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Why a Tariff War May not Decrease Global CO_2 Emissions

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Abstract

It has been suggested that an intensified trade war between China and the US could reduce CO2 emissions associated with exports. We develop an export-greenfield-endogenous merger model, showing that significantly increased tariffs can enable domestic firms to undertake entry-deterring acquisitions. This forces foreign firms to remain exporters, which, in turn, leads to higher emissions. Strong competition policies and support for green technologies can help address this issue, resulting in lower emissions. Furthermore, we show that implementing an emissions trading system combined with a carbon border adjustment mechanism has effects comparable to those of increased tariffs.

Keywords: Tariff war, CO2 emissions, M&A, Endogenous Mergers Emission Trading System, Carbon Border Adjustments, Competition Policy
JEL classification: F23, L40, Q56, Q58

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1. Introduction

Climate change is accelerating, yet governments have been unsuccessful in reaching agreements to quickly address this urgent issue. Major climate accords, such as the UN Glasgow Climate Pact and COP27, have not yielded rapid, substantial reductions in global carbon emissions. Notably is that approximately 25 percent of all greenhouse gas emissions are embodied in traded goods (Wiedmann and Lenzen, 2018), and changes in tariffs could have a substantial effect on CO2 emissions, as tariffs function as an indirect CO2 tax. Thivierge (2023) proposes a two-country, two-good partial equilibrium model to decompose the foreign emissions effects of trade tariffs versus carbon tariffs, showing that trade tariffs provide a lower bound on the emissions effect of a carbon tariff. Shapiro (2021), however, shows that in most countries, import tariffs and non-tariff barriers are significantly lower for CO2-intensive industries, effectively creating a global implicit subsidy for CO2 emissions in internationally traded goods and thereby exacerbating climate change.

In the current policy debate, several countries, including the USA and China, are discussing a more general increase in import tariffs. Such a general tariff increase would likely function as an indirect tax on CO2 emissions and is therefore expected to reduce emissions, albeit at the potential cost of decreased consumer welfare. However, in this paper, we demonstrate that if the tariff increase is sufficiently high, it could, in fact, lead to higher CO2 emissions. This counterintuitive outcome arises because the majority of CO2 emissions in traded goods are generated in oligopolistic markets, where foreign direct investment (FDI) through cross-border mergers and acquisitions (M&As) plays a critical role in shaping the resulting market structure.[1] Thus, the impact of increased tariffs on CO2 emissions will likely depend significantly on how market power-driven international mergers in oligopolistic markets are affected by such policy changes[2]—an aspect that has not been sufficiently addressed in the existing literature. Indeed, we show that substantially raised import tariffs can provide domestic firms with sufficiently strong incentives to undertake entry-deterring acquisitions, forcing foreign firms to continue exporting. This, in turn, can lead to higher CO2 emissions.

We develop a stylized international oligopoly model in which a foreign firm has the option to produce using existing CO2 emission-intensive plants in its own country, acquire older CO2 emission-intensive plants, or establish new CO2 emission-neutral plants (greenfield investments) in the domestic country. In this model, both production and international transportation contribute to CO2 emissions[3] To capture the potential effects of a trade war, we then analyze the impact of raised import tariffs within this model on CO2 emissions.

We first show that moderate import tariff increases may reduce CO2 emissions by (i) decreas-

[1] In 2019, the value of global net cross-border M&As, as a percentage of FDI inflows, reached 62 percent.

[2] Market-power effects are becoming increasingly important for M&A patterns in many markets worldwide. De Loecker and Eeckhout (2018) find that the average global markup has risen from nearly 1.1 in 1980 to around 1.6 in 2016.

[3] Cristea, Hummels, Puzzello, and Avetisyan (2013) find that international transport accounts for a significant share of trade-related emissions globally.

ing imports and thereby international transportation or (ii) encouraging greenfield investments by foreign firms (so-called tariff-jumping FDI). By raising the cost of imported CO2-intensive products, increased tariffs can thus trigger investments in cleaner production.

However, more substantial tariff increases may be counterproductive from a climate perspective, potentially leading to higher CO2 emissions for two reasons. First, we show that higher tariffs can increase transport-associated emissions. This is because increased tariffs heighten domestic firms' incentives to undertake entry-deterring acquisitions, which force foreign firms to continue exporting from their home countries instead of producing locally in the domestic country. Second, tariffs may encourage cross-border acquisitions of old, CO2 emission intensive plants. These acquisitions enable foreign firms to become more aggressive in the domestic product market, leading to an increase in aggregate production and, consequently, a rise in carbon emissions.

Several countries aim to encourage both domestic and foreign firms to invest in clean-tech within their borders. For example, the US has introduced the Inflation Reduction Act (IRA) to incentives clean-tech investments, making both domestic and foreign firms eligible for benefits. In our model, we highlight this dynamic in a simplified manner by incorporating a reduction in greenfield investment costs. Such a policy not only impacts trade and greenfield investment patterns but also influences the identity of the buyer and the selling price in mergers and acquisitions (M&A). Notably, we demonstrate that these policies can be counterproductive from a domestic welfare perspective: subsidies for clean-tech production might fail to increase clean-tech investments and instead merely lower the sales price of domestic assets in a foreign acquisition.

Despite slow progress toward establishing a global price on CO2 emissions, some regions, most notably the European Union with its EU Emissions Trading System (EU ETS), are advancing regional CO2 pricing initiatives. One might expect that such a regime would be less prone to domestic entry-deterring and emissions-increasing acquisitions. However, in an extended version of our model that incorporates both an emissions trading system (ETS) and a carbon border adjustment (CBA) mechanism, we demonstrate that the introduction of a ETS and CBA system can elevate the risk of domestic entry-deterring, emissions-increasing acquisitions when ETS prices and CBA tariffs reach sufficiently high levels. This effect arises because CBAs function similarly to import tariffs, making the introduction of a CBA potentially counterproductive by encouraging entry-deterring, emissions-increasing domestic acquisitions.

Our paper contributes to the literature on international production, trade costs and emissions.[4] One strand examines how trade liberalization affect emissions and show that it can lead to higher emissions through increased production and transportation (scale and transport effects) but may also contribute to emissions reductions via technological advancements and reallocation of production to locations where more resource effective production can take place.[5] For instance,

[4] See, for instance, Copeland and Taylor (2003, 2004) and Lin et al. (2014).

[5] There is also a strand studying the effects of carbon tariffs which have found that a large enough country or group of countries can reduce the foreign production of a polluting good through the use of an import tariff (Markusen, 1975; Fowlie, Reguant and Ryan, 2016; Böhringer, Carbone and Rutherford, 2018; Hsiao, 2020).

Forslid, Okubo, and Ulltveit-Moe (2018) find that trade liberalization removes the least productive and dirtiest firms, thereby shifting production away from relatively dirty, low-productivity local firms. Kreickemeier and Richter (2014) find that aggregate emissions decrease when trade is liberalized if firm-specific emissions intensity declines with rising firm productivity. Sanna-Randaccio and Sestini (2012) and Sanna-Randaccio, Sestini, and Tarola (2016) examine the effect of unilateral climate policy under endogenous plant location, finding that conditions such as lack of reallocation, large market asymmetry, and limited technology transfers are sufficient to reduce global emissions.

Our contribution lies in introducing endogenous mergers in this context by developing an import-greenfield-acquisition oligopoly model. This model enables us to demonstrate that an increase in import tariffs may be counterproductive from a climate perspective, potentially leading to higher CO2 emissions. This outcome arises because the import tariff can trigger: (i) domestic entry-deterring acquisitions, which force foreign firms to continue operating as exporters, or (ii) foreign acquisitions that increase total production in CO2-intensive plants. There is a relatively small literature on merger incentives and environmental impact in oligopolistic markets; see, for example, Benchekroun et al. (2019) and Fikru and Gautier (2016, 2017). We contribute to this literature by proposing an endogenous merger model showing that the most environmentally friendly merger may not occur in equilibrium.

We also contribute to the literature examining the effects of carbon border adjustment mechanisms (CBAs) on emissions, production, and welfare. Existing literature, which primarily relies on simulations, finds that CBAs have only modest effects on these outcomes (Böhringer, Balistreri, and Rutherford 2012; Devarajan et al. 2022; Irfanoglu, Sesmero, and Golub 2015; Branger and Quirion 2014). A smaller body of research has drawn on recent experiences to estimate leakage effects from carbon pricing. Dechezleprêtre and Sato (2017) reviewed these ex post studies and concluded that competitiveness and leakage effects tend to be small compared to other determinants of trade, such as infrastructure, geography, availability of raw materials, and skilled labor. We contribute to this literature by exploring how CBA mechanisms may affect the inflow of foreign direct investment into regions implementing CBAs. Specifically, we identify a mechanism wherein domestic entry-deterring acquisitions result in fewer emissions-reducing foreign acquisitions.[6]

2. The Model

Consider an industry in country H, where firm b and firm d are active. Firm b is run less efficiently than firm d, and its owners intend to sell it or close it down. There is also a foreign firm, firm f, in country F. Firm f can serve the market in country H in three different ways:

[6] There is a relatively small literature on merger incentives and environmental impact in oligopolistic markets; see, for example, Benchekroun et al. (2019) and Fikru and Gautier (2016, 2017). We contribute to this literature by proposing an endogenous merger model showing that the most environmentally friendly merger may not occur in equilibrium.

through exporting, facing import tariff t, or through starting local production, which circumvents tariff t, by either engaging in greenfield investment at a fixed cost, G, or by acquiring firm b at the endogenously determined price S in addition to the transaction cost T.

If firm f chooses greenfield entry, it will build a new production facility in the local market with an emissions-free, clean production technology. However, if firm f acquires firm b, production will take place with an older technology that releases emissions at an emissions cost of ρ per unit of output. If firm f chooses to export, the older technology is also used in its home plant. Moreover, exports are associated with emissions from the physical transport of goods with a cost of τ per unit, and thus, the total emissions cost from exports is $\tau + \rho$ per unit. Emissions are not paid for by the firms. For the ease of exposition and without loss of generality, we assume that there is no emission tax at the outset. We discuss this in the last section of the paper.

The starting point of the analysis is that country H contemplates an increase in an import tariff, t. This could be for political, social or economic reasons. The interaction in country H takes place in four stages. In the first stage, the government in country H decides on the level of the import tariff, t. In the second stage, firm b's assets may be sold. In the third stage, firm f has the option to make a greenfield investment. Finally, in the fourth stage, firms in the product market compete in oligopoly fashion in country H.

2.1. Stage 4: The product market

In the fourth stage, firms compete in Cournot fashion in a homogeneous good market. We assume linear demand, $P = a - Q$,, where $Q = \Sigma_i q_i$ is total output and q_i is the output of an individual firm. The (variable) profit of a firm i is $\pi_i = (P - c_i)q_i$, where c_i is a constant marginal cost. If both firm f and firm d are active, the Cournot quantities are $q_i^D(c_i, c_j) = \frac{a-2c_i+c_j}{3}$, whereas if a monopoly arises, the monopoly quantity is $q_i^M(c_i) = \frac{a-c_i}{2}$. With linear demand and constant marginal costs, profits are quadratic in output, i.e., $\pi_i^D(c_i, c_j) = \left(\frac{a-2c_i+c_j}{3}\right)^2$ and $\pi_i^M = \left(\frac{a-c_i}{2}\right)^2$. Assume that the marginal cost of production is zero.

2.1.1. Firm f exports to country H

If firm f exports to country H, it will face import tariff t. It then follows that its profits are:

$$\begin{cases} \pi_d^D(0,t) = \left(\frac{a+t}{3}\right)^2 > \left(\frac{a-2t}{3}\right)^2 = \pi_f^D(t,0), \text{ if } \ t \in [0, t^{\max}], \\ \pi_d^M(0) = \left(\frac{a}{2}\right)^2, \text{ if } \ t > t^{\max}. \end{cases} \tag{2.1}$$

where $t^{\max} = \frac{a}{2}$ is the highest tariff associated with profitable exports by foreign firm f.

2.1.2. Firm f produces locally in country H

If firm f produces locally, import tariff t is avoided. Hence, the firms' profits are

$$\pi_d^D(0,0) = \left(\frac{a}{3}\right)^2 = \pi_f^D(0,0). \tag{2.2}$$

2.2. Stage 3: Green "greenfield" investments

At this stage, firm f might undertake a green-technology greenfield investment at a fixed cost G if it did not acquire firm b in Stage 2. This reduces its marginal costs from t to 0. Define $\bar{G}(t)$ as the value of the greenfield cost, such that firm f is indifferent between the alternatives of supplying the market by exporting or making a new greenfield investment. Using (2.1) and (2.2), we have:

$$\bar{G}(t) = \begin{cases} \pi_f^D(0,0) - \pi_f^D(t,0) = \frac{4}{9}t\,(a-t)\,, \text{ if } t \in [0, t^{\max}], \\ \pi_f^D(0,0) = \left(\frac{a}{3}\right)^2 \text{ if } t > t^{\max}. \end{cases} \tag{2.3}$$

The greenfield critical cost $\bar{G}(t)$ is illustrated in the lower panel of Figure 1(ii). Since export profits $\pi_f^D(t,0)$ decrease monotonically in t from (2.1), the greenfield critical cost $\bar{G}(t)$ is increasing in t and reaches its maximum at $t = t^{\max}$. For $t > t^{\max}$, the goods are not exported (i.e., non-tradable) and $\bar{G}(t) = \pi_f^D(0,0)$.

Figur 1 here

2.3. Stage 2: The equilibrium market structure

To focus on the market forces that determine the equilibrium market structure, we assume that firm b is sold to the highest bidder at an auction. The acquisition process is depicted as an auction where firm d and firm f simultaneously post bids and the bidder with the highest bid obtains the assets of firm b.

To proceed, first define the firms' gross valuations of obtaining firm b, $\tilde{v}_i(t)$. These consist of the profit when acquiring firm b minus the gross profit when a rival obtains firm b, in a situation where greenfield investment is not an equilibrium outcome in stage 3, and where there are no transaction costs:

$$\tilde{v}_f(t) = \begin{cases} \pi_f^D(0,0) - \pi_f^D(t,0) = \frac{4}{9}t\,(a-t)\,, \text{if } t \in [0, t^{\max}], \\ \pi_f^D(0,0) = \left(\frac{a}{3}\right)^2, \text{if } t > t^{\max}, \end{cases}, \tag{2.4}$$

$$\tilde{v}_d(t) = \begin{cases} \pi_d^D(0,t) - \pi_d^D(0,0) = \frac{1}{9}t\,(2a+t)\,, \text{if } t \in [0, t^{\max}], \\ \pi_d^M(0) = \left(\frac{a}{2}\right)^2, \text{if } t > t^{\max}. \end{cases}, \tag{2.5}$$

where $\tilde{v}_d(t)$ and $\tilde{v}_f(t)$ are depicted in Figure 1(i).

Norbäck and Persson (2004) show that there exists a unique $t^* \in (0, t^{\max})$ such that $\tilde{v}_f(t)$ exceeds $\tilde{v}_d(t)$ at tariffs lower than t^* but that this inequality is reversed for tariffs higher than t^*. This result is due to two opposing forces: (i) There is an *anti-competitive effect*, whereby an acquisition of firm b provides firm d with higher market power in the product market when the foreign rival is subject to a higher tariff t. On the other hand, (ii) there is a *trade cost-savings effect*. When the foreign rival is subject to the tariff, a higher tariff increases firm f's incentive to acquire firm b, since it can avoid a higher trade cost through the acquisition.

Firms' bidding behavior in the auction is determined from their net valuations, v_i, based on their gross valuations, equilibrium behavior in the greenfield stage and fixed costs. The analysis is straightforward since both firms bid their maximum willingness to pay, and we can state the following result:

Lemma 1. *Let firm i be the firm with the highest net valuation, v_i. (i) If $v_i > v_h > 0$, the target firm's assets are then acquired by firm i at a price equal to the other firm's valuation v_h, $h \neq i$. (ii) If $v_i > 0 > v_h$, the target firm's assets are then acquired by firm i at a price equal to zero. (iii) If $0 > v_i > v_h$, no acquisition takes place, and firm b exits.*

Proof: See the Appendix.

In Table 2.1 we depicts all possible equilibrium market structures in the $G - t$ space. We can then use Figure 1(ii) derive the different equilibrium market structure regions. Consider first the case where greenfield entry is not profitable, $G > \bar{G}(t)$. In Region 1, both firms' net valuations are zero or negative, $v_d = v_f \leq 0$. As shown in Figure 1(i), at a very low tariff $t \leq t_f^{\min}$, neither firm f's trade cost-savings effect nor firm d's anti-competitive effect is sufficient to drive the gross valuations above the transaction cost, T. Hence, in Region 1, firm b is closed down, and firm f supplies the market by exports. When the tariff increases beyond $t_f^{\min}$, we move into Region 2 and Region 3 in Figure 1(ii). In Region 2, the trade cost-savings effect dominates the anti-competitive effect, so firm f acquires firm b at the price $S^* = v_d$, and firm f then supplies the market locally. However, when trade costs are above t^*, the anti-competitive effect dominates, and now firm d acquires the target at price $S^* = v_f$. This forces firm f into exporting (as long as the tariff is less than $t^{\max}$).

Suppose now that greenfield entry is profitable, $G < \bar{G}(t)$. Then, both firms know that if firm f faces the choice between exporting or making a greenfield investment in stage 3, it will always make the investment: so the trade cost-savings effect for firm f in an acquisition vanishes. However, the anti-competitive effect also vanishes for firm d. Why? Firm d can then no longer prevent firm f from enhancing its competitiveness in the product market and is thus not willing to pay for firm b's assets, i.e., $v_d = 0$. We then have two distinguishing cases based on fixed cost savings: (i) If the greenfield cost exceeds the transaction cost $G > T$, firm f saves the fixed costs by completing the acquisition, and its valuation is $v_f = G - T > 0$. Then, firm f acquires firm b at price $S^* = v_d = 0$, as shown in Region 4 in Figure 1(ii). However, when $G < T$, Firm f's net valuation becomes negative, and thus it make the greenfield investment and no acquisition occurs. This is shown in Region 5 in Figure 1(ii).

2.4. Stage 1: Why tariff wars can increase equilibrium emission levels

In Table 2.1, we also depict the total equilibrium emissions in each region, labelled E^*. Recall that exports are associated with an emissions cost of τ per unit, while production is associated with an emissions cost of ρ per unit, except under greenfield entry, under which a new technology is used with zero emissions costs.

Using Table 2.1 we can derive a condition that shows when total emissions are higher when firm f exports to country H, $E^*(t)$ compared to when it supplies the market locally by acquiring firm b and using the old technology, $E^*(0)$:

$$\underbrace{\tau \cdot q_f^D(t,0) + \rho \cdot Q(t)}_{\text{Emissions under exports with old technology}} > \underbrace{\rho \cdot Q^D(0)}_{\text{Emissions under local production with old technology}}, \tag{2.6}$$

where $Q^D(0) = q_f^D(0,0) + q_d^D(0,0)$ and $Q(t) = q_f^D(t,0) + q_d^D(0,t)$ for $t < t^{\max}$ and $Q(t) = q_d^M(0)$ for $t > t^{\max}$.

Rewriting (2.6), we have

$$\underbrace{\tau \cdot q_f^D(t,0)}_{\text{Emission from transports}} > \underbrace{\rho \cdot \left[Q^D(0) - Q(t)\right]}_{\text{Increase in emissions from switch to local production}} > 0. \tag{2.7}$$

Inequality (2.7) shows that the exporting regime (Region 1 or Region 3) implies higher emissions than the acquisition regime (Region 2 or Region 4) if export emissions exceed the increase in production emissions that occur if firm f switches from exports to local production (since $Q^D(0) \geq Q(t)$). Also note that if (2.6) holds, it directly follows that emissions will also be higher when firm f exports than when it makes a greenfield investment in green technology without production emissions (i.e., Region 5).

For $t < t^{\max}$, using equilibrium quantities, Inequality 2.7 can be rewritten:

$$\frac{\tau}{\rho} \geq \frac{t}{a - 2t} \tag{2.8}$$

We can now use Inequality 2.7 to derive the main results of our analysis. In Figure 2 (i), $\tilde{v}_d(t)$ and $\tilde{v}_f(t)$ are depicted under the assumption that greenfield entry is not profitable, i.e. $G > \bar{G}(t)$. Figure 2 (i) then illustrates that no acquisitions will occur for low tariffs $t < t_f^{\min}$, that foreign acquisitions will occur for medium high tariffs, $t \in [t_f^{\min}, t^*)$and that domestic acquisitions will occur for high tariffs, $t \geq t^*$.

Figur 2 here

Two cases arise: First, suppose transport emissions are high compared to production emissions, i.e. $\tau > 2\rho$.[7] This case is depicted in Figure 2 (ii). We note that increasing tariffs from low levels reduce emissions since foreign exports decrease. This effect is illustrated by the negative slope of the emission curve in the interval $t \in [0, t_f^{\min})$. For somewhat higher tariff, an increased tariff discretely reduces emissions by inducing the foreign firm to jump the tariff by making an acquisition. The reason for the strong reductions in emissions is that transport emissions vanish. The breakpoint occurs at $t = t_f^{\min}$ in the figure where the emission-curve shifts down. However, increasing the tariff level beyond t^*, triggers a preemptive domestic acquisition. The foreign firm will then export and transportation emissions increase. This effect is illustrated in the figure

[7] The condition $\tau > 2\rho$ will guarantee that the emission-curve shift upward at t^* in Figure 2 (ii).

as the upward shift of the emission-curve at $t = t^*$. At the tariff level $\tilde{t} \in (t^*, t^{\max})$, emissions are equalized under domestic- or foreign acquisition, as transport emissions decline further from smaller exports.

We then turn to the case with low transport emissions, $\tau = 0 < 2\rho$, which is illustrated in Figure 2 (iii). We there observe that an increased tariff at low tariff levels again leads to lower emissions when foreign exports are reduced. For a somewhat higher tariff level, an increase in the tariff triggers a foreign acquisition. In this case, however, under low transport emissions, the rise in production emissions from a higher total output leads to an increase in total emissions. This effect is shown by the upward shift in the emission-curve at $t = t_f^{\min}$ in Figure 2 (iii). The shift to a preemptive domestic acquisition at high tariff $t = t^*$ now instead produces a reduction in total emissions since total production decreases. This effect is illustrated by the discrete downward shift of the emissions-curve at $t = t^*$.

Let us now summarize our main result on how an increased tariff can increase emissions in the following proposition, as proved above:

Proposition 1. *Suppose that Greenfield investment is not profitable, $G > \bar{G}(t)$. Then, the following holds:*

(i) *If transport emissions are high compared to production emissions, i.e. when $\tau > 2\rho$ holds, increasing tariffs from medium-high levels to high levels, i.e. from $t \in (t_f^{\min}, t^*)$ to $t \in (t^*, \tilde{t})$, will lead to increased emission levels. The reason is that tariffs induces the domestic firm to undertake a foreign entry-deterring acquisition, forcing the foreign firm to remain as an exporter.*

(ii) *If transport emissions are low, i.e. $\tau = 0$, increasing tariffs from low levels to medium-high levels, i.e. from $t \in (0, t_f^{\min})$ to $t \in (t_f^{\min}, t^*)$, will lead to increased emission levels. The reason is that tariffs triggers the foreign firm to undertake a tariff-jumping acquisition, which will increase total production in the market.*

Let us now relax the assumption that greenfield investment is not profitable to identify other effects of increased tariffs on emission levels. This exercise is illustrated in Figure 3.

Suppose we start in region R1 and increase the tariff t so that we move into region R2, raising the tariff from t_C to t_D, moving from point C to point D in Figure 3. At the higher tariff, the trade cost-savings effect in a foreign acquisition now becomes higher than the transaction cost making a foreign acquisition profitable. This foreign acquisition will reduce emissions since emissions associated with transportation is avoided.

Figur 3 here

If trade costs are initially of intermediate size, the effects of an increase in tariff may look different. Suppose we start in Region 2 and increase tariff t so that we move into Region 3, raising the tariff from t_A to t_B, moving from point A to point B in Figure 3. At the higher tariff, the market-power effect in a domestic entry-deterring acquisition is stronger than the trade cost-savings effect in a foreign acquisition. Paradoxically, the higher tariff forces the foreign firm to export—even though export costs increase. With the switch from two locally producing duopolists with no transport pollution under a foreign acquisition to a duopoly with one local producer and one polluting foreign exporter under a domestic acquisition, emissions increase.[8] For higher initial tariff, we are already initially in Region 3, and the increase in tariff will not affect the equilibrium market structure but only reduce exports by the foreign firm. Then, emissions decrease.

What if making a greenfield investment is profitable? This case is also shown in Figure 3. If we start in Region 1 and increase tariff t, with low greenfield costs, $G < T$, we enter Region 5, where the foreign firm produces locally without emitting pollution. This effect is illustrated in Figure 3 as an increase in the tariff from t_E to t_F, and a movement from point E to point F**.** Thus the tariff increase triggers a tariff jumping green greenfield investment.

Thus, we can state the following corollary:

Corollary 1. *For a sufficiently low cost of greenfield investment, an increased tariff will decrease emissions. The reason is that the tariff increase then triggers a tariff-jumping green greenfield investment.*

2.4.1. Welfare

Let us now turn to the effects on aggregate domestic welfare. To this end, we define domestic welfare $\dot{W}$:

$$W^* = S^* - E^* + CS^* + \pi_d^* + R^*$$

where S^* is the equilibrium sales price of firm b, CS^* is the equilibrium consumer surplus, and π_d^* is the equilibrium profit. In Table 2.2, we depict each component of the different welfare components in each region.

We can make the results on the welfare effects of tariff increases:

Proposition 2. *(i) Higher tariffs can increase welfare by triggering high-priced foreign acquisitions. In such situations, the target firm's owners benefit, and consumers benefit from better environmental quality and lower consumer prices. (ii) Higher tariffs can reduce welfare by triggering entry-deterring domestic acquisitions. In such situations, the target firm's owners benefit, and consumers lose from a worse environmental quality and higher prices.*

The proof of Proposition 2 is available upon request. It follows the graphical procedure as in Figure 3.

[8] For developing countries, the emissions cost of foreign entry-deterring acquisition under tariff shields might be high. As shown by Brucal, Javorcik and Love (2019), foreign acquisitions in developing countries can be associated with substantial sequential greenfield investments in green technologies.

Subsidizing clean tech can be counterproductive Many countries subsidize investments in clean-tech to attract firms to invest in their countries. For instance, the US have launched the Inflation Reduction act (IRA) to stimulate investment in clean-tech which both domestic and foreign firms are eligible for. The above analysis indicates that subsidizing clean tech in home country can be counterproductive. To highlight this mechanism i suppose that we model such subsidies by a reduction in the greenfield cost G. This will not only affect trade and greenfield investment patterns, but also the buyer's identity and the selling price in the privatization. In particular, a direct implication is that such policies can be counter productive from a domestic welfare perspective:

Corollary 2. *(i) Subsidies for clean-tech (as the IRA) might be counterproductive, since these do not necessarily increase clean-tech investments but may only reduce the sales price of the domestic assets.*

Summing up, when greenfield investments costs are sufficiently high CBA taxes may trigger preemptive domestic acquisitions that could be determinantal to environmental and consumer welfare. These findings suggest that environmental policy should be complemented with an active competition policy.

2.5. Extension: Emissions trading systems (ETS) and carbon border adjustment systems (CBAM)

To simplify our analysis, we have assumed that country H does not have a price on CO2 emissions at the outset. This fact is clearly at odds with the present situation, different countries and regions have established various emissions trading systems and carbon taxes. While 23 percent of greenhouse gas emissions worldwide are covered by some sort of pricing regime, that share is over 80 percent in Germany, 75 percent in Japan, 33 percent in China, and 78 percent in British Columbia. Within the nations belonging to the OECD, one-third of CO2 emissions are covered by an explicit price, and the share rises to nearly 55 percent when the United States is excluded. (Clausing and Wolfram 2023).

The introduction of a pricing regime on local CO2 emissions give raise to a risk of leakages problems and worsening of competitiveness of the local firms. Leakages and competitiveness issues raised by a CO2-pricing policy in the domestic market are mitigated by the so called carbon border adjustment mechanism: a policy where a jurisdiction with CO2 pricing applies import fees based on the CO2 content of imported goods—the amount of the border adjustment fee is based on the local CO2 price, with an adjustment for any CO2 price in the exporting country. For example, if the home market has a $110 per ton CO2 price and the foreign market has a $10 per ton CO2 price, the tariff would be $100 per ton of CO2 embedded in the product. If one unit of the product contained the equivalent of 0.02 tons of CO2, that would imply a $2 fee per unit.

In December 2022, the European Parliament and the Council of the European Union reached a provisional agreement to implement a carbon border adjustment mechanism beginning in late 2023; this agreement was finalized in April 2023. The proposed mechanism would levy a fee on imported goods in key energy-intensive, trade-exposed industries; the fee would be set at a level that would offset the competitive disadvantage associated with European Union CO2 costs. The proposal was designed to level the playing field in a manner that was consistent with World Trade Organization rules.

To simplify our analysis, we have so far assumed that country H does not tax emissions at the outset. In the next subsection we show that our main result that import tariffs can trigger entry-deterring emission-increasing domestic acquisitions can also occur in a emissions trading system (ETS) complemented with a carbon border adjustment mechanism (CBMA).

2.5.1. Entry-deterring domestic acquisition under ETS and CBAM

To see this, suppose that the domestic production faces an exogenous emission fee per unit output, ρ, when using non-clean technology, which is the price of emissions exogenously given from an ETS in the home country. The ETS covers a large part of the economy in the home country, and emissions from the industry in which the home- and foreign firm compete are assumed to be limited compared to the emissions in the whole economy, and thus we treated it as exogenous for the firms. Imports to be supplied from the foreign firm are assumed to be produced in a country without an ETS. To preserve a level playing field between the home- and the foreign firm, the home country has levied CBA on imports from the foreign firm set at the same price unit output as the ETS price, ρ. Finally, the foreign firm also faces a cost τ per unit of output exported to the home country, which we can assume is a tariff.

It is straightforward to solve the full model, but to highlight our main mechanism we focus on the equilibrium where Greenfield investment is not profitable. Then, under the ETS-CBMA-system, (2.4) and (2.5) now become:

$$\tilde{v}_f(\rho) = \begin{cases} \pi_f^D(\rho,\rho) - \pi_f^D(\rho+\tau,\rho) = \frac{1}{9}\tau\left(2a+\tau-2\rho\right), \text{if } \ \rho \in [0,\rho^{\max}], \\ \pi_f^D(\rho,\rho) = \left(\frac{a-\rho}{3}\right)^2, \text{if } \rho \in (\rho^{\max}, a), \end{cases} \tag{2.9}$$

and

$$\tilde{v}_d(\rho) = \begin{cases} \pi_d^D(\rho,\rho+\tau) - \pi_d^D(\rho,\rho) = \frac{4}{9}\tau\left(a-\tau-\rho\right), \text{if } \rho \in [0,\rho^{\max}], \\ \pi_d^M(\rho) = \left(\frac{a-\rho}{2}\right)^2, \text{if } \rho \in (\rho^{\max}, a), \end{cases}, \tag{2.10}$$

where $\rho^{\max} = a - 2\tau$ defined from $\pi_f^D(\rho+\tau,\rho) = \frac{1}{9}\left(a-2\tau-\rho\right)^2 = 0$.

From (2.9) and (2.10), we then get:

$$\tilde{v}_d(\rho) - \tilde{v}_f(\rho) = \begin{cases} -\frac{1}{9}\tau\left(2a-5\tau-2\rho\right), \text{ if } \ \rho \in [0,\rho^{\max}], \\ \frac{5}{36}\left(a-\rho\right)^2, \text{ if } \rho \in (\rho^{\max}, a). \end{cases} \tag{2.11}$$

From (2.11), we can state the following proposition:

Proposition 3. *Suppose the government in the home country applies an emissions trade system (ETS) which gives an exogenous emissions price, ρ per unit of domestic production. To level the playing field, the home government also applies a carbon border adjustment (CBA) on imports equal to per unit ETS price, ρ. Then, a foreign acquisition occurs if $\rho \in [0, a - \frac{2}{5}\tau)$ and a domestic acquisition occurs when $\rho \in (a - \frac{2}{5}\tau, a)$*

Thus, increasing the combined ETS-CBAM fee, ρ, sufficiently much will induce an entry deterring domestic acquisition, and force the foreign to export. Moreover, noting that domestic monopolization becomes easier under the ETS and CBA systems due to increased total variable costs for firms, we observe that more modest tariff increases can in such a system lead to entry-deterring acquisitions by domestic firms. This reinforces the importance of a strong competition policy during times of tariff wars, particularly from a climate perspective.

3. Concluding discussion

We have demonstrated that a tariff war does not necessarily result in reduced CO2 emissions by limiting export flows. This is because import tariffs incentives domestic firms to engage in entry-deterring acquisitions, preventing foreign firms from entering the domestic market and thereby maintaining their role as exporters. From a climate perspective, this underscores the importance of upholding a robust competition policy during trade wars.

Lowering the cost of greenfield investments through subsidies for clean-tech and low-emission production in the domestic market (e.g., initiatives like the IRA) could mitigate the risk of domestic firms pursuing foreign entry-deterring acquisitions, potentially resulting in lower CO2 emissions if competition policy remains stringent. However, in the absence of strict merger policies, such subsidies could become counterproductive from a welfare perspective. Specifically, they might inadvertently reduce the sale price of domestic target firms without significantly boosting investments in clean-tech or low-emission production.

In an extended version of our model, which incorporates both an emissions trading system (ETS) and a carbon border adjustment mechanism (CBAM), we demonstrate that the introduction of an ETS and CBAM can increase the risk of domestic, foreign entry-deterring acquisitions that also raise emissions when ETS prices and CBAM tariffs reach sufficiently high levels. This effect arises because CBAMs function similarly to import tariffs, potentially rendering CBAMs counterproductive by encouraging entry-deterring, emissions-increasing domestic acquisitions.

Our findings indicate that cross-border acquisitions, as opposed to domestic acquisitions, can enhance both domestic and global welfare by reducing CO2 emissions and lowering consumer prices. However, when multiple domestic and foreign firms are involved, a domestic merger may sometimes be the socially preferred option from a domestic welfare perspective, as buyers often fail to account for the aggregate externalities their acquisitions impose on rival firms. Furthermore, if domestic and foreign firms differ in other dimensions beyond location—such as market share, potential cost savings, or objectives—a policy that discriminates against foreign acquisitions may be justifiable. National security concerns, for example, may provide a rationale for restricting foreign acquisitions.

Table 2.1: The Equilibrium Market Structure (EMS) and Equilibrium Emissions.

	R1:	R2:	R3:	R4:	R5:
	Regions:				
Def:	$G \geq \bar{G}(t)$, $t \leq t_f^{\min}$	$G \geq \bar{G}(t)$, $t \in (t_f^{\min}, t^*)$	$G \geq \bar{G}(t)$, $t \geq t^*$	$G < \bar{G}(t)$, $G > T$	$G < \bar{G}(t)$ $G < T$
	(Net) Valuations:				
v_d:	0	$0, \text{if } t < t_d^{\min}$ $\tilde{v}_d(t) - T > 0, \text{if } t \geq t_d^{\min}$	$\tilde{v}_d(t) - T > 0$	$G - T > 0$	0,
v_f:	0	$\tilde{v}_f(t) - T > 0$	$\tilde{v}_f(t) - T > 0$	0,	0,
	Equilibrium Ownership Structure (EOS):				
Buyer:	·	*Firm f*	*Firm d*	*Firm f*	·
Price, S^*	·	$0, \text{if } t \leq t_d^{\min}$ $\tilde{v}_d(t) - T > 0, \text{if } t > t_d^{\min}$	$\tilde{v}_f(t) - T > 0$	0	·
Firm f:	Exports from Country F	Produces locally by acquiring Firm b	Exports from Country F	Produces locally by acquiring Firm b	Produces locally by investing Greenfield
	Equilibrium Emissions:				
$E(t)$:	$\tau q_f^D(0,t) +$ $\rho Q^D(t)$	$\rho Q^D(t)$	$\tau q_f^D(0,t) +$ $\rho Q^D(t)$ if $t < t^{\max}$ and $\rho q_d^M(0)$ if $t \geq t^{\max}$	$\rho Q^D(t)$	$\rho q_d^D(0,0)$
Note:	$0 < t_f^{\min} = \frac{a+\sqrt{a^2-9T}}{2} < t_d^{\min} = \sqrt{a^2+9T} - a < t^* = \frac{2}{5}a, \;\; a > 3\sqrt{T}.$				

Table 2.2: The Equilibrium Market Structure and Welfare (acquisition price, consumer surplus, tariff revenue, firm d profits and emissions).

	Regions:				
	R1:	R2:	R3:	R4:	R5:
Def:	$G \geq \bar{G}(t)$, $t \leq t_f^{\min}$	$G \geq \bar{G}(t)$, $t \in (t_f^{\min}, t^*)$	$G \geq \bar{G}(t)$, $t \geq t^*$	$G < \bar{G}(t)$, $G > T$	$G < \bar{G}(t)$ $G < T$
	Equilibrium Ownership Structure (EOS):				
Buyer:	$\cdot$	*Firm f*	*Firm d*	*Firm f*	$\cdot$
	Welfare: $W^* = S^* - E^* + CS^* + \pi_d^* + R^*$				
S^*	$\cdot$	$0, \text{if } t < t_d^{\min}$ $\tilde{v}_d(t) - T > 0, \text{if } t \geq t_d^{\min}$	$\tilde{v}_f(t) - T > 0$	0	$\cdot$
CS^*	$\frac{1}{2}\left[Q^D(t)\right]^2$	$\frac{1}{2}\left[Q^D(0)\right]^2$	$\frac{1}{2}\left[Q^D(t)\right]^2, \text{if } t < t^{\max}$ $\frac{1}{2}\left[q_d^m(0)\right]^2, \text{if } t \geq t^{\max}$	$\frac{1}{2}\left[Q^D(0)\right]^2$	$\frac{1}{2}\left[Q^D(0)\right]^2$
R^*	$tq_f^D(0,t)$	0	$tq_f^D(0,t), \text{if } t < t^{\max}$ $0, \text{if } t \geq t^{\max}$	0	0
π_d^*	$\pi_d^D(0,t)$	$\pi_d^D(0,0)$	$\pi_d^D(0,t), \text{if } t < t^{\max}$ $\pi_d^m(0), \text{if } t \geq t^{\max}$	$\pi_d^D(0,0)$	$\pi_d^D(0,0)$
$E^*:$	$\tau q_f^D(0,t)+$ $\rho Q^D(t)$	$\rho Q^D(0)$	$\tau q_f^D(0,t)+$ $\rho Q^D(t)$ if $t < t^{\max}$ and $\rho q_d^M(0)$ if $t \geq t^{\max}$	$\rho Q^D(0)$	$\rho q_d^D(0,0)$
Note:	$0 < t_f^{\min} = \frac{a+\sqrt{a^2-9T}}{2} < t_d^{\min} = \sqrt{a^2+9T} - a < t^* = \frac{2}{5}a < t^{\max} = a/2, \;\; a > 3\sqrt{T}.$				

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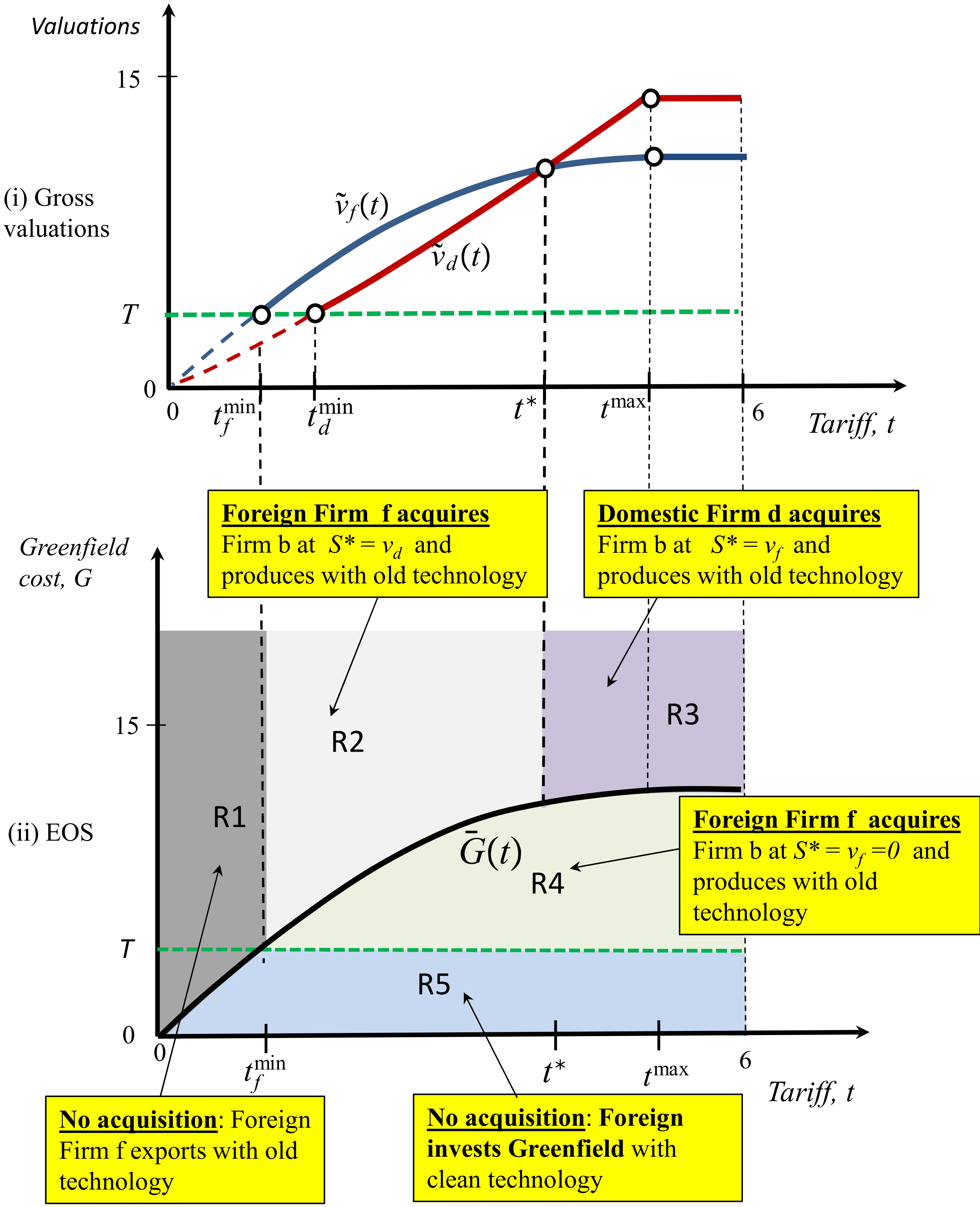

Figure 1: Deriving the Equilibrium Market Structure (EOS). Illustration with a=10 and T=4.

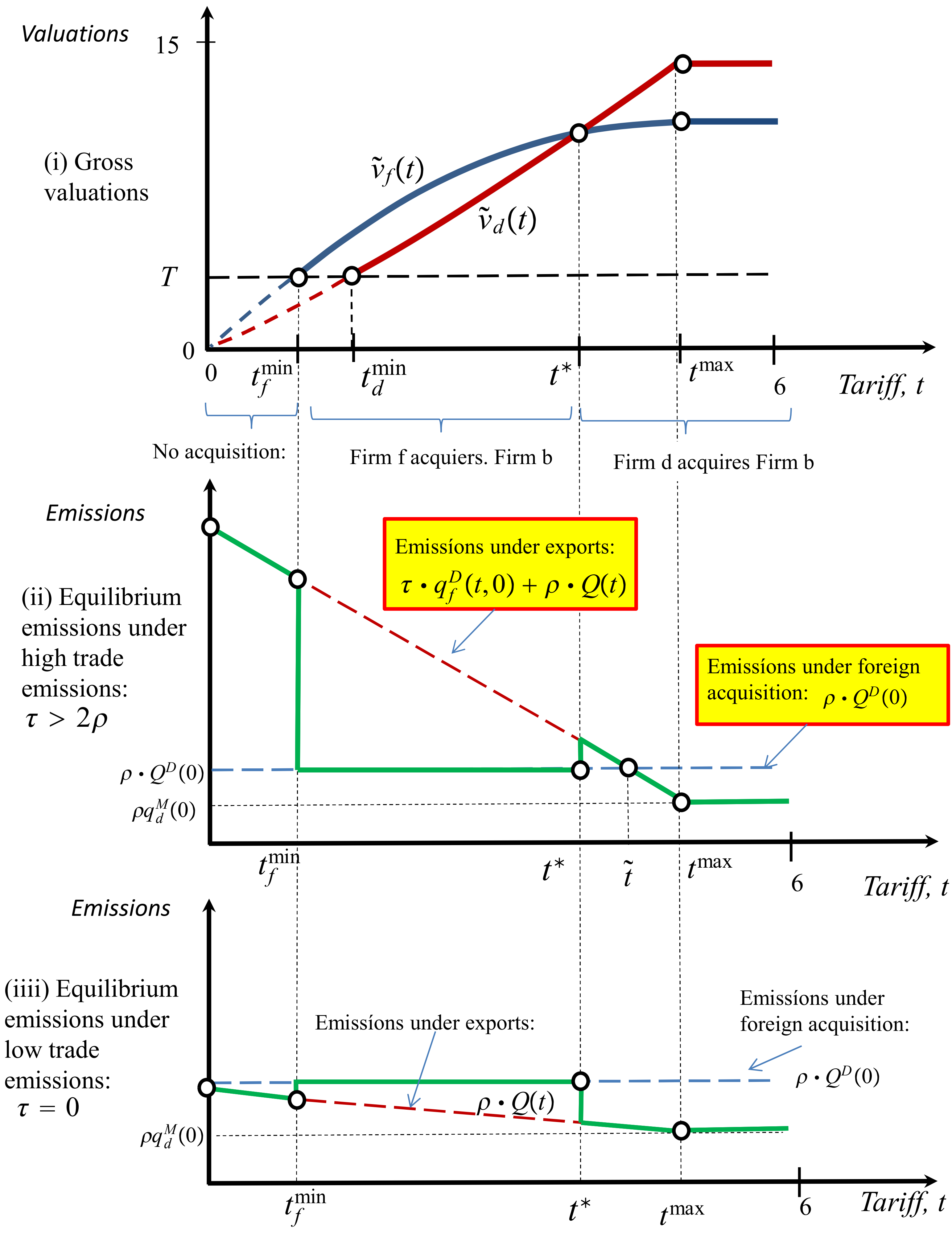

Figure 2: Deriving the Equilibrium Market Structure (EOS). Illustration with a=10 and T=4.

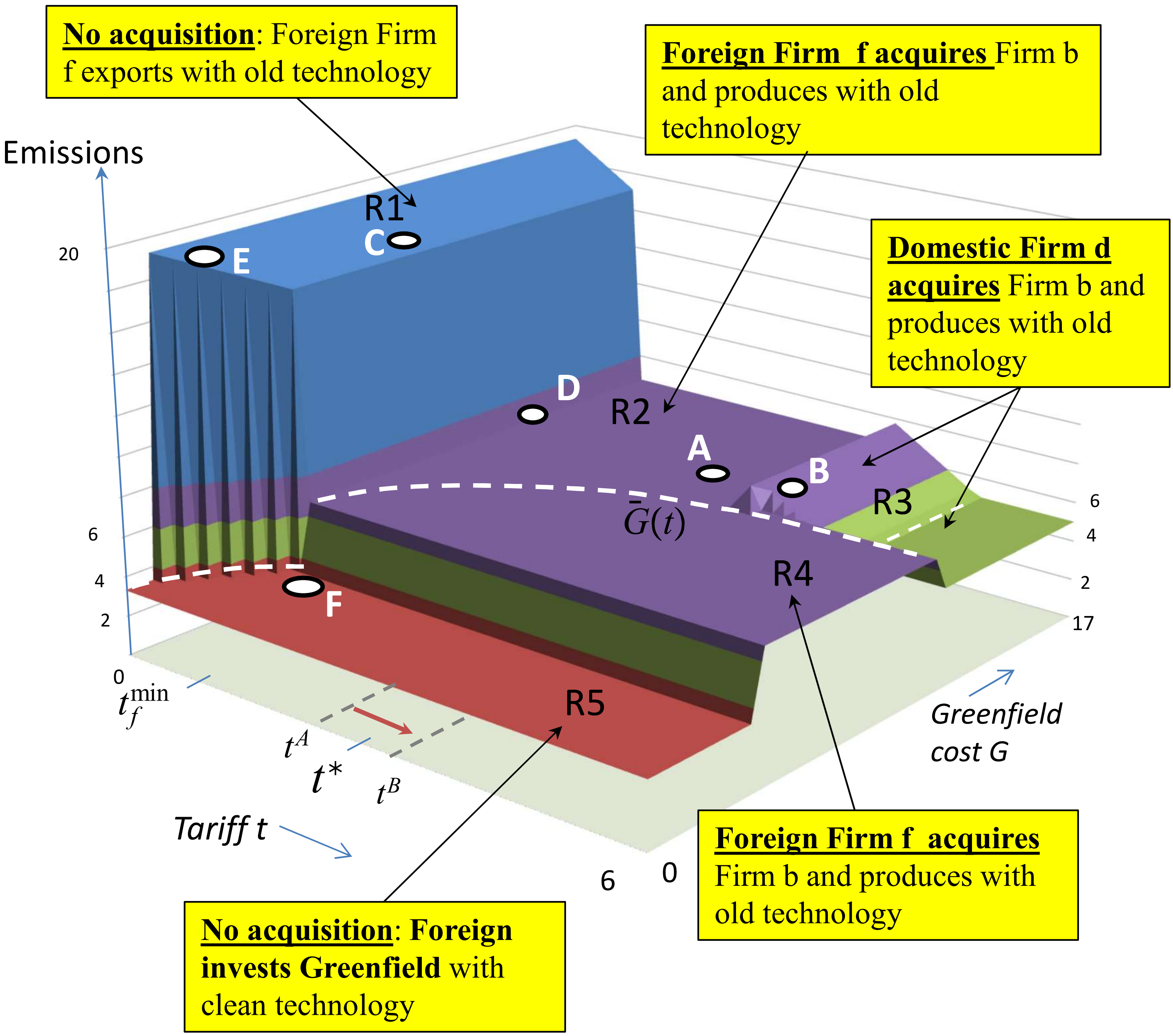

Figure 3: Equilibrium emissions and the Equilibrium Ownership Structure (EOS). Illustration with a=10 , T=4,ρ=1 and τ=4.

A. Web Appendix (not for publication)

A.1. Proof of Lemma 1

Let $v_i > v_h$ without loss of generality and assume that the target firm's reservation price is zero. (i) Let $v_i > v_h > 0$. Then, first, consider the equilibrium candidate where firm i acquires the target firm's assets and firm b accept the bid. Consider the equilibrium candidate $\mathbf{b}^*$, where $b_i^* > b_h^*$, $h \neq i$. Let owner i be the owner obtaining the target firm's assets. Note that $b_i^* > v_i$ is a weakly dominated strategy, since no owner will post a bid over its maximum valuation of obtaining the assets. If $b_i^* < v_h$, firm h benefits from deviating to $b_h^{**} = b_i^* + \varepsilon$, since it then obtains the assets and pays a price for the assets lower than its valuation of obtaining them. Last, consider candidate $b_i^* = v_h$, $b_h^* = v_h - \varepsilon$. Then, no owner has an incentive to deviate including owner b. Thus, this is a Nash equilibrium and the only NE where firm i obtains the assets.

Let us now show that this is the only Nash equilibrium. First, consider the situation where firm h obtains the assets. Consider the equilibrium candidate $\mathbf{b}^*$, where $b_h^* > b_i^*$, $h \neq i$. But we know that in equilibrium, $b_h^* < v_h$, since firm h otherwise plays a weakly dominated strategy. But if $b_h^* < v_h$, firm i benefits from deviating to $b_i^{**} = b_h^* + \varepsilon$, since it then obtains the assets and pays a price which is lower than its valuation of obtaining them. Thus, firm h obtaining the assets is not an equilibrium.

Second, note that the situation where neither firm i nor firm j obtains the assets cannot occur since firm b will accept any bid from zero and higher and such a bid will be made since $v_i > v_h > 0$.

(ii) If $v_i > 0 > v_h$, the same reasoning as above implies that firm i will acquire the target firm's assets, but now it has to pay the reservation price zero. Consider candidate $b_i^* = 0$, $b_h^* = v_h - \varepsilon$. Then, no owner has an incentive to deviate including owner b. Thus, this is the only Nash equilibrium.

(iii) If $0 > v_i > v_h$, it follows immediately that no acquisition takes place, and firm b exits. ■