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## Asymmetric commodity tax competition: Are tax rates always too low?

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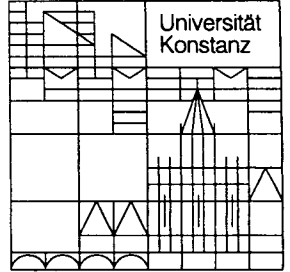
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Andreas Haufler

**Asymmetric  
Commodity Tax Competition:  
Are Tax Rates Always Too Low?**

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**Asymmetric Commodity Tax Competition:  
Are Tax Rates Always Too Low?**

**Andreas Haufler<sup>1</sup>**

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## **Abstract**

A widely noticed result by de Crombrugghe and Tulkens (1990) states that asymmetric commodity tax competition always leads to tax rates being too low in both countries, even though there are counteracting tax base and terms of trade effects. This note argues that the result depends crucially on the assumption that welfare in the high-tax region is concave in the tax rate of the low-tax country and shows that this assumption cannot generally be met in the underlying Mintz and Tulkens (1986) model. It is also shown that a tax increase in the low-tax country will hurt the high-tax region when the marginal transaction cost schedule is sufficiently elastic with respect to the level of cross-border shopping.

*JEL classification:* H23, H73

*Key words:* commodity tax competition, fiscal externalities

## 1. Introduction

In a widely noticed article, de Crombrugghe and Tulkens (1990) argue that when two countries play a Nash game in origin-based commodity taxes, both countries undersupply the public good in equilibrium, and raising each country's tax rate improves welfare in the other region. The result is obtained in the rather general model of commodity tax competition introduced by Mintz and Tulkens (1986), which allows for asymmetries between countries and imposes no specific constraints on the underlying utility and transaction cost functions. In this model, a tax rise in the low-tax country has both a public consumption effect (tax base effect) and a private consumption effect (terms of trade effect) on the high-tax region. While Mintz and Tulkens (MT hereafter) cannot sign the net effect in their paper, de Crombrugghe and Tulkens (CT hereafter) obtain the strong result that the public consumption effect always dominates in the Nash equilibrium and hence that the strategic setting of origin-based commodity taxes is always shaped, on net, by tax base considerations. Terms of trade effects – which play an important role, for example, in the related field of trade policy – could then be effectively neglected in a qualitative analysis of commodity tax competition.

Related studies, however, fail to obtain equally general results. Lockwood (1993) compares tax competition under destination and origin regimes and, in the latter case, cannot sign the net “strategic effect”, which is composed of the public and private consumption effects of the MT analysis. Other authors obtain the CT result, but only under additional constraints. Kanbur and Keen (1993) assume that the objective function of each country includes only public, but not private consumption and that the transaction cost function is quadratic in the volume of cross-border purchases. Haufler (1996) generalizes the first assumption but retains the specification of quadratic transportation costs. It is also worth looking at the literature on source-based capital taxation, which runs parallel in many respects. Here, a number of contributions have considered the case of symmetric countries, where no trade occurs in equilibrium and terms of trade effects are thus excluded (e.g. Zodrow and Mieszkowski, 1986; Bucovetsky and Wilson, 1991). When asymmetries between countries are introduced, however, then the tax shifting or terms of trade motive may dominate for the low-tax region, and this region may thus oversupply the public good in the Nash equilibrium (Bucovetsky, 1991, Lemma 2).

The present note argues that this conflict between the CT result and the findings of other studies is explained by the particular assumption made in the CT analysis that the

objective function of the high-tax region is concave in the tax rate of the low-tax country. It will be shown here that this assumption cannot generally hold in the underlying MT model. To develop the argument, section 2 sets up a simplified version of the MT framework which preserves the core features of the original model. In this setting section 3 shows that there must be a subset of transaction cost functions covered by the MT analysis, for which the private consumption effect dominates the public consumption effect and a tax increase in the low-tax region hurts the high-tax country. Section 4 ‘explains’ the divergence between this and the CT result by turning to the role of the concavity assumption made in the CT analysis. Section 5 concludes.

## 2. A simplified model of commodity tax competition

The purpose of this section is to present a simplified version of the Mintz-Tulkens model which is tailored to the issue under discussion here, yet preserves all the relevant features of the original framework. Any result that is to hold in the more general MT model must then also apply to the special case considered here.

There are two regions  $i$  and  $j$ , each inhabited by a representative household. For ease of exposition, we assume throughout the analysis that country  $i$  is the high-tax region. In the MT taxonomy (1986, p. 142) we focus on a particular regime ( $r = 3$ ), in which residents of country  $i$  shop in the neighbouring country; it is in this regime where the conflicting results arise. In comparison to the MT framework, the first simplification in the present model is that aggregate labour supply  $x^i, x^j$  (which is here defined positively) is fixed in each country. Without loss of generality, we also assume a production technology which transforms one unit of labour into one unit of output. With competitive conditions in production the price of labour and the producer price of the output good are then equal in each country. There is free trade in the untaxed good so that the common producer prices of the output good (or the prices of labor) can jointly be normalized to unity.

A consumption tax is levied in each country, leading to consumer prices of  $(1 + t^i)$  and  $(1 + t^j)$ . Residents of the high-tax country can, however, cross the border in order to take advantage of lower consumer prices abroad. National income in the high-tax region  $i$  is thus spent on domestic purchases,  $Q_i^i$ , and on cross-border purchases,  $Q_j^i$ , whereas residents of the low-tax country  $j$  spend all their income at home ( $Q_i^j = 0$ ). Cross-border shopping is subject to convex transaction costs  $\tau_j^i(Q_j^i)$ , which consume real resources. The budget

constraint for the high-tax country is<sup>1</sup>

$$(1 + t^i) Q_i^i + (1 + t^j) Q_j^i + \tau_j^i(Q_j^i) = x^i, \quad x^i \geq (1 + t^i), \quad (1)$$

where we assume (for reasons that will be explained below) that the labour endowment is sufficient to buy at least one unit of the private good. Taxes in both countries are used to finance local public goods  $R^i$  and  $R^j$ , respectively. Since the tax revenues from consumer purchases abroad remain in the country of origin, whereas balancing exports are untaxed, the government budget constraint for the high-tax country  $i$  is

$$R^i = t^i Q_i^i. \quad (2)$$

The second simplification in comparison to the MT model is made with respect to the transportation cost schedule for cross-border purchases. MT only assume that the schedule is convex and that  $\tau_j^i(0) = 0$ ,  $\tau_j^{i'}(0) \geq 0$ . We consider instead the more restricted set of isoelastic transaction cost functions

$$\tau_j^i = \frac{\beta}{\gamma} (Q_j^i)^\gamma, \quad \beta > 0, \quad \gamma > 1, \quad (3)$$

which satisfies the MT assumptions. Differentiating (3) with respect to  $Q_j^i$  leads to

$$\tau_j^{i'} = \beta (Q_j^i)^{(\gamma-1)} \geq 0, \quad \tau_j^{i''} = (\gamma - 1) \beta (Q_j^i)^{(\gamma-2)} \geq 0, \quad (4)$$

where the inequality signs hold strictly only for positive levels of  $Q_j^i$ . The constant elasticity of the marginal transaction cost schedule is given by

$$\frac{\partial \tau_j^i}{\partial Q_j^i} \frac{Q_j^i}{\tau_j^i} = \tau_j^{i'} \frac{Q_j^i}{\tau_j^i} = \gamma - 1. \quad (5)$$

Since marginal transaction costs start out from zero any tax differential leads to positive levels of trade. Thus the “double autarky” regime ( $r = 1$ ) in the MT analysis reduces to a straight line with  $t^i = t^j$ , which is a boundary line of the regime discussed here. Arbitrage by residents of the high-tax country ensures that the tax differential equals the marginal transaction costs incurred

$$\tau_j^{i'}(Q_j^i) = t^i - t^j, \quad t^i \geq t^j. \quad (6)$$

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<sup>1</sup>Budget balance implies that the high-tax country’s expenditures for cross-border shopping must be paid by exports of the untaxed numeraire good. This can either be interpreted as labour services performed abroad (as in MT) or – when labour is assumed to be internationally immobile – as the exportation of the single output good at *producer* prices. In the latter case, cross-hauling occurs as producers in the high-tax country export the single output good at net-of-tax prices to the low-tax region whereas consumers in the high-tax country re-import their own produce from the low-tax country in order to save taxes.



Solving the first equation in (4) for  $Q_j^i$  and substituting (6) determines the equilibrium level of cross-border shopping as a function of the tax differential

$$Q_j^i = \left( \frac{t^i - t^j}{\beta} \right)^{1/(\gamma-1)}. \quad (7)$$

The goal of country  $i$ 's government is to maximize the welfare of its representative consumer,  $U^i(Q^i, R^i)$ , where  $Q^i = Q_i^i + Q_j^i$  is aggregate private consumption and  $R^i$  is the tax-financed supply of the public good. The utility function is assumed to be continuously differentiable and strictly increasing in both arguments. Introducing the indirect utility function and incorporating the government budget constraint (2), the optimization problem is

$$\max_{t^i} V^i(t^i, t^j) \equiv U^i[Q^i(t^i, t^j), t^i Q_i^i(t^i, t^j)] \quad s.t. \quad (1), (7), \quad t^i - t^j \geq 0. \quad (8)$$

An analogous problem is solved by the low-tax country. The discontinuity of best response functions in the MT model, and the resulting possibility that no Nash equilibrium exists in pure strategies, has been discussed in detail in the original paper. It has been shown elsewhere, however, that identical transaction cost functions for the two countries and zero marginal transaction costs for the first unit of consumer purchases are sufficient to ensure the continuity of reaction functions in this model (Haufler, 1996). Assuming that the transaction cost parameters  $\beta$  and  $\gamma$  in (3) are equal in the trading countries will thus establish the existence of a Nash equilibrium in the present analysis.

### 3. A tax increase in the low-tax region

It is known from the analysis in MT (1986, Proposition 11) that, starting from a non-cooperative tax equilibrium, a small, exogenous tax increase in the high-tax region will unambiguously increase welfare in the low-tax country. Intuitively, there is only a public consumption effect (or tax base effect) in this case, which is always positive for the union partner and causes the high-tax region to undersupply the public good. However, when the low-tax region raises its tax rate then a negative private consumption effect (terms of trade effect) interacts with the tax base externality. Evaluating the partial derivative of (8) with respect to  $t^j$  at the optimal level of  $t^i$  gives<sup>2</sup>

$$\frac{\partial V^i}{\partial t^j} = \frac{\partial U^i}{\partial Q^i} \frac{\partial Q^i}{\partial t^j} + \frac{\partial U^i}{\partial R^i} t^i \frac{\partial Q_i^i}{\partial t^j}. \quad (9)$$

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<sup>2</sup>Equation (9) corresponds to eq. (16.3) in MT. Since  $t^i$  is optimized initially, the change in country  $i$ 's optimal tax rate induced by a variation in  $t^j$  has no first-order welfare effect on  $V^i$ .

The partial derivatives in (9) are determined by differentiating (1) and (7) with respect to  $t^j$ , using (4) and (6). This yields<sup>3</sup>

$$\frac{\partial Q_j^i}{\partial t^j} = -\frac{1}{\tau^i} < 0, \quad (10)$$

$$\frac{\partial Q_i^i}{\partial t^j} = \frac{-Q_j^i}{(1+t^i)} + \frac{1}{\tau^i} <> 0, \quad (11)$$

$$\frac{\partial Q^i}{\partial t^j} = \frac{-Q_j^i}{(1+t^i)} < 0, \quad (12)$$

where we have dropped the indices of the transportation cost function. The first effect in (9) is the *private consumption effect*; from (12) this is always negative for the high-tax region. Intuitively, for any initial level of cross-border shopping, a rise in  $t^j$  increases the commodity price for cross-border shoppers and thus reduces aggregate purchasing power in country  $i$  for a constant level of the domestic tax rate. The second effect in (9) is the *public consumption effect*. Importantly, it is seen from (11) that the tax base in the high-tax region does not necessarily increase following a rise in  $t^j$  because there are counteracting substitution and income effects. While the substitution effect (residents of country  $i$  returning to their home market after the increase in the foreign price) tends to increase country  $i$ 's tax base, the loss in purchasing power due to the private consumption effect also reduces country  $i$ 's tax base.

While MT (Proposition 10) cannot sign the net welfare effect in (9), it is claimed in CT (Proposition 1) that the overall effect of an increase in  $t^j$  must be unambiguously positive for country  $i$ , if the latter remains on its fiscal reaction curve. The following proposition argues that this cannot generally be true for all transaction cost functions covered by the MT framework:

**Proposition:** *If the elasticity of the marginal transaction cost schedule is sufficiently large, then a tax increase in the low-tax region must reduce welfare in the high-tax country for some range of initial tax rates  $t^j$ .*

*Proof:* The proof takes advantage of the fact that the sign of the derivative  $\partial Q_i^i / \partial t^j$  is ambiguous. Introducing the elasticity of the marginal transaction cost schedule (5) and

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<sup>3</sup>Equations (10)–(12) correspond to Proposition 2, case (b) in MT (1986, p. 140). This case applies when country  $i$  is in ‘mixed’ equilibrium; this is the regime on which the present discussion is focused. Note that there is a typographical error here in the MT paper, and all derivatives in the second row of case (b) should be taken with respect to  $t^j$ . Cf. also the appendix of the MT analysis (p. 164, eq. (A.7e)).

using (6), equation (11) can be rewritten as

$$\frac{\partial Q_i^i}{\partial t^j} = Q_j^i \left[ \frac{-1}{(1+t^i)} + \frac{1}{(\gamma-1)(t^i-t^j)} \right]. \quad (13)$$

As the exogenous elasticity of the marginal transaction cost schedule rises, an increase in  $t^j$  leads to a smaller reduction in the volume of cross-border shopping and the positive substitution effect declines for any initial tax differential. In the limit, equation (7) gives  $\lim_{\gamma \rightarrow \infty} Q_j^i = 1$ , so that cross-border shopping reaches a finite level that is *independent* of the tax differential  $t^i - t^j$  (as long as this remains strictly positive). Furthermore,  $x^i \geq (1+t^i)$  in (1) ensures that this level of cross-border shopping is feasible for residents of the high-tax country.<sup>4</sup> The derivative  $\partial Q_i^i / \partial t^j$  in (13) then approaches

$$\lim_{\gamma \rightarrow \infty} \frac{\partial Q_i^i}{\partial t^j} = \frac{-1}{(1+t^i)} < 0, \quad (14)$$

where the positive substitution effect has disappeared and only the negative income effect remains. Thus there must be a finite, critical elasticity of the marginal transaction cost schedule for which the effect of an increase in  $t^j$  on country  $i$ 's tax base and public good supply is nonpositive. At the same time, aggregate private consumption unambiguously falls from (12). It then follows from (9) that a rise in  $t^j$  must lower welfare in the high-tax country  $i$ .  $\square$

The intuition for our result is straightforward. For a very high elasticity of the transaction cost schedule, it is seen from (4) that the marginal costs of cross-border shopping are negligible as long as  $Q_j^i \leq 1$ , but they become prohibitive as soon as  $Q_j^i$  exceeds one. Together with the endowment restriction  $x^i \geq (1+t^i)$ , this implies that residents of the high-tax country always buy the first unit of the private good abroad, but all additional purchases are made in the home country. With the level of cross-border shopping effectively fixed, it is then obvious that a tax rise in  $t^j$  causes only a negative income effect in country  $i$  as long as the latter remains the high-tax region. While  $\gamma \rightarrow \infty$  is clearly an extreme assumption, we will show in the following section that counterexamples to the CT result can already be demonstrated for transaction cost schedules with an elasticity of  $\gamma - 1 = 2$ .

Note also that the finite loss in country  $i$ 's tax base (and the finite gain in the tax base of country  $j$ ) ensures that the optimal tax problems in both countries remain well-defined even as  $\gamma \rightarrow \infty$ . In particular, if countries differ exogenously in their preferences for

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<sup>4</sup>I thank Alain de Crombrughe for pointing out this additional requirement to me.

public goods then there will be a finite, positive tax differential in the Nash equilibrium.<sup>5</sup> Furthermore the arbitrage condition (6) is compatible with any positive tax differential  $t^i - t^j$  since the marginal transaction cost schedule is vertical at  $Q_j^i = 1$ . However, if the tax differential is very small in the initial Nash equilibrium, then the second term in (13) need not be zero even for large values of  $\gamma$ . We will return to this issue below and show that  $\partial V^i / \partial t^j$  is actually positive when  $t^i - t^j$  approaches zero. It is for this reason that the proposition allows for both a falling and a rising branch of  $V^i$  as a function of  $t^j$  for a given, elastic marginal transaction cost schedule.

#### 4. The role of the concavity assumption

The above result is in direct contrast to Proposition 1 in CT (1990, p. 346) which states that, starting from any asymmetric Nash equilibrium in the MT model, each country must gain from a tax increase in the other region. Clearly, our simplifications of the MT framework cannot be the reason for this difference since the CT analysis is based on the more general model, yet gives the stronger result. This section points out that the CT result depends crucially on the additional assumption introduced in their analysis that the (regime-specific) objective function of country  $i$  is *concave in the tax rate of region  $j$* . This is very different from the standard assumption that each country's objective is concave in *its own tax rate*, which ensures the second-order condition for a maximum to hold and is also made in the original MT analysis. It is argued here that the concavity assumption with respect to the foreign country's tax rate cannot generally be fulfilled in the MT model, and that it excludes the possibility of the high-tax country losing from a tax increase in the low-tax region.

The crucial part of the CT argument is step (3) in the proof of Proposition 1 (1990, p. 348), which builds on the concept of a regime-specific global maximum of a regional welfare function. This concept defines the maximum utility level attainable by the high-tax country  $i$  if it is able to choose *both* tax rates but is constrained not to leave the high-tax regime. It is then intuitive – and rigorously shown in Lemma 2 of CT – that for any choice of its *own* tax rate  $t^i$ , country  $i$  will choose the *foreign* tax rate just high enough to eliminate all losses from cross-border shopping by domestic residents. Thus an ‘optimal’ regime-specific tax pair  $(t^i, t^j)$  from the perspective of country  $i$  is always at the boundary of the

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<sup>5</sup>This is easily checked for the special case of fixed (but diverging) revenue requirements, which underlies our numerical analysis in the following section.

double-autarky regime, where no cross-border shopping occurs.<sup>6</sup> Any Nash equilibrium with positive levels of cross-border shopping (i.e., any Nash equilibrium in the interior of the relevant regime) thus implies that  $t^j$  is “too low” from the perspective of country  $i$ , relative to this regime-specific global optimum. But if this is so, then the assumption that country  $i$ ’s objective function is concave in  $t^j$  – used in step (3) of the proof – implies that country  $i$  must always benefit from an increase in  $t^j$ .

What has to be shown, then, is that  $V^i$  cannot be concave in  $t^j$  throughout the relevant regime, and for all permitted transaction cost schedules. The argument is based on the proposition of the previous section and is given in the following

**Corollary:** *If the elasticity of the marginal transaction cost schedule is sufficiently large, then at least some segment of country  $i$ ’s objective function must be convex in  $t^j$ .*

*Proof:* We consider the partial derivative  $\partial V^i / \partial t^j$  from (9), evaluated at the optimal choices of  $t^i$ , at the boundaries of the relevant regime. The minimum level of  $t^j$  within this regime is  $t^j = 0$ . Evaluating (13) at this point leads to

$$\left. \frac{\partial Q_i^i}{\partial t^j} \right|_{t^j=0} < 0 \quad \Leftrightarrow \quad \gamma - 1 > \frac{1 + t^i}{t^i}.$$

Since  $\partial Q_i^i / \partial t^j < 0$  from (12), a sufficient condition for  $V^i$  to be falling in  $t^j = 0$  is that  $(\gamma - 1)$  satisfies the above inequality. By the same argument as given above, this must be fulfilled for sufficiently high levels of  $\gamma$  since  $t^i$  will not generally approach zero when cross-border shopping is bounded from above. Consider now the other boundary of the regime, where  $t^j$  approaches  $t^i$  from below. From (12) this gives

$$\lim_{t^j \rightarrow t^i} \frac{\partial Q_i^i}{\partial t^j} = \lim_{t^j \rightarrow t^i} \frac{-Q_j^i}{(1 + t^i)} = 0,$$

since, from (7),  $Q_j^i$  approaches zero for  $t^j \rightarrow t^i$ . Thus private consumption is unaffected by an increase in  $t^j$  if the tax differential is very small initially. For the same reason, the first term in (13) also approaches zero and we get for the change in  $Q_i^i$

$$\lim_{t^j \rightarrow t^i} \frac{\partial Q_i^i}{\partial t^j} = \lim_{t^j \rightarrow t^i} \frac{1}{(\gamma - 1)} \frac{Q_j^i}{(t^i - t^j)} = \frac{1}{(\gamma - 1) \tau'''(0)} = +\infty,$$

where the second step has used l’Hôpital’s rule and (10), and  $\tau'''(0) = 0$  from the second equation in (4). Since  $Q_i^i$  (and thus  $R^i$ ) is rising in  $t^j$  while  $Q^i$  is unaffected,  $V^i$  must be increasing in  $t^j$  as the tax differential approaches zero.

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<sup>6</sup>In the special case considered here, where the ‘double autarky’ regime consists only of the straight line  $t^i = t^j$ , this implies that country  $i$  sets the foreign tax rate at the level of the optimal domestic tax rate.

Summarizing the behaviour of  $V^i(t^j)$  at the boundaries of the relevant regime, the function is falling for low levels of country  $j$ 's tax rate (and a high elasticity  $\gamma$ ) but is rising when  $t^j$  approaches  $t^i$  from below. Also, *within* the considered regime  $V^i$  must be continuous and differentiable in  $t^j$  since both arguments of the utility function are continuous and differentiable in  $t^j$  from (11) and (12). Hence, for sufficiently high levels of  $\gamma$ ,  $V^i(t^j)$  must have at least one local minimum within the relevant regime, and thus be convex in the neighbourhood of this minimum.  $\square$

The corollary confirms the CT analysis in the neighbourhood of a symmetric Nash equilibrium: if countries are rather similar, and the difference in Nash equilibrium tax rates is very small, then the high-tax country  $i$  will generally benefit from an increase in country  $j$ 's tax rate, irrespective of the transaction cost schedule. The intuition for this result is that cross-border shopping is low in the initial equilibrium, and hence the private consumption effect – which is proportional to  $Q_j^i$  – is negligible. However, if the tax differential in the initial equilibrium is sufficiently large due to different preferences for public goods, then the private consumption effect is substantial and dominates the substitution effect for high elasticities of the marginal transaction cost schedule.

The theoretical result is illustrated with a numerical analysis for the case where both countries have fixed revenue requirements.<sup>7</sup> Each country has a fixed endowment equal to  $x = 100$  and maximizes private consumption, subject to different constraints. The revenue requirement in country  $i$  is  $\bar{R}^i = 20$  whereas  $R^j$  is varied parametrically between zero and (slightly less than) 20. This yields a continuum of initial Nash equilibria with country  $i$  as the high-tax country. From each initial Nash equilibrium, a small (1 per cent) increase in  $t^j$  is considered and the numerical analysis is terminated before  $t^j$  reaches country  $i$ 's autarky tax rate.<sup>8</sup> The numerical specification of the transaction cost function (3) assumes  $\beta = 0.1$  and considers alternative values for  $\gamma \in \{1.5, 2.0, 3.0\}$ . Figure 1 plots country  $i$ 's maximized objective  $V_*^i$  (which equals  $Q^i$  since countries simply maximize private consumption in the presence of a fixed revenue constraint) as a function of  $t^j$  for each of the three transaction cost schedules.

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<sup>7</sup>This is discussed in MT (1986, p. 153) as a special case. However, the fixed revenue assumption is not critical in this context. Simulation results do not differ qualitatively if the utility function is of the Cobb-Douglas type, or if country  $i$ 's government maximizes tax revenues, as in Kanbur and Keen (1993).

<sup>8</sup>Given the endowment  $x = 100$  and the revenue constraint  $\bar{R}^i = 20$ , the autarky tax rate in country  $i$  is 25 per cent and the autarky level of private consumption is  $Q^i = 80$ .

\*\*\*\*\* Figure 1 about here \*\*\*\*\*

Figure 1 shows that the maximum value function  $V_{\star}^i(t^j)$  is concave only in the low-elasticity case  $\gamma = 1.5$ . In the intermediate case ( $\gamma = 2$ ) welfare in country  $i$  is still monotonously increasing in  $t^j$ , even though the maximum value function is convex in  $t^j$ . This shows that the concavity assumption made by CT is even stronger than necessary to obtain the result that a tax increase in the low-tax country benefits the high-tax region. In the high-elasticity case  $\gamma = 3$ , however, there is a falling branch of the function, and an increase in  $t^j$  lowers welfare in country  $i$  if country  $j$ 's tax rate is low initially. The intuition for the last result follows directly from our previous discussion: a low level of  $t^j$  implies a large tax differential and a high volume of cross-border shopping in the initial Nash equilibrium. From (12) the private consumption effect is thus strong in this case and an increase in  $t^j$  leads to a substantial loss of private purchasing power in country  $i$ . As country  $j$ 's revenue requirement is increased towards the level of  $\bar{R}^i$ , cross-border shopping is reduced and the income effect declines, relative to the substitution effect. This result is fully compatible with the general pattern underlying other models of tax competition: private consumption effects (terms of trade effects) are strong when differences between the trading countries are large, whereas tax base externalities dominate when countries are rather similar.

## 5. Conclusion

This note has argued that, in a general model of commodity tax competition between asymmetric regions, it is not possible to establish that tax rates will be unambiguously too low in the non-cooperative equilibrium. Rather, the more modest result in the original contribution by Mintz and Tulkens (1986) is correct that the high-tax region will unambiguously undersupply the public good in the non-cooperative equilibrium, whereas the low-tax region may either under- or oversupply the public good. The stronger result that tax base externalities dominate for both regions can be obtained only by imposing additional restrictions on transportation technology, which would require empirical support in a particular institutional setting. More generally, however, terms of trade considerations can play an important role in the strategic behaviour of a tax-exporting country, in particular when tax differentials are large between countries that face widely diverging revenue needs.

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Figure 1: Welfare in Country  $i$  as a Function of  $t^j$

