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**Tax Principles and Coordination
of Trade and Domestic Policies
under Imperfect Competition**

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TAX PRINCIPLES AND COORDINATION OF TRADE AND DOMESTIC POLICIES UNDER IMPERFECT COMPETITION

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Abstract

We construct an exporting monopoly model to compare destination- and origin-based commodity taxes in a context of a trade and domestic tax reform. We show that an export tax reduction and a change in destination (resp. origin) tax that fix the world price is strictly Pareto-improving (resp. deteriorating), which holds whether markets are integrated or segmented. This result may provide a new rationale for preferring the destination-based consumption tax to the origin-based production tax that has been discussed in the literature of tax harmonization and tax competition.

Keywords: export tax, consumption tax, production tax, monopoly, strict Pareto improvement/deterioration.

JEL Classifications: F12, F13, H2.

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I. INTRODUCTION

Trade liberalization taking the form of reductions in protective measures has markedly contributed to world trade growth. As is suggested theoretically and empirically, freer trade renders an individual country and the world better off.¹ However, many countries have still protected their trade flows. Export taxes are, among others, ‘by far the leading type of export restrictions’ (Fliess and Mard, 2012, p. 14) in the sense that they are used by 16 of the 29 countries in 2009, and 19 of the 35 countries in 2010. More updated evidence of Evenett and Jenny (2012) reports that export taxes and restrictions are the fifth top protective measure.² As a more specific example, WTO (2010, p. 11) states that ‘about one-third of all export taxes recorded in TPRs (Trade Policy Reviews) cover natural resource sectors,’ and that ‘export taxes occur with greater frequency in fishing and forestry than in fuels and mining.’ Furthermore, Tarr (2010) empirically finds that Russia greatly benefits from taxing its export of natural gas.

While these facts suffice to know the relevance of export taxes in modern world trade, export taxes have received less attention than import tariffs in the literature for two main reasons. First, one need not separately consider export taxes because Lerner’s Symmetry Theorem ensures the equivalence between import tariffs and export taxes. Second, import tariffs are arguably the most pervasive trade policy. However, depending on the situation, a straightforward application of tariff analysis is inappropriate since Lerner’s Theorem is no longer valid under imperfect competition, and ‘the rise of export taxes relative to other measures may be explained by a lack of discipline on export taxes in the WTO law’ (Solleder, p. 2) unlike the import tariff.

¹Love and Lattimore (2009) provide evidence suggesting welfare gains from trade liberalization.

²The other four are bail-outs, trade remedies, tariffs and non-tariff barriers.

Given these motivations, this paper considers the welfare effects of export tax reductions, but our focus is on the comparison between origin-based production taxes and destination-based consumption taxes that are adjusted to export tax reductions. More specifically, in a context of an exporting monopoly, we examine the welfare effects on exporting and importing countries of export tax reductions accompanied by a change in either of the above taxes so that the world price is fixed.³ The requirement to fix the world price owes to an influential work of Bagwell and Staiger (1999, 2002). According to them, if any change in trade taxes conforms to the reciprocity principle of the GATT/WTO, it must leave the world price unchanged. While they apply this observation to the *multilateral* trade reform, the idea therein is useful in discussing the *unilateral* trade reform.⁴ We demonstrate that using the destination-based consumption tax improves welfare while the opposite holds under the origin-based production tax. As a result, the choice of domestic taxes is very important in enjoying efficiency gains from export tax reductions. This conclusion may be helpful in practical policy-making of export tax reductions.

The coordinated reform of trade and domestic taxes has a large literature. Hatzipanayotou et al. (1994) and Keen and Ligthart (2002), assuming a perfectly competitive small open economy, prove that a point-by-point tariff reduction associated with a consumption tax increase improves both welfare and government revenue. However, Keen and Ligthart (2005) show that the same no longer survives a duopoly model.⁵ These authors assume the case of import tariffs, but the case of export taxes is dealt with by Emran (2005) and Emran and Stiglitz (2005). Emran (2005) shows a welfare- and revenue-increasing possibility of reducing export taxes and raising production taxes whereas Emran and Stiglitz (2005) turn to the welfare effects of reduc-

³The model we develop is similar to that of Ishikawa (2000), Ishikawa and Kuroda (2007), and Ishikawa and Mukunoki (2008a, b).

⁴We do not say that our policy reform either conforms to the reciprocity of the GATT/WTO or that it is reciprocity-based.

⁵The result of Keen and Ligthart (2005) is challenged by Naito and Abe (2008) and Fujiwara (2013) both of whom demonstrate the welfare- and revenue-improving possibility.

ing export taxes and raising consumption taxes. But, the previous studies neither address the world-price-fixing policy reform nor allow for imperfect competition in the exporting sector.

This paper proceeds as follows. Section II presents a model, and examines the welfare of the world-price-fixing policy reform in the case of origin-based production taxes. The case of destination-based consumption taxes is considered in Section III. Section IV compares our case with the perfectly competitive case of a small open economy, and briefly addresses the case of segmented markets while the main text focuses on the case of integrated markets. Section V concludes. The mathematical proofs of the main results are left into Appendix.

II. ORIGIN-BASED PRODUCTION TAXES

This section examines a welfare effect of a world-price-fixing reform composed of an export tax reduction and a production tax increase.⁶ Suppose two countries Home and Foreign, with an asterisk (*) denoting a Foreign variable. The utility function of each country is given by:

$$U = u(C_1) + C_2, \quad U^* = u^*(C_1^*) + C_2^*, \quad (1)$$

where U, C_1 and C_2 are utility and consumption of Goods 1 and 2, respectively, $u(\cdot)$ is an increasing, and strictly concave function, and Foreign's variables are similarly defined. Letting p and p^* be a (consumer) price of Good 1 measured by Good 2, utility maximization under the budget constraint yields $u'(C_1) = p$ and $u^{*'}(C_1^*) = p^*$, which are inverted to get demand functions $D(p) \equiv u'^{-1}(p)$ and $D^*(p^*) \equiv u^{*'}^{-1}(p^*)$.

The Home government imposes an export tax t and an origin-based production tax s both of which take a specific (per-unit) form whereas Foreign observes levies an import tariff t^* . Then, the relationship between the domestic prices and the world price p^W is given by $p+t = p^W$ and $p^* = p^W + t^*$.

⁶We may interchangeably use two terminologies 'origin-based tax' (resp. 'destination-based tax') and 'production tax' (resp. 'consumption tax') to have the same meaning.

And, Good 1 is monopolistically supplied by a Home firm whose output is denoted by X . When the world market is integrated, the market-clearing condition is⁷

$$D(p) + D^*(p^*) = D(p) + D^*(p + t + t^*) = X. \quad (2)$$

The Home price p that solves (2) is given by a function of X and $t + t^*$ as $p(X, t + t^*)$ that has the following properties.

$$p_X(X, t + t^*) \equiv \frac{\partial p(X, t + t^*)}{\partial X} = \frac{1}{D' + D^{*'}} < 0 \quad (3)$$

$$p_T(X, t + t^*) \equiv \frac{\partial p(X, t + t^*)}{\partial T} = -\frac{D^{*'}}{D' + D^{*'}} < 0, \quad (4)$$

where $T \equiv t + t^*$. In this paper, we assume linear demand so that $p_{XX} = p_{XT} = p_{TT} = 0$. While this is undoubtedly a restrictive assumption, it allows us to obtain clear results.

Making use of the inverse demand function $p(\cdot)$, the profit of the Home firm is defined by $p(X, t + t^*)X - cX - sX$, where $c \geq$ is a constant marginal cost. The first- and second-order conditions for profit maximization are⁸

$$Xp_X + p - c - s = 0, \quad 2p_X < 0. \quad (5)$$

Totally differentiating the first-order condition, we have⁹

$$2p_X dX = -p_T dt + ds, \quad (6)$$

and thus the equilibrium output responds to the two tax rates as follows.

$$\frac{\partial X}{\partial t} = -\frac{p_T}{2p_X}, \quad \frac{\partial X}{\partial s} = \frac{1}{2p_X}. \quad (7)$$

Using (7), we now define a world-price-fixing reform. To this end, let us note that the change in the world price $p^W = p(X, t + t^*) + t$ is

$$dp^W = \left(p_X \frac{\partial X}{\partial t} + p_T + 1 \right) dt + p_X \frac{\partial X}{\partial s} ds.$$

⁷Section IV deals with the segmented market case.

⁸In what follows, any argument of a function is suppressed unless any confusion arises.

⁹Note that the second-derivatives of $p(\cdot)$ are all zero from the assumption of linear demand.

Therefore, the requirement that the world price is frozen is given by $dp^W = 0$, and we have

$$ds = -\frac{p_X \frac{\partial X}{\partial t} + p_T + 1}{p_X \frac{\partial X}{\partial s}} dt = -(p_T + 2)dt = \frac{-2D' - D^{*'}}{D' + D^{*'}} dt = \left(-1 - \underbrace{\frac{D'}{D' + D^{*'}}}_{(-)} \right) dt, \quad (8)$$

where the last equality uses (3) and (4).

Eq. (8) suggests that the production tax must be raised so that the world price remains constant ($ds > 0$), and that the production tax must be raised by more than the reduced export tax ($|ds| > |dt|$). The reasons for these properties of the reform are as follows. When Home unilaterally reduces an export tax, the associated change in the world price is computed as

$$dp^W = \left(p_X \frac{\partial X}{\partial t} + p_T \right) dt + dt = \frac{p_T}{2} dt + dt.$$

According to this equation, a reduction in export taxes affects the world price in two ways. The first effect, which is captured by the first term in the right-hand side, gives the (indirect) effect associated with an increase in exports. Noting that the consumer price of Foreign is $p + t + t^*$, a reduction in t encourages Foreign demand, and hence raises the world price as is indicated by $(p_T/2)dt > 0$. The second effect is given by the last term in the above equation, which is a direct effect on the world price. As is inferred from the case of fixed world prices (small open economy), a fall in export taxes decreases the world price by expanding Home exports. In our model, the second effect is stronger than the first effect, and hence the world price declines as a result of export tax reductions.

Accordingly, the Home government needs to prevent the world price from falling by discouraging domestic production with a higher production tax. In addition, domestic production has to be over-taxed since the production tax alone is available. These properties of the reform in (8) will be helpful in interpreting its welfare effect.

When ds in the right-hand side of (6) is replaced with (8), it becomes

$$-p_T dt + ds = -2(p_T + 1)dt.$$

The rest of our task is to compute comparative statics outcomes associated with this change in t . A simple manipulation leads to the output change:

$$\left. \frac{\partial X}{\partial t} \right|_{dp^w=0} = -\frac{p_T + 1}{p_X}. \quad (9)$$

We now investigate the welfare effect of the above-defined tax reform. First of all, note that the proposed reform leaves Foreign neither better- nor worse-off since the Foreign welfare depends only on the world price, which is kept constant by construction. Therefore, we have only to know the welfare effect on Home in order to check whether this reform is strictly Pareto-improving, i.e., it raises the Home welfare without hurting Foreign in the absence of international transfers. Leaving the proof into Appendix, the main text states the main result.

Proposition 1: The integrated reform of export tax reductions and origin-based production tax increases that fixes the world price reduces welfare of Home, and achieves a strict Pareto deterioration.

We now intuitively interpret Proposition 1. As has already been addressed, the proposed tax reform requires the Home government to over-tax domestic production to cancel out the decline in the world price led by export tax reductions. The resultant effects of this reform are summarized in the first row of Table 1.

(Table 1 around here)

The natural consequence of the taxation on domestic production is that production becomes smaller. This output contraction raises the domestic price in Home while leaving the world price unaltered, and hence reduces Home's consumer surplus. Furthermore, the Home firm also loses its profit

from the decreased output. While the effect on government tax revenue G is unclear, the overall effect on welfare turns to be negative because the negative effects on consumer surplus and the firm profit play a dominant role. Taking into account that Foreign's welfare remains unchanged, the proposed policy reform ends up with a strict Pareto deterioration.

This result clearly suggests that using an origin-based production tax to accommodate trade liberalization is not recommended. Then, one naturally asks: what if the production tax is replaced by a destination-based consumption tax? We answer this question in the next section.

III. DESTINATION-BASED CONSUMPTION TAXES

This section examines how the negative evaluation in the last section is modified if a destination-based consumption tax is employed instead of an origin-based production tax. As will be clear, this alternative reform strategy has a desirable property in the sense that it ensures a strict Pareto improvement.

When the Home government imposes a destination-based consumption tax τ and an export tax t , and the Foreign government uses an import tariff t^* , we have a relationship between the two countries' domestic prices and the world price as follows: $p + t = p^W + \tau$ and $p^* = p^W + t^*$. Thus, eliminating p^W , the world market-clearing condition is

$$D(p) + D^*(p^*) = D(p) + D^*(p + t + t^* - \tau) = X. \quad (10)$$

Solving (10) for p gives $p(X, t + t^* - \tau)$ with the following properties:

$$p_X(X, t + t^* - \tau) \equiv \frac{\partial p(X, t + t^* - \tau)}{\partial X} = \frac{1}{D' + D^{*'}} < 0 \quad (11)$$

$$p_T(X, t + t^* - \tau) \equiv \frac{\partial p(X, t + t^* - \tau)}{\partial T} = -\frac{D^{*'}}{D' + D^{*'}} < 0, \quad (12)$$

where $T \equiv t + t^* - \tau$. Using this inverse demand function, the profit of the Home firm is defined by $[p(X, t + t^* - \tau) - \tau]X - cX$, and the first- and second-order conditions for profit maximization are

$$Xp_X + p - c - \tau = 0, \quad 2p_X < 0. \quad (13)$$

Recalling the assumption of linear demand, total differentiation of the first-order condition yields

$$2p_X dX = -p_T dt + (p_T + 1)d\tau, \quad (14)$$

which leads to the comparative statics outcomes as follows.

$$\frac{\partial X}{\partial t} = -\frac{p_T}{2p_X}, \quad \frac{\partial X}{\partial \tau} = \frac{p_T + 1}{2p_X}. \quad (15)$$

We are ready to define the world-price-fixing change in destination-based consumption taxes and export taxes. Considering that in the present case the world price is $p^W = p(X, t + t^* - \tau) + t - \tau$, its change associated with a small increment in t and τ becomes

$$dp^W = \left(p_X \frac{\partial X}{\partial t} + p_T + 1 \right) dt + \left(p_X \frac{\partial X}{\partial \tau} - p_T - 1 \right) d\tau.$$

Accordingly, in order to leave p^W unaltered, the two tax rates must change according to

$$d\tau = -\frac{p_X \frac{\partial X}{\partial t} + p_T + 1}{p_X \frac{\partial X}{\partial \tau} - p_T - 1} dt = \frac{p_T + 2}{p_T + 1} dt = \frac{2D' + D^*'}{D'} dt = \left(1 + \underbrace{\frac{D' + D^*'}{D'}}_{(+)} \right) dt, \quad (16)$$

by setting $dp^W = 0$. The last equality is obtained by substituting (11) and (12). Eq. (16) provides us with two properties of the reform similar to the production tax case.

The origin-based consumption tax must be lowered ($d\tau < 0$), and the extent of the reduction in consumption tax must be larger than the extent of the export tax reduction ($|d\tau| > |dt|$). As was noted in the previous section, an export tax reduction results in a fall in the world price. Thus, the Home government should encourage domestic consumption by lowering the consumption tax so as to keep the world price unaltered. Furthermore, because the origin-based consumption tax can affect only the consumption, the Home government needs to over-reduce the consumption tax.

Substituting $d\tau$ above into (14), its right-hand side is rewritten as

$$-p_T dt + (p_T + 1)d\tau = (-p_T + p_T + 2)dt = 2dt.$$

That is, making comparative statics under this reform amounts to making comparative statics under this change in t . Then, the equilibrium output is affected by the reform as

$$\left. \frac{\partial X}{\partial t} \right|_{dp^W=0} = \frac{1}{p_X}. \quad (17)$$

Straightforward manipulations give rise to:

Proposition 2: The integrated reform of export tax reductions and destination-based consumption tax reductions that fixes the world price raises welfare of Home, and achieves a strict Pareto improvement.

The second row of Table 1 allows us to develop the intuitions behind Proposition 2. As was commented, the Home government over-reduces the consumption tax in response to the reduced export tax. This reduction in the consumption tax naturally increases domestic consumption, which involves a gain in consumer surplus. The Home firm, on the other hand, expands output in response to this incremental demand, which leads to an increase in the firm profit. Although the effect on government revenue is ambiguous, the total effect on welfare ends up being positive since the favorable effects on consumer surplus and the firm profit are large enough to outweigh the government revenue effect. Since Foreign is neither better-off nor worse-off, the proposed reform guarantees a strict Pareto improvement, namely, it raises the Home welfare without hurting Foreign.

It is worth mentioning that Propositions 1 and 2 provide a simple but important implication concerning the comparison of two tax bases. They propose adopting destination-based consumption taxes rather than origin-based production taxes if they accompany the export tax reductions, and the reform is subject to the constraint that Foreign is left no-worse-off.

As we reviewed in Introduction, the superiority of the destination-based consumption tax over the origin-based production tax has already been demonstrated by Keen et al. (2002), Haufler and Pfluger (2004) and Haufler et al. (2005). While Keen et al. (2002) reach this conclusion in a context of tax harmonization with an oligopoly model, Haufler and Pfluger (2004) (resp. Haufler et al. (2005)) obtain the same in a context of a noncooperative tax setting with a monopolistically competitive model (resp. a segmented market oligopoly model). Our findings could complement these contributions in the sense that we have also shown the superiority of the destination tax in a context of a trade and domestic tax reform which has not been considered.

IV. DISCUSSIONS

This section compares our results with the perfectly competitive case of a small open economy, and then briefly mentions the setting of market segmentation.

Small open economy

The reform of trade and domestic taxes is addressed in Hatzipanayotou et al. (1994), Keen and Ligthart (2002), Emran (2005), and Emran and Stiglitz (2005), all of which assume a small open country and a point-by-point replacement of trade taxes with a domestic tax. While their arguments are proved mathematically, the key idea is understood by noting that the effect of an export tax is decomposed into the effect of a production tax and that of a consumption subsidy. Thus, reducing the export tax and raising the production tax simultaneously ensures a welfare improvement because the export-tax-distorted consumption is removed, with the production level unchanged. This result is in sharp contrast to Proposition 1 above, and the reason for this difference in conclusions is attributed to the effect on domestic production. In the case of perfect competition, the tax reform (positively) affects on the consumer without affecting the producer since $|ds| = |dt|$. In

contrast, both domestic production as well as domestic consumption is influenced by the reform because the fixed world prices require $|ds| > |dt|$, which eventually leads to welfare losses.

If, on the other hand, export tax reductions are accompanied by consumption tax decreases in a point-by-point way ($|dt| = |d\tau|$), domestic consumption is kept constant but export-tax-distorted production is eliminated, thereby improving welfare. This positive welfare effect is qualitatively the same as Proposition 2, welfare improvements in our model are due to output expansion induced by the reform.

Segmented markets

While the foregoing arguments hinge on the assumption that the world goods market is integrated, it may be useful to address the case of segmented markets. We show that results similar to Propositions 1 and 2 survive market segmentation. Formally, we can claim:

Proposition 3: The integrated reform of export tax reductions and origin (resp. destination) -based production (resp. consumption) tax changes that fixes the world price reduces (resp. raises) welfare of Home, and achieves a strict Pareto deterioration (resp. improvement).

(Table 2 around here)

While most of the intuitions behind Propositions 1 and 2 are valid in the segmented market case as well, we should note that the suggested reform changes the Foreign welfare unlike the integrated market case (see Table 2). This is because the effect of the reform on the delivery into the Foreign market becomes non-zero. In spite of this difference, the final results are parallel between the cases of integrated markets and segmented markets.

V. CONCLUDING REMARKS

This paper has explored how the difference between origin-based production taxes and destination-based consumption taxes affects the welfare effect of a trade and tax reform. We have established that a world-price-fixing reform has a positive welfare effect under destination-based consumption taxes while the opposite holds under origin-based production taxes. Our result may be a helpful reference in the debate over the choice of the two tax principles that has been made in a context of tax harmonization and a noncooperative tax setting.

Despite the above novelty, we have admittedly made a number of simplifying assumptions to make the result as transparent as possible. First, we have focused on the case of integrated markets in which an arbitrage between the two countries is allowed. However, we can show that the main results in this paper are true of market segmentation. Second, we have intentionally chosen a model of international monopoly in which the profit-shifting effect is absent. The biggest limitation of this setting is that we can not properly discuss a reduction in import tariffs. In view of the fact that import tariffs are the most popular trade policies, we need to make a further analysis by comprising an import tariff. These extensions and further elaborations are left as future research agenda.

APPENDIX

a) Proof of Proposition 1

Home's welfare W consists of consumer surplus CS , the firm profit π and government revenue G each of which is defined as

$$CS \equiv u(D(p(X, t + t^*))) - p(X, t + t^*)D(p(X, t + t^*)) \quad (18)$$

$$\pi \equiv p(X, t + t^*)X - cX - sX \quad (19)$$

$$G \equiv sX + t[X - D(p(X, t + t^*))], \quad (20)$$

where X in these equations is affected by s and t .

The change in CS associated with the suggested reform is¹⁰

$$\left. \frac{\partial CS}{\partial t} \right|_{dp^W=0} = -D \cdot \left(p_X \left. \frac{\partial X}{\partial t} \right|_{dp^W=0} + p_T \right) = D, \quad (21)$$

because (9) is equivalent to

$$p_X \left. \frac{\partial X}{\partial t} \right|_{dp^W=0} + p_T = -1.$$

The change in π is

$$\left. \frac{\partial \pi}{\partial t} \right|_{dp^W=0} = p_T X - \frac{\partial s}{\partial t} X = 2(p_T + 1)X, \quad (22)$$

where we have used (8) to replace ∂s above. Finally, the change in G becomes

$$\begin{aligned} \left. \frac{\partial G}{\partial t} \right|_{dp^W=0} &= \frac{\partial s}{\partial t} X + s \left. \frac{\partial X}{\partial t} \right|_{dp^W=0} + X - D + t \left[\left. \frac{\partial X}{\partial t} \right|_{dp^W=0} - D' \cdot \left(p_X \left. \frac{\partial X}{\partial t} \right|_{dp^W=0} + p_T \right) \right] \\ &= X - D + (t + s) \left. \frac{\partial X}{\partial t} \right|_{dp^W=0} + \frac{\partial s}{\partial t} X - t D' \cdot \left(p_X \left. \frac{\partial X}{\partial t} \right|_{dp^W=0} + p_T \right) \\ &= X - D - \frac{(t + s)(p_T + 1)}{p_X} - (p_T + 2)X + t D'. \end{aligned} \quad (23)$$

Summing up Eqs. (21)-(23) and rearranging terms, the welfare effect is eventually obtained as

$$\left. \frac{\partial W}{\partial t} \right|_{dp^W=0} = \frac{(X p_X - t - s)(p_T + 1) + t p_X D'}{p_X},$$

which, by using (3) and (4), simplifies to

$$\left. \frac{\partial W}{\partial t} \right|_{dp^W=0} = (X p_X - s) D' = -(p - c) D' > 0, \quad (24)$$

where the right-hand side uses the first-order condition for profit maximization.

¹⁰The utility maximization condition $u' = p$ is used to obtain (21).

Note finally that the Foreign welfare is unchanged with this reform because both consumer surplus and tariff revenue solely depend on the world price p^W as follows.

$$\begin{aligned} CS^* &\equiv u^*(D^*(p^W + t^*)) - (p^W + t^*)D^*(p^W + t^*) \\ G^* &\equiv t^*D^*(p^W + t^*). \end{aligned}$$

b) *Proof of Proposition 2*

Once we know (17), the effects on three components of welfare are found just by differentiations and substitutions. Home's welfare consists of

$$CS \equiv u(D(p(X, t + t^* - \tau))) - p(X, t + t^* - \tau)D(p(X, t + t^* - \tau)) \quad (25)$$

$$\pi \equiv [p(X, t + t^* - \tau) - \tau]X - cX \quad (26)$$

$$G \equiv \tau D(p(X, t + t^* - \tau)) + t[X - D(p(X, t + t^* - \tau))]. \quad (27)$$

Since the rest of our manipulations is the same as those in the previous section, it suffices to briefly outline the argument.

The change in CS is

$$\begin{aligned} \left. \frac{\partial CS}{\partial t} \right|_{dp^W=0} &= -D \cdot \left[p_X \left. \frac{\partial X}{\partial t} \right|_{dp^W=0} + p_T \left(1 - \frac{\partial \tau}{\partial t} \right) \right] \\ &= -\frac{D}{p_T + 1}, \end{aligned} \quad (28)$$

by noting that

$$p_X \left. \frac{\partial X}{\partial t} \right|_{dp^W=0} + p_T \left(1 - \frac{\partial \tau}{\partial t} \right) = \frac{1}{p_T + 1}.$$

The change in π is

$$\left. \frac{\partial \pi}{\partial t} \right|_{dp^W=0} = p_T X + \left(p_T \frac{-\partial \tau}{\partial t} - \frac{\partial \tau}{\partial t} \right) X = -2X, \quad (29)$$

Finally, the change in G is

$$\left. \frac{\partial G}{\partial t} \right|_{dp^W=0} = \frac{\partial \tau}{\partial t} D + \tau D' \cdot \left[p_X \left. \frac{\partial X}{\partial t} \right|_{dp^W=0} + p_T \left(1 - \frac{\partial \tau}{\partial t} \right) \right] + X - D$$

$$\begin{aligned}
& +t \left\{ \left. \frac{\partial X}{\partial t} \right|_{dp^W=0} - D' \cdot \left[p_X \left. \frac{\partial X}{\partial t} \right|_{dp^W=0} + p_T \left(1 - \frac{\partial \tau}{\partial t} \right) \right] \right\} \\
& = X + \frac{D}{p_X D'} + \frac{\tau}{p_X}. \tag{30}
\end{aligned}$$

Summing up Eqs. (28)-(30) and rearranging terms, the welfare effect turns out to be

$$\left. \frac{\partial W}{\partial t} \right|_{dp^W=0} = \frac{-X p_X + \tau}{p_X} = (p - c) (D' + D^{*'}) < 0. \tag{31}$$

where the right-hand side uses the first-order condition (13).

Since the proposed reform leaves the Foreign welfare unaltered, we have arrived at Proposition 2.

c) Proof of Proposition 3

When the market of the two countries is segmented, the market-clearing condition is $D(p) = x$ and $D^*(p^*) = x^*$, which is inverted to get the inverse demand functions: $p(x)$ and $p^*(x^*)$. In the case of origin taxation, the monopolist's profit is $p(x)x + p^*(x^*)x^* - c \cdot (x + x^*) - s \cdot (x + x^*) - (t + t^*)x^*$, and hence the first-order conditions for profit maximization are

$$x p' + p - c - s = 0, \quad x^* p^{*'} + p^* - c - s - t - t^* = 0. \tag{32}$$

Totally differentiating (32), we have

$$\frac{\partial x}{\partial t} = 0, \quad \frac{\partial x}{\partial s} = \frac{1}{2p'}. \tag{33}$$

Since the world price of Good 1 is defined by $p^W = p(x) + t$, the change in the export tax and the production tax that fixes it is given by

$$\begin{aligned}
dp^W & = \left(p' \frac{\partial x}{\partial t} + 1 \right) dt + p' \frac{\partial x}{\partial s} ds = 0 \\
\Rightarrow ds & = -\frac{p' \partial x / \partial t + 1}{p' \partial x / \partial s} dt = -2dt,
\end{aligned}$$

where use is made of (33). Applying the same manipulation as the case of integrated markets, the present reform affects x and x^* as follows.

$$\left. \frac{\partial x}{\partial t} \right|_{dp^W=0} = -\frac{1}{p'}, \quad \left. \frac{\partial x^*}{\partial t} \right|_{dp^W=0} = -\frac{1}{2p^{*'}}. \tag{34}$$

In this case, consumer surplus, the firm profit, and tax revenue in each country is

$$\begin{aligned}
CS &\equiv \int_0^x p(y)dy - p(x)x \\
\pi &\equiv p(x)x + p^*(x^*)x^* - c \cdot (x + x^*) - s \cdot (x + x^*) - (t + t^*)x^* \\
G &\equiv tx^* + s \cdot (x + x^*) \\
CS^* &\equiv \int_0^{x^*} p^*(y^*)dy^* - p^*(x^*)x^* \\
G^* &\equiv t^*x^*.
\end{aligned}$$

Differentiating these welfare components with respect to t , and substituting (34), the welfare effect on each country is computed as follows.

$$\left. \frac{\partial W}{\partial t} \right|_{dp^W=0} = -\frac{p-c}{p'} - \frac{t+s}{2p^{*'}} > 0, \quad \left. \frac{\partial W^*}{\partial t} \right|_{dp^W=0} = -\frac{p^*-c-s-t}{2p^{*'}} > 0.$$

Table 2 summarizes the effect of the reform on each component above. What differs from the integrated market case is that the Foreign welfare (negatively) changes as a result of the suggested reform. Despite this difference, we can conclude that the reform is detrimental to the world welfare since both Home and Foreign lose from it.

Let us finally address the case where the destination-based consumption is imposed. We outline the core arguments very briefly because one has only to iterate the above manipulations. In the presence of a consumption tax τ , the Home firm's profit is $p(x)x + p^*(x^*)x^* - c \cdot (x + x^*) - \tau x - (t + t^*)x^*$. The first-order conditions are

$$xp' + p - c - \tau = 0, \quad x^*p^{*'} + p^* - c - t - t^* = 0.$$

Taking into account that the world price is equal to $p^W = p(x) - t - \tau$, the two taxes must change according to $d\tau = 2dt$ so as to fix p^W . Utilizing this observation, the output effects are obtained as

$$\left. \frac{\partial x}{\partial t} \right|_{dp^W=0} = \frac{1}{p'}, \quad \left. \frac{\partial x^*}{\partial t} \right|_{dp^W=0} = \frac{1}{2p^{*'}}.$$

The welfare components of each country are defined analogously to the production tax case, excepting that the Home tax revenue is now defined by $G \equiv tx^* + \tau x$. The final outcome is

$$\left. \frac{\partial W}{\partial t} \right|_{dp^W=0} = \frac{p-c}{p'} + \frac{t}{2p^{*'}} < 0, \quad \left. \frac{\partial W^*}{\partial t} \right|_{dp^W=0} = \frac{p^* - c - t}{2p^{*'}} < 0,$$

from which we can say that the present reform favorably affects both the Home and the Foreign countries.

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	X	CS	π	G	W	W^*	$W + W^*$
production tax	-	-	-	?	-	0	-
consumption tax	+	+	+	?	+	0	+

Table 1: The effects of the reforms (integrated markets)

	$x + x^*$	CS	π	G	W	CS^*	G^*	W^*	$W + W^*$
production tax	-	-	-	?	-	-	-	-	-
consumption tax	+	+	+	?	+	+	+	+	+

Table 2: The effects of the reforms (segmented markets)