}] + \\ \eta.\{-\frac{w^{1-\epsilon}}{\lambda}.\frac{(1+t_b)^{1-\epsilon}}{(1+t_a)^{1-\epsilon}} + w^{\epsilon}.\epsilon.\frac{t_a}{1+t_a}] \tag{A9}$$

where now $\eta = (1-\epsilon)/(1-2.\epsilon)$. For quasi–concavity of v^a in (28), we need the derivative of the LHS of (A8) to be negative at the solution to (A8), which requires

$$\partial\Phi^3/\partial t^a + \partial\Phi^3/\partial w.\frac{dw}{dt_a} < 0 \tag{A10}$$

so from (A9), as long as $t > -1$, (A10) holds at the symmetric solution if and only if;

$$\frac{[2-1/\lambda-\eta/\lambda]}{2.\epsilon-\eta.\epsilon}.2.\epsilon + \frac{\eta}{\lambda}[(1-\epsilon).(1-\eta)] + \epsilon.(\eta-2) < 0 \tag{A11}$$

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Figure 1

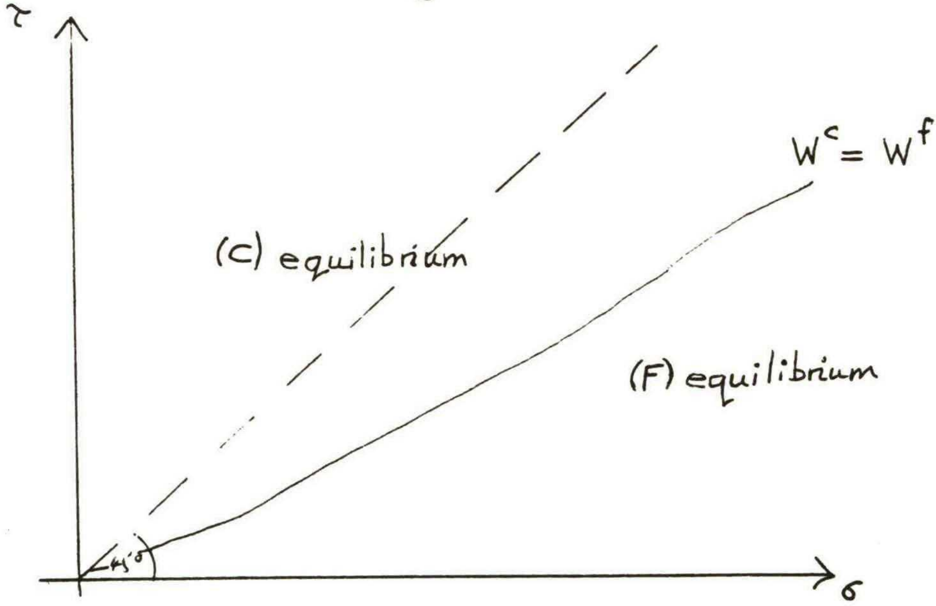
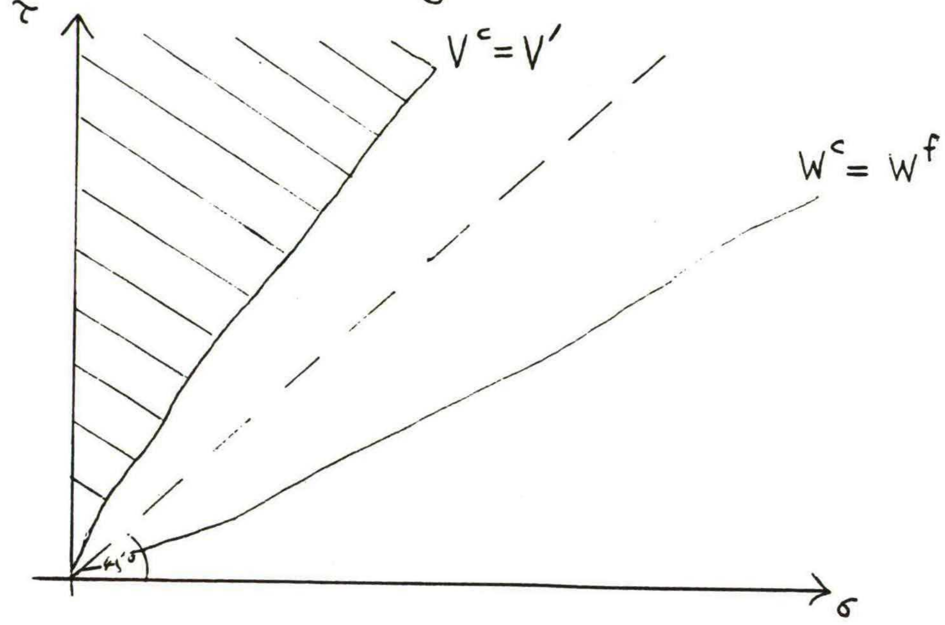


Figure 2



In the shaded region, there is a (c) equilibrium both with and without border controls

Figure 3

Values of t, z, and τ as ε varies

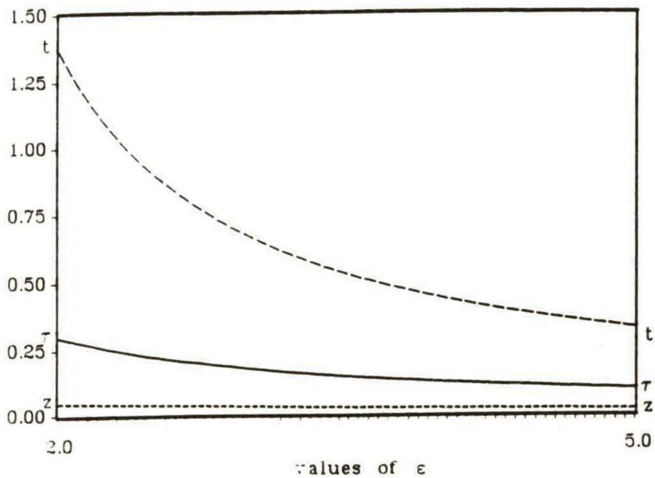
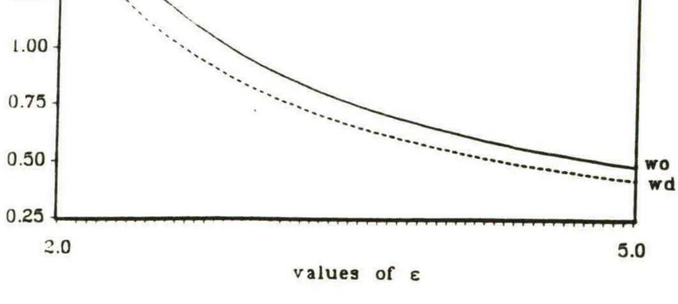


Figure 4

Values of consumer welfare as ε varies



Note: for all values of ϵ, $\lambda = 1.1$ and all second–order conditions are satisfied for all parameter values.

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