Tax competition and production subsidies: how to deal with cost shocks and the Inflation Reduction Act

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Abstract. We analyze current issues of how to react to both jumps in energy cost and international tax competition as implied by the Inflation Reduction Act of the Biden administration. Our two-country framework exhibits international cost differentials and imperfect competition in many sectors. The high-cost country uses profit taxes to steer location decisions and may add tariffs. When a production cost subsidy is available, it will be reduced upon encountering higher domestic cost because imports become more attractive. In the absence of tariffs, lower foreign profit taxes affect neither the domestic profit tax nor the domestic production subsidy. By contrast, an increase in the foreign production subsidy will be met by higher profit taxes so as to exploit the increased value of relocating firms and, if available, higher tariffs.

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1. Introduction

Several European countries are currently facing substantial competitive challenges. In the recent period we have witnessed considerable increases in energy prices in several categories, including gas, oil and electricity. Firms in sectors using energy heavily encounter a substantial rise in production cost. The persistent cost gaps may lead firms to leave the high-cost countries, albeit at some substantial setup cost. Moreover, the Inflation Reduction Act (IRA) of the Biden administration attracts firms to produce in the US via production subsidies so as to support carbon-saving production processes. This adds to an earlier tax reform of the Trump administration that had cut profit taxes for firms producing in the US. According to the German Chamber of Industry and Commerce, more than half of the German enterprises employing more than 500 workers are currently considering relocating production. In a poll of around 3,300 companies in 2024, 37% planned cutting production or moving abroad, rising from only 16% in 2022 (MSN, 2024). Against this background, some countries have implemented or increased energy subsidies while others are thinking about introducing them. Fossil fuel subsidies in the European Union more than doubled after the outbreak of the Ukraine war, rising from 56 billion EUR in 2021 to 123 billion EUR in 2022 (European Environment Agency, 2023). Production subsidies may also be appealing to curb inefficiencies in overall output in imperfect markets. They can be complemented by adapting profit taxes or tariffs as more standard instruments in international tax competition. In the political debate, possible retailiation subsidies by the EU against the IRA are heavily disputed: while Bernoth and Meyer (2023) call for easing state aid rules in the EU, Grimm et al. (2023) consider a subsidization race as risky.

Differences in energy prices may indeed induce relocation decisions in view of substantial heterogeneity across countries. For example, Statista (2024a) reports that at the end of 2023 electricity prices (all in U.S. Dollars per kilowatt hour) in the UK (0.47), Italy (0.47) and Germany (0.27) exceeded to a considerable extent prices in France (0.19), Japan (0.14), the U.S. (0.14), India (0.13) and China (0.09). Similarly, natural gas prices for the industrial sector in 2020 U.S. dollars per megawatt hour in France (37.78), Germany (26.4) and UK (25.46) outpaced the respective levels in the U. S. (10.86) and Canada (9.87) by more than 100 per cent (Statista, 2024b).

The questions we are addressing are as follows: First, how can the emergence and popularity of production subsidies be explained? Second, how does a cost shock affect choices of profit taxes, tariffs and production subsidies? Third, how will a government change its policy faced with lower profit taxes or production subsidies abroad?

We analyze a model of oligopolistic competition with many sectors where domestic firms face a disadvantage in unit production cost. This structure captures stylized facts of international cost differentials and acknowledges some market power of internationally operating enterprises. Domestic firms are differentiated according to cost of relocation such that firms with low relocation cost will move abroad. Accordingly, some markets fall under the trade regime where part of demand is served via domestic production, while demand in other sectors is met exclusively by imports. The government of the high-cost country taxes profits of firms producing domestically and may also be allowed to impose tariffs on imports. It maximizes rents consisting of consumer surplus, capital income of its citizens and government revenue. Tax policy abroad is taken as exogenous.

In our framework, the profit tax serves as an instrument to affect location decisions of firms. It will be set at a level where the rent differential between the import and the trade regime equals the relocation cost of the pivotal firm. In a first benchmark scenario, we consider a version in which consumption takes place abroad. Consequently, there is no tariff, and impacts on consumer surplus are ignored. In that situation, the profit tax is set to zero in the absence of output subsidies because there is no need to correct location choices. However, if output subsidies are available, they will be used for shifting profits from foreign to domestic firms. This in turn entails a positive fiscal externality of relocation which will be internalized by a corresponding profit tax.

We move on by analyzing frameworks with domestic consumption, adding consumer surplus as additional policy objective. Consumers benefit both from higher overall production and lower prices, which can be achieved by driving firms into low-cost locations as well as by subsidizing their output. Consequently, profit taxes will al-

ways remain positive, decreasing with increasing production cost abroad. The tariff choice balances revenue against market rent losses. They tend to be higher under the trade regime because profit can then be redistributed to domestic firms. Therefore, tariff levels rise in the fraction of sectors in which the output is produced also in the country under consideration. Interestingly, the reaction of the profit tax to higher domestic unit cost depends on the availability of the tariff instrument. Without the tariff, the profit tax increases because the import regime becomes more attractive in terms of consumer surplus. This result is turned around with an endogenous tariff since the consumer surplus effect is then dominated by higher tariff revenue under the trade regime, implying a lower profit tax.

We extend the model by allowing for an output subsidy granted to firms producing in the high-cost country. The output subsidy is set so as to balance gains in consumer surplus and profit of domestically producing firms against the cost of the subsidy. It turns out that the output subsidy will be implemented if the tariff per unit falls short of the domestic market rent, which occurs when the international cost differential is not too high. If such an output subsidy is employed, it will induce lower tariff and higher profit taxes. Without tariff, it decreases with higher domestic cost. This happens because the cost shock again makes the import regime more attractive.

Turning to policy changes abroad, we consider reductions in foreign profit taxes and an introduction or increase of foreign output subsidies. Changes in foreign profit taxes mainly affect location decisions. Again, the reaction of the domestic profit tax depends on the availability of the tariff instrument. Without tariffs, the domestic profit tax does not react since the relevant consumer rent differential stays unchanged. With endogenous tariff, the tariff will decrease due to a higher share of sectors working under the import regime. This is combined with a lower own profit tax due to the reduced fiscal externality of relocation. New or increased foreign output subsidies yield higher tariff levels since the associated cost in terms of consumer surplus declines. At the same time, the higher profitability of producing abroad induces an increase in profit taxes.

Finally, if the country under consideration also uses a production subsidy, the subsidy is not affected by a cut of the foreign profit tax or an increase in the foreign subsi-

dy in a free trade environment. However, with endogenous tariff, these measures induce opposite impacts. A lower foreign profit tax is met by lower tariff and higher domestic subsidy because the smaller tariff makes the output subsidy mote effective. By contrast, at given distribution of sectors into the trade and import regime a higher foreign production subsidy induces higher tariff and lower own production subsidy.

Our contribution is related to several strands of the literature. First, the tax competition literature stresses that governments respond to foreign corporate income tax cut by reducing domestic tax rates so as to attract capital (Devereux et al., 2008, Langenmayr et al, 2013, Keen and Konrad, 2013). Our approach arrives at different conclusions pointing to potential extra profits of inframarginal firms due to cost heterogeneity. Second, tariffs have been dismissed since Adam Smith as distorting prices and reducing consumer welfare. Responding to a favorable production environment abroad due to lower input prices, subsidies or tax cuts seems irrational. However, with strategic trade policies in international oligopoly, as surveyed by Head and Spencer (2017), the use of tariffs can raise national welfare via redistributing profits to domestic firms (Brander and Spencer, 1984; Dixit 1984). In a dynamic context, tariffs may be used in a transition period if otherwise building the corresponding domestic "infant" industry is impossible (Melitz, 2005). Finally, political economy considerations like resistance against redistribution or national security issues may matter for formulation trade policies (Baldwin, 1989). Third, production subsidies have attracted renewed attention in the form of export subsidies. These can increase national welfare in a Cournot duopoly setting (Brander and Spencer, 1985) and will be increased if the international cost differential is narrowing or if learning-by-doing effects are taken into account (Neary, 1994). For given international duopoly, the choice of the combination of production subsidy or tax and the use of a tariff changes qualitatively when moving from Cournot to Bertrand competition (Cheng, 1988). Our contribution is largely in line with the view of the papers dealing with strategic trade policies that justify tariffs and subsidies in the presence of imperfect competition, where we add the interactions with tax competition and related location decisions of firms. Among the few contributions trying to combine tax competition and strategic trade policy issues, Janeba (1998) considers a tax competition game with two countries in which governments commit to policies be-

fore firms chose their location. He argues that Nash equilibria exhibit a strong tendency in favor of laissez faire and non-discriminatory taxes in an oligopolistic environment with highly mobile firms. Taking a step back by analyzing reactions in a asymmetric setting, our paper shows that there are substantial forces in favor of higher profit taxes and lower subsidies when replying to protectionist policies.

The remainder of the paper is organized as follows. Section 2 introduces the basic framework before location decisions of firms are discussed in Section 3 and the determination of profit taxes and output subsidies is presented in Section 4. The baseline scenario with consumption abroad is analyzed in Section 5. Section 6 discusses the consequences of adding consumer surplus in the policy objective with respect to the interaction of profit taxes, tariffs and output subsidies. The reactions to foreign tax competition policies are dealt with in Section 7. Following an extensive discussion in Section 8, the final Section 9 concludes and indicates directions for future research.

2. Setup

We are using the framework of Fuest (2005) and Fuest and Huber (2006) in which location of firms operating in oligopolistic markets is endogenously determined. The world is divided into a country under consideration A and a rest of the world country B. To keep matters simple, policy choices of country B are taken as exogenous. Firms are imperfectly mobile while households are immobile. Preferences are represented by a quasi-linear utility function in which all income effects fall on the numeraire good Y while energy-intensive goods are produced in the differentiated goods sector X. For simplicity, the nonlinear-part of the utility function of the representative consumer is separable and quadratic with parameters $a > 0, b > 0$:

$$U_A = Y + \int_0^1 \left[aX(s) - \frac{1}{2} bX(s)^2 \right] \psi(s) ds \qquad (1)$$

In this expression s is an index of differentiation with density $\psi(s)$, where the related cumulative density is denoted by $\Psi(s)$. In each sector s, one domestically owned

firm (with superscript index A) competes with foreign-owned firm, denoted by a superscript index B. With household profit income Π and lump-sum-transfer T, the budget restriction of the representative household is given by

$$\Pi + T = \mathrm{Y} + \int_0^1 p(s)X(s)\psi(s)ds \qquad (2)$$

Maximizing utility (1) subject to the budget equation (2) yields a linear inverse demand function for each variety:

$$p(s) = a - bX(s) \qquad (3)$$

Firms may relocate to the other country at specific relocation cost $k(s)$ that is distributed on the interval $[\underline{k}, \overline{k}]$ with density $\varphi(k)$ and cumulative density $\Phi(k)$. Moreover, goods can be traded internationally. For simplicity, the transport cost per unit is set to zero.

The timing of events is as follows, where the predetermined policy vector of country B consists of its profit tax τ_B and its output subsidy σ_B: (1) government of A sets profit taxes τ_A and an output subsidy σ_A, (2) firms from country A decide on whether or not investing in B, (3) government of A sets tariff t_A, (4) firms engage in Cournot competition, setting quantities.

Unit cost of production varies and is location-specific at $c_A > c_B$, which reflects local energy markets. Even more so, our situation is characterized by an energy crisis in country A describing a situation where production in country A would be inefficient in the absence of fixed cost. Further, country A sets a tariff t_A per imported unit. Avoiding further distortions, production subsidies are financed by a lump-sum tax, to be financed by households, being part of the residual transfer T.

Output is chosen so as to maximize profits taking the output choice of the foreign firm as given. Consider first the trade regime, denoted by superscript index T, in which the A firm produces in country A and the B firm produces in country B. Profit of the country B firm from exporting to country A is given by

$$\pi^{BT} = p(s)^T x(s)^{BT} - (c_B - \sigma_B + t_A)x(s)^{BT} \quad (4)$$

The price under the trade regime is determined by the linear inverse demand function

$$p(s)^T = a - b(x(s)^{AT} + x(s)^{BT}) \quad (5)$$

Profit of the country A firm is

$$\pi^{AT} = p(s)^T x(s)^{AT} - (c_A - \sigma_A)x(s)^{AT} \quad (6)$$

Equilibrium quantities are

$$x(s)^{AT} = \frac{a + (c_B - \sigma_B + t_A) - 2(c_A - \sigma_A)}{3b} \quad (7)$$

and

$$x(s)^{BT} = \frac{a - 2(c_B - \sigma_B + t_A) + c_A - \sigma_A}{3b} \quad (8)$$

resulting in an equilibrium price

$$p(s)^T = \frac{a + c_A - \sigma_A + c_B - \sigma_B + t_A}{3} \quad (9)$$

and equilibrium profits

$$\pi(s)^{AT} = \frac{\left(a + (c_B - \sigma_B + t_A) - 2(c_A - \sigma_A)\right)^2}{9b} \quad (10)$$

and

$$\pi(s)^{BT} = \frac{\left(a - 2(c_B - \sigma_B + t_A) + (c_A - \sigma_A)\right)^2}{9b} \quad (11)$$

If both firms are located abroad (regime M), we obtain equilibrium quantities

$$x(s)^{AM} = x(s)^{BM} = \frac{a - (c_B - \sigma_B + t_A)}{3b} \tag{12}$$

for each of the two firms with a resulting equilibrium price

$$p(s)^{M} = \frac{a + 2(c_B - \sigma_B + t_A)}{3} \tag{13}$$

and equilibrium gross profits per firm

$$\pi(s)^{AM} = \pi(s)^{BM} = \frac{\left(a - (c_B - \sigma_B + t_A)\right)^2}{9b} \tag{14}$$

As we are mainly concerned with relocating firms away from the high-cost country, we do not model the third regime with both firms locating in A.

In the absence of tariffs and production subsidies, $t_A = \sigma_A = \sigma_B = 0$, a cost advantage of country B, given by $c_A > c_B$, implies lower price, $p(s)^M < p(s)^T$, and higher output under the import regime, $2x(s)^{BM} > x(s)^{AT} + x(s)^{BT}$, where $x(s)^{AT} < x(s)^{BM} < x(s)^{BT}$. Regarding gross profits at $t_A = 0$, these are highest for the foreign firm under the trade regime, $\pi(s)^{BT} > \pi(s)^{BM} > \pi(s)^{AT}$.

If tariffs and taxes can be neglected, consumer surplus of consumers in A and profits of firms owned by residents of country A are higher under the import regime. Hence, as long as externalities can be disregarded, subsidizing country A unit production cost c_A seems pointless.

3. Tax policy and location choices

Consider a lump-sum profit tax τ_A of country A. The government of A can tax firms that actually produce in that country, assumed to be owned by residents of A and

denoted by index A. Let the number of sectors under the trade regime be m^T, while m is the number of all differentiated sectors. Overall gross profits of firms owned by country A residents can be written as

$$\Pi = (m - m^T)\pi(s)^{AM} + m^T\pi(s)^{AT} \tag{15}$$

The government revenue is given by

$$T = m^T\tau_A + (2m - m^T)t_A x^{BT} \tag{16}$$

where t_A is an import tariff and x^{BT} the imported quantity.

In our framework domestic firms decide whether to remain in A - if the relocation cost is too large - or to move to B, where the critical cost level is $\pi(s)^{AT} = \pi(s)^{BM} - k^*$. With lump-sum profit taxes τ_A and τ_B, the threshold relocation cost turns out to be

$$\begin{aligned} k^* &= \frac{\big(a - (c_B - \sigma_B + t_A)\big)^2 - (a + (c_B - \sigma_B + t_A) - 2(c_A - \sigma_A))^2}{9b} - \tau_B + \tau_A \qquad (17)\\ &= \frac{4}{9b}[-a(c_B - \sigma_B + t_A) + (c_A - \sigma_A)(a + c_B - \sigma_B + t_A - (c_A - \sigma_A))] - \tau_B + \tau_A \\ &= \frac{4(c_A - \sigma_A - a)(c_B - \sigma_B + t_A - c_A + \sigma_A)}{9b} - \tau_B + \tau_A \end{aligned}$$

The threshold level decreases in the tariff t_A and increases with higher domestic profit tax τ_A. Notice that $\frac{\partial k^*}{\partial \tau_A} = 1 = -\frac{\partial k^*}{\partial \tau_B}$. The threshold level also increases in domestic unit cost c_A:

$$\frac{\partial k^*}{\partial c_A} = \frac{4(a + (c_B - \sigma_B + t_A) - 2(c_A - \sigma_A))}{9b} > 0$$

since $x(s)^{AT} > 0$ implies $a + (c_B - \sigma_B + t_A) - 2(c_A - \sigma_A) > 0$ according to equation (7), and decreases in foreign unit cost c_B as $c_A - \sigma_A - a < 0$.

4. Choice of profit tax and output subsidy

At the first stage, country A decides on its profit tax taking into account impacts on location decisions. In reduced form, the objective of the government of A reads

$$U_A = \Phi(k^*)U_A^M + [1 - \Phi(k^*)]U_A^T - \int_0^{k^*} kf(k)dk \qquad (18)$$

The former part $\Phi(k^*)U_A^M$ is welfare under the import regime, consisting of consumer surplus, net capital income, and tariff revenue. The latter term $[1 - \Phi(k^*)]U_A^T$ is related to the trade regime with consumer surplus, domestic profits, profit taxes and tariff revenue. In our analysis, the aggregate cost of relocation $\int_0^{k^*} kf(k)dk$ also matters. The share of domestic firms choosing to produce abroad is denoted by $\Phi(k^*)$ with $\Phi' > 0$.

Since the profit tax is constructed lump-sum, it does not affect prices, quantities and consumer surplus in any given market. Moreover, the profit tax τ_A is netted out by showing up in the profit and in the tax revenue term. Hence the impact of the tax on welfare works through affecting the location decisions of firms.

Recalling $\frac{\partial k^*}{\partial \tau_A} = 1$, the first-order condition with respect to τ_A reads

$$\frac{\partial U_A}{\partial \tau_A} = \Phi'(k^*)[U_A^M - U_A^T - k^*] = 0 \qquad (19)$$

At the margin, firm profits are identical for the pivotal firm taking its specific relocation cost k^* into account. From country A's point of view, the optimum distribution of firms is found when the welfare gain by moving to the import regime $U_A^M - U_A^T$ is just offset by the fixed cost of the marginal firm k^*.

The output subsidy σ_A has impacts on welfare under the trade regime and also affects location decisions. The first-order condition reads

$$\frac{\partial U_A}{\partial \sigma_A} = [1 - \Phi(k^*)]\frac{\partial U_A^T}{\partial \sigma_A} + \Phi'(k^*)[U_A^M - U_A^T - k^*]\frac{\partial k^*}{\partial \sigma_A} = 0 \qquad (20)$$

which boils down to $\frac{\partial U_A^T}{\partial \sigma_A} = 0$ noting that $[U_A^M - U_A^T - k^*]$ always equals zero due to the first-order condition (19). As we have an optimal choice of the profit tax in all specifications, the output subsidy, if available as instrument, is always designed so as to maximize welfare under the trade regime.

5. Baseline scenario: consumption abroad

We start out by considering a framework in which consumption takes place abroad. Thus produced goods are transported to country B or some third market C being characterized by demand functions as described. In this setting, the government of country A ignores impacts on consumer surplus in the country of destination. Moreover, there is no import tariff, $t_A = 0$. Hence, welfare simply captures profits of domestically-owned firms and budgetary impacts of production subsidies, the latter being equivalent to export subsidies. Thus the welfare measure is specified as

$$U_A = \Phi(k^*)(U_A^M) + [1 - \Phi(k^*)](U_A^T) - \int_0^{k^*} kf(k)dk \qquad (21)$$

with $U_A^M = \pi^{AM} - \tau_B$ and $U_A^T = \pi^{AT} - \tau_A + \tau_A - \sigma_A x^{AT}$. In this setting, regime M still refers to all firms residing in country *B* while regime T involves firms producing both in A and *B*.

Proposition 1 collects the relevant results.

Proposition 1.

(i) *Without production subsidies in country A, $\sigma_A = 0$, the optimal profit tax is zero, $\tau_A^*(\sigma_A = 0) = 0$, regardless of changes in own production cost c_A, foreign profit tax τ_B and foreign production subsidy σ_B.*

(ii) *If the production subsidy is optimized, it will be set at a positive level, $\sigma_A^* > 0$, accompanied by a positive profit tax $\tau_A^*(\sigma_A^*) = \sigma_A^* x^{AT}(\sigma_A^*) > 0$. Both the*

optimum production subsidy σ_A^* and the related optimal profit tax $\tau_A^*(\sigma_A^*)$ decrease in the own production cost c_A and in the foreign production subsidy σ_B, while remaining unaffected by changes of the foreign profit tax τ_B.

Proof. See Appendix A.

Without the own output subsidy, the location decision is not associated with any externality. Accordingly, the profit tax is set to zero. This message holds irrespective of changes in own production cost c_A or foreign policy parameters.

Allowing to optimize the production (or export) subsidy, it will be used so as to exploit profit shifting from the foreign to the domestic firm, as in Brander and Spencer (1985). The level of the optimal output subsidy balances the budgetary cost against the additional profit of that firm. Implementing the subsidy however generates a positive fiscal externality of moving abroad. Accordingly, a profit tax is set so as to internalize this externality perfectly. The optimum profit tax turns out to be equal to the output subsidy in equilibrium. Increasing either the own production cost c_A or the foreign output subsidy σ_B decreases marginal profit of the domestic firm across the board. Since this makes using the output subsidy less attractive, both its level and the related profit tax will be reduced. Changes in the foreign profit tax τ_B induce relocation of firms. An impact on the optimal production subsidy σ_A^* is absent in our setting of aligned sectors because marginal profit of the pivotal firm is not affected.

Note that these results have immediate implications if country B introduces or increases a tariff t_B per imported unit when the relevant market lies in country B. All results from Proposition 1 then carry over with a relevant total unit cost $\tilde{c}_A = c_A + t_B$. Hence, increasing t_B will not induce any reaction of country A as long as it does not employ an output subsidy. If an output subsidy σ_A is chosen as decribed, it will be decreased upon increasing the tariff t_B bercause marginal profits of the country A firms decline across the board. This will be associated with a lower profit tax $\tau_A^*(\sigma_A^*)$. Thus, a policy of tariff increases as announced by Trump for his second presidency is met by less rather than more protectionist policy. The reason for the asymmetric response here lies in reduced benefits for the domestic firms from subsidization. As our framework does not allow for interaction of domestic and foreign tariffs, this

result is understood as an interesting side issue, while a full-fledged analysis of such trade conflicts lies beyond the scope of our paper.

6. Home country as relevant market

We now turn to considering the situation in which the relevant market lies in the home country A. This has two main implications. First, the objective of the government changes because consumer surplus enters the welfare function. Second, an import tariff becomes a potential additional instrument of country A, depending on the institutional framework that may allow or limit the use of this instrument.

Utility of the representative household of country A is measured in physical units. It sums up consumer surplus from the trade and import regime, tariff revenue, profit tax revenue net of output subsidies and net profits of domestically owned firms. Consumer surplus per market is

$$CS^{AT} = \frac{[2a - c_A + \sigma_A - c_B + \sigma_B - t_A]^2}{18b} \tag{22}$$

under the trade regime and

$$CS^{AM} = \frac{[a - c_B - t_A + \sigma_B]^2}{9b} \tag{23}$$

under the import regime. The tariff revenue can be written as

$$\Psi(t_A) = t_A \left[m^T \frac{a + c_A - \sigma_A - 2(c_B - \sigma_B + t_A)}{3b} + 2(m - m^T) \frac{a - (c_B - \sigma_B + t_A)}{3b} \right] \tag{24}$$

Note that the revenue function $\Psi(t_A)$ is concave in the tariff t_A. Marginal tariff revenue is first increasing, then decreasing in the level of the tariff t_A. An optimal tariff is found where the sum of the additional tariff revenue plus the additional profit of

domestic firms equals the sum of losses in consumer surplus under either regime and losses of domestic firms producing abroad under the import regime. Lemma 1 characterizes properties of the optimal tariff.

Lemma 1. *Maximizing welfare with respect to the tariff t_A yields*

$$t_A = \frac{4m + m^T}{8m + m^T}(a - c_B + \sigma_B) \tag{25}$$

Proof. See Appendix B.

In our specification, the optimal tariff increases in the rent of producing abroad $a - c_B + \sigma_B$ irrespective of which part of this rent is affected. Note that the optimal tariff under the trade regime exceeds the optimal tariff under the import regime. This feature turns out because a higher tariff decreases consumer surplus more strongly under the import regime. In addition, the positive impact of the tariff on domestic firm profits is absent under the import regime. Consequently, the optimal tariff rises with the number of sectors under the trade regime. More specifically, $t_A(m^T = 0) = \frac{1}{2}(a - c_B + \sigma_B)$ if all markets act under the import regime while $t_A(m^T = m) = \frac{5}{9}(a - c_B + \sigma_B)$ if a domestic competitor is present in each market.

When determining the optimal profit tax, note that the difference in profit terms of domestic firms add up to zero at the margin, taking into account the threshold fixed cost of relocation. The relevant difference therefore considers only consumer surplus, tariff revenue, output subsidies and the loss of the profit tax revenue:

$$\frac{\partial U_A}{\partial \tau_A} = \Phi'(k^*)[CS^{AM} - CS^{AT} + t_A[x^{AM} + x^{BM} - x^{BT}] + \sigma_A x^{AT} - \tau_A] = 0 \tag{26}$$

It turns out that properties of profit taxes depend to some extent on tariff institutions. We distinguish between two tariff frameworks. In the free trade framework, the tariff is bound at $t_A = 0$. It should be noted that all qualitative results from the free trade framework also hold if the tariff is set exogenously at a sufficiently low level. By contrast, in the standard setting, the tariff will be chosen as described in Lemma 1.

We start by considering the case in which output subsidies are absent, $\sigma_A = \sigma_B = 0$. Proposition 2 collects the results.

Proposition 2. *In the absence of output subsidies, $\sigma_A = \sigma_B = 0$:*

- *(i) The welfare maximizing profit tax is always positive, $\tau_A^* > 0$ and decreases in the foreign unit cost measure c_B.*
- *(ii) With exogenous tariff, if $4(a - c_A) > [a - c_B - t_A]$, the profit tax increases in the tariff t_A.*
- *(iii) With endogenous tariff, the profit tax decreases in the domestic unit cost measure c_A. With exogenous tariff fixed at $t_A = 0$, the profit tax increases in the domestic unit cost measure c_A.*

Proof. See Appendix C.

Implementing or increasing a profit tax exclusively affect domestic firms under the trade regime. Some of these firms are driven into the import regime, serving the domestic market from abroad. This can increase consumer surplus and firm profit. Hence, the profit tax may be used with the surprising goal to raise consumer welfare by encouraging firms to move out of the country. The profit tax is raised until the net welfare gain by relocating abroad from a higher sum of tariff revenue and consumer surplus just offsets the loss in profit tax revenue.

As the sum of consumer surplus and tariff revenue is higher under the import regime, there is a unique positive optimal profit tax $\tau_A^* > 0$ that satisfies $\frac{\partial U_A}{\partial \tau_A} = 0$. When the foreign unit cost measure c_B rises, consumer surplus and tariff revenue (if any) decrease more strongly under the import regime. Accordingly, the trade regime becomes more attractive, yielding a lower profit tax. If the tariff is exogenous and the mild condition $4(a - c_A) > [a - c_B - t_A]$ holds, raising the tariff from a low (suboptimal) level increases national welfare more strongly under the import regime, inducing an increase of the profit tax.

It turns out that the tariff framework is crucial for determining the reaction to changing the measure of the domestic unit cost c_A. This result can be explained as follows. At given (zero or small) tariff, increasing the domestic unit cost reduces the related

consumer surplus, making the import regime more attractive, contributing to an increasing profit tax. If the tariff is endogenously set, this is counteracted by a rising tariff revenue under the trade regime through an increase in imports. Since the tariff is set at a substantial level according to Lemma 1, the tariff revenue effect dominates the direct impact on consumer welfare, ultimately decreasing the profit tax.

We now turn to impacts of an output subsidy $\sigma_A \geq 0$ that cuts the unit production cost in country A down to $c_A - \sigma_A$. While one aim of the policy is to avoid relocation, it is granted to all firms producing in country A, including foreign firms, if any. Another rationale for production subsidies is familiar from the theory of imperfect markets. Acknowledging that overall output falls short of Pareto efficient levels suggests combining output subsidies and higher profit taxes. The subsidy is financed by a lump-sum tax to be paid by inhabitants of A, which is represented by subtracting the aggregate amount of the subsidy in the welfare term.

Subsidizing domestic unit cost is not equivalent to reducing the profit tax, as it affects production decisions under the trade regime, increasing output and profit of the domestic at the expense of the foreign firm, and increasing consumer surplus. Can shifting the cost of financing the subsidy partly to the foreign firm be enough to make such a policy worthwhile? In addition, more firms will be inclined to remain in country A, suggesting an inefficiency by increasing overall production cost. The latter impact may be modified by adapting the profit tax.

The role of the production subsidy lies in maximizing surplus under the trade regime where profit of the domestic firm, consumer surplus, tariff revenue and cost of the subsidy are taken into account. Changes in profit taxes are irrelevant as the profit tax is optimized simultaneously. Moreover, the profit tax has no direct impact on the choice of the production subsidy since the number of sectors under the trade regime cancels out. However, the profit tax affects the choice of the tariff, where expecting a different level of the tariff affects the determination of the production subsidy.

Proposition 3 describes the properties of the production subsidy. It will generally be employed and decreases in the domestic unit cost. Any introduction or increase of the production subsidy will be associated with a higher profit tax.

Proposition 3. *Maximizing welfare with respect to the production subsidy σ_A and the profit tax τ_A displays the feature that $\sigma_A^* = (a - t_A - c_A)/3$, that is, a positive subsidy will be chosen if and only if the tariff t_A falls short of the market rent measure $a - c_A$. Accordingly, in a free trade regime with $t_A = 0$, the production subsidy will always be employed and decreases in the domestic cost c_A. With endogenous tariff at given number of firms under the trade regime m^T, the production subsidy increases in the foreign production cost c_B and decreases in the domestic production cost c_A. If the production subsidy is employed, an increase of the production subsidy will be complemented by a higher profit tax τ_A.*

Proof. See Appendix D.

This outcome can be explained as follows. Recall that the role of the production subsidy is to maximize welfare under the trade regime. With a higher domestic production cost c_A, at unchanged policy, the trade regime will be associated by lower domestic and higher imported quantities. This situation will be met by lowering the tariff. The direct impact on the production subsidy is negative, dominating the counteracting force through the cut of the tariff. At the same time, the profit tax will be increased, acknowledging the higher value of the import regime.

If the foreign production cost c_B increases, its direct impact under the trade regime at unchanged policy consists in lower foreign and higher domestic output. While there is no immediate impact on the production subsidy, the tariff will be cut, accompanied by a corresponding increase in the subsidy.

7. International tax competition

We proceed by analyzing reactions to changes of policies abroad. These may either consist of standard tax competition methods as reducing the profit tax τ_B, or by subsidizing unit cost c_B, which bears some similarity to the inflation reduction act (IRA) of the Biden administration. Both policies induce relocation of country A firms to country B, thus increasing the threshold cost k^*.

Cutting the foreign profit tax. As direct impact of a cutting the foreign profit tax τ_B, some firms relocate to country B, increasing the threshold cost k^* and reducing the number of firms under the trade regime m^T. Welfare of country A increases due to a windfall profit for inframarginal firms serving the domestic market from abroad. If tariffs are not available due to international agreements, there is no systematic impact on both the domestic profit tax and the domestic production subsidy. With endogenous tariff t_A, the tariff will fall with a smaller number of sectors under the trade regime. Following the cut of the tariff, increasing the domestic profit tax τ_A is likely since the sum of consumer surplus and tariff increases more strongly under the import regime, implying a higher benefit of inducing firms to move abroad. At the same time, the cut of the tariff raises the benefits of the production subsidy, inducing an increase in its optimal level σ_A^*.

Proposition 4.

(i) *Under a free trade regime, $t_A = 0$, cutting the foreign proft tax τ_B leaves both the optimal domestic profit tax τ_A^* and the optimal home production subsidy σ_A^* unchanged.*

(ii) *With endogenous tariff, a lower foreign profit tax τ_B is met by a lower tariff t_A. The cut of the tariff t_A increases the optimal home production subsidy σ_A^* and, provided $4(a - c_A) > [a - c_B - t_A]$, reduces the profit tax τ_A^*.*

Proof. See Appendix E.

Note that the profit tax of country A and the output subsidy change due to the adaptation of the tariff. In a free trade environment with $t_A = 0$, both would be kept constant. The indifference turns out because unchanged prices and quantities leaves relevant rents per market constant, while foreign profit taxes are not considered as sources of an externality. The neutrality result has to be taken with caution because it is obtained due to the assumption that differences in consumer surplus are not correlated with the relocation cost.

With endogenous tariff, the tariff will be cut due to the increased number of ectors under the import regime. This in turn reduces the fiscal externality of moving abroad,

which is addressed by decreasing the profit tax. Moreover, the reduced tariff increases foreign output and decreases domestic production under the trade regime. This enhances the value of the production subsidy which is raised accordingly.

Foreign production subsidies. Suppose that foreign output is subsidized at rate σ_B regardless of ownership. In our setting this will not only reduce prices in country B, but also in country A and increase consumer surplus. Under free trade, $t_A = 0$, the increase in consumer surplus under the import regime exceeds the corresponding differential under the trade regime. Accordingly, the externality of relocating the firm away from the high-cost country rises, inducing a higher profit tax τ_A^*. The optimal production subsidy still has the structure $\sigma_A^* = \frac{a - t_A - c_A}{3}$. It does not change because it is affected only by the tariff and the own production cost.

With endogenous tariff, Lemma 1 states that at given number of sectors under the trade regime m^T, country A partly compensates the (increased) production subsidy abroad by applying a higher tariff. At the same time, we expect a lower number of sectors under the trade regime m^T which in itself contributes to cutting the tariff.

As a consequence of the production subsidy, the sum of consumer surplus and tariff rises under the import regime, while it tends to fall under the trade regime. Therefore, the welfare value of relocation to country B increases, which in turn is reflected in a higher profit tax.

Proposition 5.

(i) *Under a free trade regime, $t_A = 0$, a higher foreign production subsidy σ_B induces a rise in the profit tax τ_A^* and leaves the optimal home production subsidy σ_A^* unchanged.*

(ii) *With endogenous tariff, a higher foreign production subsidy σ_B increases both the tariff t_A and the profit tax τ_A^*. It reduces the optimal production subsidy σ_A^* at given distribution of firms under the trade and import regime due to the higher tariff t_A.*

Proof. See Appendix F.

Note that there are counteracting impacts on the optimal home production subsidy if the foreign production subsidy is increased. While the higher tariff that is employed at given distribution of firms tends to reduce the domestic profuction subsidy, the smaller number of sectors under the trade regime induce a lower tariff and therefore work in the opposite direction. Accordingly, the decisive factor is whether the tariff is rising or declining.

8. **Discussion**

Our results have been obtained in a simple setting that justifies the use of tariffs, profit taxes and production subsidies. In the following we discuss whether and to what extent the messages carry over to structures that may offer a further motivation for these policy measures.

Positive externalities. Up to now, we have not considered the possibility of externalities in the production process. A typical structure consists in a cluster externality, which may be formulated as follows: The unit cost may rise in the number of oligopolistic firms that produce in the high-cost country, or decrease in the threshold setup cost, $c_A(k^*)$ with $\frac{\partial c_A}{\partial k^*} < 0$. In that event, inframarginal firms will face a cost increase due to other firms leaving the country. Having such a cluster externality does not directly affect the values of the import and the trade regime. Instead, it increases the welfare cost of relocation of firms to country B, which is taken into account when determining the profit tax τ_A, suggesting picking a lower profit tax.

A second version of nationwide production externalities may be formulated as increasing returns to scale, $c_A(m^T x^{AT})$ with $c_A' < 0$. The increasing returns property would be ignored at the firm level. Moving to such an environment suggests to increse the production subsidy and to pick a lower profit tax. However, as in our baseline setting, an upward shift in the production cost will generally still be answered by cutting the production subsidy.

A third version of production externalities can consider the case of an externality that is related to the domestic output of a specific "key" industry. Such a situation might be dealt with by using industry-specific subsidies, likely hidden under the heading of a program promoting specific R&D.

Negative externalities. Suppose that a negative externality is associated with imports, for example due to higher carbon emissions, that may be unrelated to unit cost and is further topped up by transportation. If the related external cost is taken into account in the welfare measure, such a change reduces the value of imports, which in turn justifies higher tariff levels and lower profit tax. A production subsidy may then be differentiated according to sector-specific externalities, which might however be challenged by EU competition law. Another approach consists of differentiated tariffs employing a carbon border adjustment mechanism. While the shift generated by taking account of the negative externalities seems clear-cut, reactions to changes in unit cost and foreign policies may still look quite similar to the baseline scenario.

Ownership structure. Our analysis assumes that all firms originating from country A are owned exclusively by citizens of country A. In general, foreign pension funds, foreign firms or foreign citizens will take a substantial share in this capital. Accordingly, we may consider a lower weight on profit in the welfare function, increasing the relative weight on consumer surplus and government revenue. In that event, profit tax revenue is no longer neutral in the welfare term, which may contribute to higher profit taxes and tariffs.

Dynamic aspects. Suppose that with some probability a technical leap occurs that would reduce domestic unit cost c_A considerably. Firms would take impacts on expected profit into account, but not the consequences related to government revenue and consumer surplus. In such a scenario, it makes sense to lower the profit tax and to employ the production subsidy, possibly in a differentiated fashion, if this is permitted by competition law. Again, it is not obvious why this has substantial impacts on reactions to changes in current production cost or foreign policy measures.

9. Conclusions

Our analysis sheds a new perspective on the debate on how to react to changes in the cost structure or policies undertaken abroad. It turns out that the profit tax steers location decision, balancing the respective values of the import against those of the trade regime. At the same time, the tariff, if available, is used so as to maximize the sum of revenue, consumer and domestic producer surplus. An interesting issue is related to the use of production subsidies, which is set so as to maximize rents under the trade regime.

If the relevant market lies abroad, profit taxes will not be employed as long as no externality arises. Implementing a production subsidy so as to shift profits from foreign to domestic firms however creates a fiscal externality which can be perfectly internalized by having a profit tax equivalent to the subsidy paid. In such an environment, higher own production cost or additional output subsidies abroad reduces domestic output subsidies and profit taxes since the related benefits are curbed.

When the relevant market is in the home country, impacts on consumer surplus are also taken into account. In the baseline free trade scenario, a higher domestic unit cost will be met by increasing the profit tax. This happens because the import regime becomes more attractive, associated with a benefit of driving firms out of the country. However, if the tariff can be optimized as well, it will be increased in view of higher tariff revenue, accompanied by lower profit tax. Considering an environment in which production subsidies are implemented, they will decrease rather then increase when encountering a higher domestic production cost, acknowledging that the rent advantage of own production relative to imports is declining.

The consequences of tax competition look as follows. A tax cut abroad does not affect own taxes in a free trade environment because relative market rents are unchanged and profit taxes do not generate a relevant externality. However, with endogenous tariff, the tariff will be reduced due to a higher number of sectors under the import regime, which in turn makes the import regime less attractive, implying a

lower profit tax. A subsidy to production abroad will be met by a rising profit tax as the import regime becomes more attractive. Moreover, the tariff, if available, is increased so as to match the lower production cost. Finally, if an own production subsidy is available, it will not be changed upon these foreign tax competition measures in a free trade environment. However with endogenous tariff, the production subsidy varies with the tariff. Accordingly, cutting the foreign profit tax induces increases the production subsidy due to a lower tariff while increasing the foreign production subsidy has just the opposite impacts.

Summing up, if cost shocks and policy measures abroad are perceived as persistent, it will generally prove resonable to reduce rather than increase exisiting production subsidies and even add measures to induce firms to exploit more favorable cost structures abroad. While externalities may exist that work against this line of reasoning, these need to be rather strong to turn around these key messages.

Appendix

A. Proof of Proposition 1

Without production subsidies, the first-order condition determining the optimal profit tax boils down to

$$\Phi'(k^*)[\pi^{AM} - \tau_B - \pi^{AT} + \tau_A^* - k^* - \tau_A^*] = 0 \qquad (A1)$$

Recalling the condition $\pi^{AM} - \tau_B - \pi^{AT} + \tau_A - k^* = 0$ that determines the pivotal fixed cost, we obtain $\tau_A^* = 0$.

If the production subsidy can be optimized, the first-order condition reads

$$\frac{\partial U_A}{\partial \sigma_A} = \Phi'(k^*)[U_A^M - U_A^T - k^*]\frac{\partial k^*}{\partial \sigma_A} + [1 - \Phi(k^*)]\left[\frac{\partial \pi^{AT}}{\partial \sigma_A} - x^{AT} - \sigma_A \frac{\partial x^{AT}}{\partial \sigma_A}\right] = 0 \qquad (A2)$$

Since at the same time $\Phi'(k^*)[U_A^M - U_A^T - k^*]$ due to the first-order condition on optimal taxes, this is equivalent to

$$\frac{\partial \pi^{AT}}{\partial \sigma_A} - x^{AT} - \sigma_A^* \frac{\partial x^{AT}}{\partial \sigma_A} = 0 \qquad (A3)$$

Inserting yields

$$\frac{4\big(a + (c_B - \sigma_B) - 2(c_A - \sigma_A^*)\big)}{9b} - \frac{\big(a + (c_B - \sigma_B) - 2(c_A - \sigma_A^*)\big)}{3b} \qquad (A4)$$

$$-\frac{2\sigma_A^*}{3b} = 0$$

Notice that the left-hand side of (26) is positive at $\sigma_A = 0$. Isolating σ_A^* obtains

$$\sigma_A^* = \frac{a + (c_B - \sigma_B) - 2c_A}{4} \qquad (A5)$$

The related profit tax is

$$\tau_A^* = \sigma_A^* x^{AT}(\sigma_A^*) = \frac{3[a + (c_B - \sigma_B) - 2c_A]^2}{48b} \qquad (A6)$$

implying the claims.

B. Proof of Lemma 1

National welfare is given by

$$\begin{aligned} U_A &= m^T[CS^{AT} + t_A x^{BT} + \pi^{AT}] + (m - m^T)[CS^{AM} + 2t_A x^{BM} + \pi^{AM}] \qquad (B1) \\ &= m^T \left[\frac{[2a - c_A - c_B - t_A + \sigma_B]^2 + 6t_A[a + c_A - 2(c_B + t_A - \sigma_B)]}{18b} \right. \\ &\qquad \left. + \frac{2(a + (c_B + t_A - \sigma_B) - 2c_A)^2}{18b} \right] \end{aligned}$$

$$+(m-m^T)\frac{[a-c_B-t_A+\sigma_B]^2+6t_A[a-(c_B+t_A-\sigma_B)]}{9b}$$
$$+(m-m^T)\frac{\left(a-(c_B+t_A-\sigma_B)\right)^2}{9b}$$

Taking the derivative with respect to the tariff and simplifying gives

$$\frac{\partial U_A}{\partial t_A}*18b \qquad (B2)$$

$$\begin{gathered}=m^T[6[a+c_A-2(c_B+t_A-\sigma_B)]-12t_A+4(a+(c_B+t_A-\sigma_B)-2c_A)\\-2(2a-c_A-c_B-\theta-t_A+\sigma_B)]\\-2(m-m^T)[4(a-c_B-t_A+\sigma_B)-6[a-(c_B+t_A-\sigma_B)]+6t_A]\\=m^T\left[6[a-(c_B-\sigma_B+3t_A)]\right]\\+2(m-m^T)[2(a-c_B+\sigma_B-4t_A)]\end{gathered}$$

Setting this to zero yields

$$t_A[18m^T+16(m-m^T)]=[6m^T+4(m-m^T)](a-c_B+\sigma_B) \qquad (B3)$$

resulting in

$$t_A=\frac{4m+m^T}{8m+m^T}(a-c_B+\sigma_B) \qquad (B4)$$

C. Proof of Proposition 2

Inserting for x^{BM} and x^{BT} in (23) yields

$$\frac{\partial U_A}{\partial \tau_A}=\Phi'(k^*)\left[\frac{2[a-(c_B+t_A)]^2-[2a-c_A-(c_B+t_A)]^2}{18b}\right] \qquad (C1)$$
$$+\Phi'(k^*)\left[t_A\left[\frac{a-c_A}{3b}\right]-\tau_A\right]$$

Since $t_A < a - c_B$ and $c_A - c_B > 0$, we obtain $\frac{\partial U_A}{\partial \tau_A} > 0$ at $\tau_A = 0$, thus $\tau_A^* > 0$. As the optimal profit tax satisfies $\frac{\partial U_A}{\partial \tau_A}(\tau_A^*) = 0$, solving for τ_A^* gives

$$\tau_A^* = \frac{[a - c_B - t_A]^2 - 1/2[2a - c_A - c_B - t_A]^2 + 3t_A(a - c_A)}{9b} \qquad (C2)$$

Differentiating $(C2)$ with respect to t_A reveals that the term increases in t_A provided the mild condition $4(a - c_A) > [a - c_B - t_A]$:

$$\frac{\partial 9b\tau_A^*}{\partial t_A} = -2[a - c_B - t_A] + [2a - c_A - c_B - t_A] + 3(a - c_A) \qquad (C3)$$
$$= 4(a - c_A) - [a - c_B - t_A]$$

Considering $t_A = 0$, related to the free trade regime, we obtain

$$\frac{\partial 9b\tau_A^*}{\partial c_B}(t_A = 0) = -2[a - c_B] + (2a - c_A - c_B) = c_B - c_A < 0 \qquad (C4)$$

$$\frac{\partial 9b\tau_A^*}{\partial c_A}(t_A = 0) = 2a - c_A - c_B > 0 \qquad (C5)$$

With endogenous tariff, according to Lemma 1, $t_A = \gamma(a - c_B)$, where $\gamma \in \left[\frac{1}{2}, \frac{5}{9}\right]$. Inserting this result, we obtain

$$9b\tau_A^*\big(t_A = \gamma(a - c_B)\big) = \qquad (C6)$$
$$\frac{(1-\gamma)^2[a - c_B]^2}{2} - \frac{[a - c_A]^2}{2} + (4\gamma - 1)(a - c_A)(a - c_B) > 0$$

since $(a - c_B) > (a - c_A)$.

At given γ, differentiating gives

$$\frac{\partial 9b\tau_A^*}{\partial c_B} = -[(1-\gamma)^2(a - c_B) + (4\gamma - 1)(a - c_A)] < 0 \qquad (C7)$$

$$\frac{\partial 9b\tau_A^*}{\partial c_A} = (a - c_A) - (4\gamma - 1)(a - c_B) < 0 \qquad (C8)$$

D. Proof of Proposition 3

The welfare impacts under the trade regime are calculated as follows:

$$\frac{\partial CS^{AT}}{\partial \sigma_A} + \frac{\partial \pi^{AT}}{\partial \sigma_A} + t_A \frac{\partial x^{BT}}{\partial \sigma_A} - \sigma_A \frac{\partial x^{AT}}{\partial \sigma_A} - x^{AT} = \tag{D1}$$

$$\frac{2a - c_A + \sigma_A - c_B - t_A}{9b} + \frac{4\big(a + (c_B + t_A) - 2(c_A - \sigma_A)\big)}{9b}$$

$$- \frac{t_A}{3b} - \sigma_A \frac{2}{3b} - \frac{a + (c_B + t_A) - 2(c_A - \sigma_A)}{3b}$$

$$= \frac{6a + 3(c_B + t_A) - 3(c_A - \sigma_A)}{9b} - \frac{a + c_B + 2t_A + 4\sigma_A - 2c_A}{3b}$$

$$= \frac{a - t_A - c_A - 3\sigma_A}{3b}$$

If in the first-order condition this adds up to zero, we have

$$\sigma_A^* = \frac{a - t_A - c_A}{3} \tag{D2}$$

Thus, a positive subsidy will be granted only if the tariff falls short of the market rent from domestic production $a - c_A$. This condition is satisfied when the international cost differential $c_A - (c_B) > 0$ is not too high. Moreover, $\sigma_A^*(t_A = 0) = \frac{a - c_A}{3} > 0$ and $\frac{\partial \sigma_A^*(t_A = 0)}{\partial c_A} = -\frac{1}{3} < 0$.

Inserting the solution on the tariff, $t_A = \frac{4m + m^T}{8m + m^T}[a - c_B] - \frac{3m^T}{8m + m^T}\sigma_A$, we obtain

$$\frac{8m + 4m^T}{8m + m^T}\sigma_A^* = a - c_A - \frac{4m + m^T}{8m + m^T}[a - c_B] \tag{D3}$$

resulting in

$$\sigma_A^* = \frac{8m + m^T}{8m + 4m^T}[a - c_A] - \frac{4m + m^T}{8m + 4m^T}[a - c_B] \tag{D4}$$

Hence, at given m^T, the optimal subsidy σ_A^* increases in the foreign production cost c_B and decreases in the domestic production cost c_A.

With a domestic production subsidy σ_A in place, the first-order condition on the optimal profit tax reads

$$\frac{\partial U_A}{\partial \tau_A} = [CS^{AM} - CS^{AT} + t_A[x^{AM} + x^{BM} - x^{BT}] + \sigma_A x^{AT} - \tau_A] \qquad (D5)$$

Inserting yields

$$\frac{\partial U_A}{\partial \tau_A} = \Phi'(k^*)\left[\frac{2[a-(c_B+t_A)]^2 - [2a-(c_A-\sigma_A)-(c_B+t_A)]^2}{18b}\right] \qquad (D6)$$
$$+\Phi'(k^*)\left[t_A\frac{a-c_A+\sigma_A}{3b} + \sigma_A\frac{a+(c_B+t_A)-2(c_A-\sigma_A)}{3b} - \tau_A\right]$$

Solving for the profit tax yields

$$9b\tau_A^* = [a-c_B-t_A]^2 - \frac{1}{2}[2a-c_A+\sigma_A-c_B-t_A]^2 \qquad (D7)$$
$$+3t_A(a-c_A+\sigma_A) + 3\sigma_A[a+(c_B+t_A)-2(c_A-\sigma_A)]$$

The direct impact of the subsidy on the profit tax is positive. A higher subsidy is associated with a positive fiscal impact of relocation to country B and an increased tariff revenue:

$$\frac{\partial 9b\tau_A^*}{\partial \sigma_A} = -[2a-c_A+\sigma_A-c_B-\theta-t_A] + 3t_A + 6\sigma_A \qquad (D8)$$
$$+3[a+(c_B+t_A)-2(c_A-\sigma_A)]$$
$$= a-c_A+4(c_B+t_A)+6t_A+11\sigma_A > 0.$$

E. Proof of Proposition 4

As all prices and output levels are unchanged, a reaction of the profit tax τ_B to changes works exclusively via adaptation of the tariff t_A. Under free trade, $t_A = 0$, first-order conditions determining τ_A^* and σ_A^* are not affected.

With endogenous tariff, the cut of the foreign profit tax τ_B reduces m^T and increases k^*, where tariff t_A falls according to Lemma 1. This is in turn associated with a lower profit tax τ_A when $4(a - c_A) > [a - c_B - t_A]$ according to the proof of Proposition 2.

The welfare impacts of varying the output subsidy σ_A under the trade regime are calculated as follows:

$$\frac{\partial CS^{AT}}{\partial \sigma_A} + \frac{\partial \pi^{AT}}{\partial \sigma_A} + t_A \frac{\partial x^{BT}}{\partial \sigma_A} - \sigma_A \frac{\partial x^{AT}}{\partial \sigma_A} - x^{AT} = \tag{E1}$$

$$\frac{2a - c_A + \sigma_A - c_B + \sigma_B - t_A}{9b} + \frac{4\big(a + (c_B - \sigma_B + t_A) - 2(c_A - \sigma_A)\big)}{9b}$$

$$- \frac{t_A}{3b} - \sigma_A \frac{2}{3b} - \frac{a + (c_B + \sigma_B + t_A) - 2(c_A - \sigma_A)}{3b}$$

$$= \frac{6a + 3(c_B - \sigma_B + t_A) - 3(c_A - \sigma_A)}{9b} - \frac{a + c_B - \sigma_B + 2t_A + 4\sigma_A - 2c_A}{3b}$$

$$= \frac{a - t_A - c_A - 3\sigma_A}{3b}$$

If in the first-order condition this adds up to zero, we have

$$\sigma_A^* = \frac{a - t_A - c_A}{3} \tag{E2}$$

Thus, as $\frac{\partial t_A}{\partial \tau_B} < 0$, we obtain $\frac{\partial \sigma_A^*}{\partial \tau_B} > 0$.

F. Proof of Proposition 5

Following the proof of Proposition 4, equation (E2) implies $\frac{\partial \sigma_A^*}{\partial \sigma_B}(t_A = 0) = 0$. With a foreign production subsidy σ_B in place, the first-order condition on the optimal profit tax reads

$$\frac{\partial U_A}{\partial \tau_A} = [CS^{AM} - CS^{AT} + t_A[x^{AM} + x^{BM} - x^{BT}] - \tau_A] \qquad (F1)$$

Inserting yields

$$\frac{\partial U_A}{\partial \tau_A} = \Phi'(k^*)\left[\frac{2[a - (c_B - \sigma_B + t_A)]^2 - [2a - c_A - (c_B - \sigma_B + t_A)]^2}{18b}\right] \qquad (F2)$$
$$+\Phi'(k^*)\left[t_A\frac{a - c_A}{3b} - \tau_A\right]$$

Solving for the profit tax, we obtain

$$9b\tau_A^* = [a - c_B + \sigma_B - t_A]^2 - \frac{1}{2}[2a - c_A - c_B + \sigma_B - t_A]^2 \qquad (F3)$$
$$+3t_A(a - c_A)$$

with $t_A = \frac{4m + m^T}{8m + m^T}(a - c_B + \sigma_B)$.

Under the free trade regime, the profit tax increases:

$$\frac{\partial 9b\tau_A^*}{\partial \sigma_B}(t_A = 0) = 2[a - c_B + \sigma_B] - [2a - c_A - c_B + \sigma_B] = c_A - c_B + \sigma_B > 0. \qquad (F4)$$

With endogenous tariff, the tariff excess of the import vs. the trade regime per market at given tariff t_A is not affected. However, the tariff will be increased with rising foreign subsidy σ_B where some counteracting movement occurs as the number of sectors under the trade regime m^T declines.

Using $t_A = \gamma(a - c_B + \sigma_B)$ and taking the derivative with respect to σ_B at given γ we obtain

$$\frac{\partial 9b\tau_A^*}{\partial \sigma_B} = 2(1-\gamma)[a - c_B + \sigma_B] - [a - c_A + (1-\gamma)(a - c_B + \sigma_B)] \qquad (F5)$$
$$+3\gamma(a - c_A)$$
$$= (1-\gamma)(a - c_B + \sigma_B) + (3\gamma - 1)(a - c_A) > 0$$

since $\gamma \epsilon \left(\frac{1}{2}, 1\right)$.

Inserting the solution on the tariff, $t_A = \frac{4m+m^T}{8m+m^T}[a - c_B + \sigma_B] - \frac{3m^T}{8m+m^T}\sigma_A$, into the condition determining the optimal subsidy (E2), we obtain

$$\frac{8m + 4m^T}{8m + m^T}\sigma_A^* = a - c_A - \frac{4m + m^T}{8m + m^T}[a - c_B + \sigma_B]$$

resulting in

$$\sigma_A^* = \frac{8m + m^T}{8m + 4m^T}[a - c_A] - \frac{4m + m^T}{8m + 4m^T}[a - c_B + \sigma_B] \qquad (F6)$$

Hence, at given m^T, the optimal subsidy σ_A^* decreases in the foreign production cost subsidy σ_B.

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