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Optimal Tariffs with Inframarginal Exporters

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Abstract

This paper shows that an importing country can have an incentive to impose a tariff to extract rents earned by foreign exporters even in a perfectly competitive setting. To demonstrate this, I develop a new model of international trade that incorporates fixed costs of exporting and firm heterogeneity within a perfectly competitive framework. In this setting, despite the fact that there are no pre-existing distortions, the optimal tariff is positive even for a small country with no world market power. In the limit, as either firm heterogeneity or the fixed costs of exporting vanish, the optimal tariff approaches zero.

JEL Classification: F13

Keywords: optimal tariff; exporter rents; inframarginal firms; firm heterogeneity; extensive margin of trade

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1 Introduction

Understanding why countries may choose to impose import tariffs has been a central concern in the theory of trade policy. One potential rationale for a tariff is that it is an indirect means of taxing the profits of foreign exporters. This rent-extraction rationale was first noted by Katrak (1977) and Svedberg (1979) in the context of a market served by a foreign monopolist, and generalized by Brander and Spencer (1984). The rationale has the merit of being both simple and consistent with perceptions in the business community, as noted by Brander and Spencer (1992). It is also readily applicable to small countries that cannot affect world market prices. Despite these merits, the argument is not without its critics. For example, De Meza (1979) argues that dealing with the distortion generated by the presence of a foreign monopolist directly through the use of price controls is preferable to using a tariff or a consumption tax. De Meza's point is a specific instance of a more general principle – pervasive in the work on optimal trade policy under imperfect competition – that in the presence of a pre-existing distortion, addressing the distortion directly dominates the use of trade policy (Helpman and Krugman, 1989).

The current paper revisits the rent-extraction rationale for a tariff and argues that it is not merely a byproduct of a pre-existing distortion caused by imperfect competition but rather, can hold even in a perfectly competitive setting as long as there are inframarginal exporters. In order to demonstrate this point, I develop a new model of international trade that features heterogeneous firms and fixed costs of exporting as in Melitz (2003) but retains a perfectly competitive market structure. Firm heterogeneity and fixed costs are compatible with perfect competition in this model because firms face increasing marginal costs of production as in Hopenhayn (1992). Like the Melitz model, such a framework features an extensive margin of trade and inframarginal firms who earn rents by exporting to a location. I show that the optimal tariff is positive in this setting even for a small country that has no power in the world market for any good. In the limit, as either firm heterogeneity or the fixed costs of exporting vanish – so that the inframarginal firms who earn rents vanish – the optimal tariff approaches zero. Hence, the optimal tariff result here is clearly driven by the presence of these inframarginal exporters.

As with the rent-extraction rationale under imperfect competition, the desirability of a tariff here still reflects an underlying terms-of-trade effect. Owing to the fixed costs of exporting, the price in the importing country is higher than in the exporting country. Though a small importing country cannot affect the producer price in the foreign country, it is able to improve its terms-of-trade by using a tariff to induce a lower producer price in its domestic market. Bickerdike (1906) noted that as long as an importing country faces an upward sloping foreign export supply curve, it will have an incentive to impose a positive tariff in order to improve its terms-of-trade. The contribution of the current paper is to identify some conditions under which even a small country that takes the world price as given faces an upward sloping foreign export supply curve. The terms-of-trade improvement in this setting is equivalent to a transfer of rents from foreign inframarginal producers to domestic agents.

In addition to the existing literature on rent-motivated tariffs, this paper also complements several recent papers that study optimal trade policy in versions of the Melitz (2003) model (e.g. Demidova and Rodriguez-Clare, 2009; Felbermeyer et al., 2013; Haaland and Venables, 2016, Costinot et al., 2016). There are two main differences between this existing work and the current paper. First, the Melitz model features a monopolistically competitive market structure, in which the optimal tariff would be positive even in the absence of any extensive margin considerations (e.g. Gros, 1987). Second, while there are firms that earn rents in equilibrium in the Melitz model, the rent-extraction incentive to impose a tariff is itself absent because owing to CES preferences and constant marginal costs, the producer price is fixed from the outset. The current paper is therefore able to provide a distinct perspective on the policy implications of firm heterogeneity in international trade.

Another closely related paper is Romer (1994), which uses a monopolistically competitive model where exporters have heterogeneous fixed costs to show that a tariff can have a much larger negative welfare effect when an extensive margin of trade is present. The rationale for this result is that the tariff causes an additional loss of welfare because it reduces the number of varieties available in the importing country – a point that is also echoed in the recent papers on trade policy in the Melitz model discussed above. This result is quite different from the present paper's finding that an extensive margin of trade can create a *stronger* incentive to impose a tariff. This difference is due to two reasons. First, as discussed above, CES preferences and monopoly pricing together imply that the producer price is fixed at the outset by marginal costs.[1] Hence, a small country's tariff cannot reduce the producer price and therefore cannot help extract rents from foreign producers in such settings. Second, in the current paper, firms produce homogeneous goods and so a reduction in the number of exporters does not lead to loss of varieties unlike in Romer (1994).

More broadly, this paper makes a methodological contribution to the literature by developing a tractable new international trade model with heterogeneous firms but without imperfect competition as in Melitz (2003) or Bernard et al. (2003). I first illustrate the optimal tariff insights using a simplified version of the model where the only dimension of firm heterogeneity is in the fixed costs

[1] Note also that this point would be true in the current context even in a monopolistic model with CES preferences and *increasing* marginal costs. This is because a small country would have a negligible effect on the total output of each foreign firm and so marginal costs would be effectively constant from the perspective of the small country's government.

of exporting. I then present the full model that also incorporates heterogeneity in production costs and increasing costs of serving a market. The full model is consistent with some of the key facts that motivate the firm heterogeneity literature in international trade and in particular, can account for the selection of larger and more productive firms into exporting. I discuss how this type of model is especially suited to explain the fact that we see exporter selection patterns similar to those predicted by Melitz (2003) even in industries where there is generally little or no firm-level product differentiation.

The rest of the paper is organized as follows. Section 2 discusses some existing empirical evidence that helps motivate the perfectly competitive setting studied in this paper. Section 3 presents a simplified version of the model. Section 4 analyzes the welfare effects of a tariff and characterizes the optimal tariff using this simplified model. Section 5 extends the analysis to the full model. Section 6 concludes.

2 Empirical Motivation

The analysis in this paper emphasizes the selection of firms into exporting and the presence of inframarginal exporters in a perfectly competitive setting. Existing analyses of the implications of exporter selection and inframarginal firms are within the context of monopolistically competitive models such as Melitz (2003), where firms produce differentiated products. This firm-level product differentiation is central to the mechanism operating in these models but is absent in the framework studied in this paper. Before turning to the theoretical analysis, it is natural to ask whether the standard patterns of firms selection into exporting are empirically relevant even in industries where an assumption of price-taking firms might be reasonable.

While there is a large empirical literature documenting firm-level patterns of exporter selection[2], this literature generally does not directly compare these patterns across industries with differentiated vs. homogeneous products. One exception is Halpern and Muraközy (2011), who provide some relevant information using firm-level data from Hungary. They report several statistics of interest using Rauch's (1999) classification of products into three broad categories: differentiated, homogeneous and reference priced. Homogeneous products are defined as ones that are traded on an organized exchange, while reference-priced products are not traded on an exchange, but have prices that are listed in industry publications. Both of these categories could be considered homogeneous goods in a broader sense in that firms producing these products do have some type of market price that is given to them. For this same reason, these types of products are relatively less suited for the existing models that operate on the basis of firm-level product differentiation.

Halpern and Muraközy (2011) find that the ratio of the total exports of the largest and smallest quintiles of exporters is 180 for homogeneous products, 337 for reference priced goods and 457 for differentiated products. While the higher value for differentiated products is consistent with the notion that firm-level product differentiation magnifies patterns of selection into exporting, these numbers also clearly demonstrate how substantially pronounced these heterogeneity patterns are even for producers of homogeneous and reference priced goods. Based on these numbers, it seems natural to expect that these top quintiles of exporters are more strongly committed to export participation and are hence inframarginal in that respect. While Halpern and Muraközy do not document the fraction of firms that are exporters in each type of industry, they do find that exporter exit played a particularly strong role in driving overall changes in exports in industries with homogeneous products, thereby highlighting the importance of extensive margin considerations in such industries.

[2]See Bernard et al. (2012) for a review of this literature.

Some additional evidence on exporter selection patterns in homogeneous goods sectors comes from existing discussions in the context of agriculture. Gopinath et al. (2013) argue that the exporter-production decisions discussed in the firm heterogeneity literature in trade seem to match those found in agriculture well despite the fact that agricultural products are generally not differentiated at the firm-level. For example, they note that about 75% of Chilean farms do not participate in exporting, and those that do participate in exporting have an average TFP score that is about 50% greater than those that do not. Consistent with the framework of the current paper, Gopinath et al. emphasize the importance of fixed costs of export participation in driving these patterns.

3 Simplified Model

The next two sections use a simplified model that illustrates the key mechanisms that drive the optimal tariff result. In this simplified model, the only dimension of heterogeneity among firms is in their fixed costs of exporting. This is enough to generate inframarginal firms and to show how their presence can lead to a positive optimal tariff. The simplified model has two major limitations that are addressed by the full version of the model in Section 5: it cannot explain why firms would produce both for their domestic market and the export market, and it cannot explain why more productive firms select into exporting.

3.1 Basic Setup

Consider a partial equilibrium setting with a small home country and a large foreign country. The main insights of this paper do not rely on having a partial vs. general equilibrium model or on considering a small vs. a large country, but these assumptions will allow us to focus on what is new in this analysis relative to the existing literature. The partial equilibrium setup analyzes trade in a good of interest, x, while abstracting from the rest of the economy. As is standard with partial equilibrium analysis, we assume a background numeraire good, m, with quasi-linear preferences of the following form:

$$U = m + V(x)$$

In order to ensure an interior solution with some consumption of x in the home country in equilibrium, I assume that $\lim_{x->0} V'(x) = \infty$. Tariff revenues are rebated lump sum to the household.

For clarity of exposition, I also assume that x is produced only in the foreign country.[3] The mass of firms that produce x will be denoted $\hat{n}$, which I assume is fixed. Note, however, that it will not be of great importance whether $\hat{n}$ is exogenous or is determined endogenously by free entry because either way, it will be fixed from the standpoint of the small country's policymaker. I discuss free entry in more detail at the end of 3.2.

Each firm can choose to pay a firm-specific fixed cost f in order to export. These fixed costs are drawn from a distribution $G(f)$ with density $g(f)$, with $f \in [\underline{\mathrm{f}}, \infty)$. In the simplified model studied in this section, I assume that the fixed costs are the only dimension of heterogeneity between firms. Given this setup, an individual firm will either export or produce for its domestic market but will have no incentive to do both. This characteristic of the model will be relaxed in Section 5.

The role of the two-country assumption here also merits some discussion in connection with the fixed cost heterogeneity. What is essential in this paper is the presence of firms that are inframarginal in their decision to export to a particular market. Put differently, there needs to be destination-specific exporter rents. With more than two countries, this would still be the case as long there

[3] As with the standard partial equilibrium analysis, the optimal tariff insights here will not be altered by the presence of import-competing producers of x.

are destination-specific fixed costs that are heterogeneous across firms. Analytically, we would require a fixed cost vector that is drawn from a multivariate distribution. With such a setup, the main point derived here in a two-country setting would hold in a multi-country setting as well.

3.2 Firm's Problem

If a firm in the foreign country produces for the foreign domestic market, it maximizes:

$$\max_{x} \quad \hat{p}x - C(x),$$

where $\hat{p}$ is the price of x in the foreign country, and $C(x)$ is a cost function with $C'(x) > 0$ and $C''(x) > 0$. This problem yields a variable profit function $\pi(\hat{p})$ and a supply function $q(\hat{p})$.

The assumptions on the cost function here are equivalent to assuming a decreasing returns to scale production function (c.f. Hopenhayn, 1992). From a technical point of view, this assumption allows fixed costs and firm heterogeneity to be possible despite perfect competition.[4] This also seems to be a reasonable assumption from a substantial point of view because in reality, both fixed costs and firm heterogeneity are pervasive even in industries such as agriculture with many firms and homogeneous products (e.g. Gopinath et al., 2013).

Turning to the exporting firm's problem, a firm with fixed cost f maximizes:

$$\max_{x} \quad px - C(x) - f,$$

where p is the producer price in the export market. The firm's problem again yields a profit function $\pi(p)$ and supply function $q(p)$.

[4]Neither fixed costs of exporting nor fixed costs more generally would be possible with perfect competition and constant returns to scale because firms would never be able to recover their fixed costs.

A firm will choose to either produce for its domestic market or for export depending on which choice will allow it to make more profits. Since there are fixed costs associated with exporting but not with domestic production, in equilibrium, the producer price in the home country will have to be greater than the price in the foreign country, i.e. $p > \hat{p}$, in order to induce firms to export. We can define a marginal firm f^* that is indifferent between producing for the foreign domestic market and exporting as follows:

$$\pi(\hat{p}) = \pi(p) - f^* \tag{1}$$

Firms with $f < f^*$ will export and firms with $f > f^*$ will produce for the foreign domestic market. The Inada condition on household preferences guarantee that some firms will export, and so will also guarantee an interior solution for f^*.

We can close the model with market clearing conditions for the foreign and home country markets, respectively:

$$\hat{D}\left(\hat{p}\right) = \hat{n}\left[1 - G\left(f^*\right)\right] q\left(\hat{p}\right)$$

$$D\left(p + \tau\right) = \hat{n} G\left(f^*\right) q\left(p\right), \tag{2}$$

where $D\left(.\right)$ and $\hat{D}\left(.\right)$ are demand functions, and τ is a specific tariff imposed on consumers.[5] Note that the demand only depends on the price and not on household income because we have assumed quasi-linear preferences. The price in the two markets are not equalized by trade here because the fixed costs of exporting need to be factored into the price in the home country. We therefore have separate market clearing conditions for each country.[6] Since the home

[5]Since this is a perfectly competitive setting, the results are not sensitive to the choice of a specific or an ad-valorem tariff.

[6]As in other models with fixed costs of exporting such as Melitz (2003), the current model implicitly requires limits to cross-border shopping and intermediation; otherwise, the fixed

country is assumed to be small, it takes the price in the foreign country $\hat{p}$ as exogenous, and ignores the foreign market clearing condition when formulating its policies. There are then two variables that are endogenous from the standpoint of the small country: f^* and p. These variables are pinned down by two conditions, (1) and (2).

We can further define a function $f^* = \Phi(p) = \pi(p) - \pi(\hat{p})$ to capture the relationship between f^* and p that is implied by the marginal exporter condition, (1). Using Hotelling's Lemma, $\partial\Phi(.)/\partial p = q(p) > 0$. Intuitively, at a higher price, the export market is more attractive and so firms with relatively higher fixed costs of exporting will be be willing to export. With this, we can re-write the home market clearing condition as:

$$D(p+\tau) = \hat{n}G[\Phi(p)]\,q(p) \tag{3}$$

This condition determines the equilibrium in the home market.

4 Tariff Analysis

4.1 The Foreign Export Supply Curve

We know from standard tariff analysis that the welfare effects of a tariff depend crucially on the nature of the foreign export supply curve. In this model, the foreign export supply function is:

$$M \equiv \hat{n}G[\Phi(p)]\,q(p)$$

This function depends on two terms: the supply of an individual firm that has chosen to export, $q(p)$, and the total mass of exporters, $\hat{n}G[\Phi(p)]$. The first

costs would simply be irrelevant.

term captures the intensive margin of foreign export supply and the second captures the extensive margin.

Figure 1 illustrates the export supply curve and its two components graphically.[7] The IM curve depicts $q(p)$, which is upward sloping because an individual firm that produces under increasing marginal costs will supply more when the price it receives is higher. The EM curve depicts the second term, $\hat{n}G[\Phi(p)]$. Since $\Phi'(p) > 0$, this term is also increasing in p, reflecting the fact that more firms will choose to serve the export market at a higher price. Note that unless the price in the export market is sufficiently high – in this example, above p_o – no firm would export.

The overall export supply curve, M, is obtained by multiplying IM and EM horizontally. At p_0, no firm is willing to export, and so the total exports supplied – given by the M curve – are also equal to zero. For large values of p, many firms will be willing to supply, leading to a greater product between the amount supplied by an individual firm and the total number of firms.[8] As a result, the M curve is flatter than both the IM and EM curves. Intuitively, this is because the M curve includes the responsiveness of exports to the price at both the intensive and extensive margins.

Consider now what happens as firm heterogeneity vanishes. First, note that the slope of the EM curve is $\hat{n}g(f^*)\Phi'(p)$. When firm heterogeneity vanishes, the probability distribution $G(.)$ approaches a degenerate distribution with a mass point at f^*. This means that the probability density function, $g(.)$, approaches a delta function, which is infinite at the mass point. The EM curve therefore flattens out, as in Figure 2. Since we multiply the IM and EM curves

[7] This graph is drawn based on a numerical parameterization using a CES demand function and a cost function that is homogeneous in quantity. The curves need not have these particular concavities.

[8] This graph is drawn assuming that $\hat{n}$ is sufficiently large. Otherwise, the M curve could be to the left of the IM curve, since the latter is a representation of a unit mass of firms. Whether the M curve is to the left or to the right has no substantial meaning.

Figure 1: Components of the Foreign Export Supply Curve

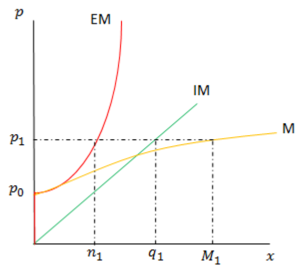
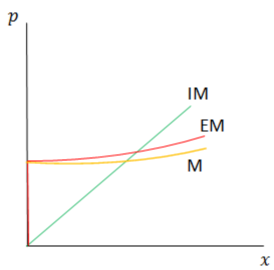


Figure 2: Foreign Export Supply Curve as Firm Heterogeneity Vanishes



horizontally in order to obtain the M curve, the M curve also flattens out. Hence, as firm heterogeneity vanishes, the export supply curve becomes infinitely elastic, thereby approaching the traditional small open economy model.

4.2 Effect of a Tariff

We now turn to studying the effect of a tariff in this setting. Figure 3 shows the earlier curves together with a demand curve D that represents $D(p+\tau)$.[9] An increase in the tariff rate shifts the demand curve down to D'.[10] This leads to a movement down the export supply curve and a consequent decrease in the price from p_1 to p_2. The quantity of imports decreases from M_1 to M_2. By tracing the price lines to the IM and EM curves, we can also see the decrease

[9] Note that if there were import-competing firms, the analysis would be identical except that we would use an import demand curve rather than a regular demand curve.

[10] The shift is a parallel one because the tariff is specific and demand only depends on the price owing to quasi-linear preferences.

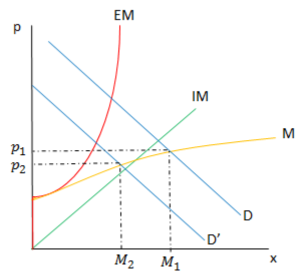
in the quantity supplied by individual firms and in the total number of firms serving the market, respectively. This analysis illustrates how the tariff forces out relatively high-cost exporters and induces a positive selection of firms into the home market.

From the analysis so far, it should be clear that a sufficiently small tariff will improve domestic welfare. This is because the tariff reduces the price received by foreign exporters, and so causes a terms-of-trade improvement for the home country. A formal proof that a sufficiently small tariff will improve welfare is provided in Appendix A.1. Underlying this analysis is the fact that while the small country has no power in the world market and cannot affect international prices, it is able to affect the producer price in its domestic market.

From Figure 3, it is also apparent that the producer surplus earned by foreign exporters in this market – the area between the export supply curve and the equilibrium price line – decreases as a result of the tariff. The only difference between producer surplus here and exporters rents – the excess profits earned by exporting – is that the latter takes into account the fixed cost of exporting but the former does not. Hence, the decrease in producer surplus is equivalent to a decrease in exporter rents. Part of the burden of the tariff falls on foreigners precisely because of a decrease in the rents earned by inframarginal exporters. The importing country can benefit from a tariff because it is able to capture a portion of these rents. This illustrates clearly the equivalence of the terms-of-trade rationale and the rent extraction rationale for a tariff here.

Another point to note is that it will not matter for the purpose of this analysis whether the total mass of firms in the foreign country, $\hat{n}$, is exogenous or determined by free entry as in Melitz (2003). In case of free entry, potential entrants in the foreign country would break even in expectation. However, a small country would not affect the expected profits of potential entrants in the

Figure 3: Effect of a Tariff



large country because ex-ante, the probability that an entrant will export to the small country is negligible. Thus, $\hat{n}$ would still be exogenous from the perspective of the small country. The exporter rents here – the excess profits from exporting – would exist even with free entry, and so nothing would be different from the small country's standpoint. Put differently, it does not matter for the small country whether the rents earned by foreign exporters end up in a foreign household's budget constraint or they end up in a foreign free entry condition.[11]

4.3 Optimal Tariff Formula

We can now derive an expression for the optimal tariff. The standard formula for the partial equilibrium optimal tariff as the inverse of the foreign export supply elasticity will still hold in this setting (see Appendix A.2. for the derivation):

$$\frac{\tau^*}{p} = \left[\frac{\partial M(p)}{\partial p}\frac{p}{M(p)}\right]^{-1}$$

Ordinarily, the foreign export supply elasticity for a small country is infinite. As discussed earlier, in this model, it is finite. It can be conveniently expressed

[11] With free entry, a large importing country would partly internalize its effect on $\hat{n}$ and so this part of the analysis would be somewhat different. Nevertheless, the importing country would not bear the entire burden of a reduction in $\hat{n}$, and so the policy incentive identified here would still be present in some form.

in the following form (see Appendix A.3 for the derivation):

$$\begin{aligned}\frac{dM}{dp}\frac{p}{M} &= q'(p)\frac{p}{q(p)} + \left\{g(f^*)\frac{f^*}{G(f^*)}\right\} \times \left\{\frac{\partial\left[\pi(p) - \pi(\hat{p})\right]}{\partial p}\frac{p}{\pi(p) - \pi(\hat{p})}\right\} \\ &= \epsilon_{q,p} + \epsilon_{G,f} \times \epsilon_{\pi-\hat{\pi},p}\end{aligned}$$

The first term, $\epsilon_{q,p}$, is the supply elasticity of an individual firm and it captures a firm's supply response to a change in the price it receives. The second term, $\epsilon_{G,f} \times \epsilon_{\pi-\hat{\pi},p}$, measures the extent of the extensive margin response. The magnitude of the extensive margin response depends on $\epsilon_{G,f}$, the elasticity of the probability distribution $G(f)$ with respect to f at f^*. It also depends on $\epsilon_{\pi-\hat{\pi},p}$, which captures the extent to which the gap between the variable profits made by exporting vs. producing for the domestic market – $\pi(p) - \pi(\hat{p})$ – is sensitive to the price in the importing country.

This formula provides several pieces of intuition about the optimal tariff in this model. First, as discussed in 3.1, if the heterogeneity among firms vanished such that $G(f)$ were to approach a degenerate distribution, then the density $g(f)$ would become infinite at the mass point. Consequently, $\epsilon_{G,f}$ would become infinite, and so the optimal tariff would go to zero. This is the point that was illustrated by Figure 2.

Second, if we scale down the random variable f so that the overall magnitude of the fixed costs becomes small, p will approach $\hat{p}$. This implies that $\pi(p) - \pi(\hat{p})$ approaches zero and so $\epsilon_{\pi-\hat{\pi},p}$ would again become infinite.[12] Graphically, this case will look the same as Figure 2.

These two points together illustrate clearly how both firm heterogeneity and fixed exporting costs are essential for generating a finite foreign export supply elasticity in this setting. This is because in order for there to be inframarginal

[12]Note that $\partial\left[\pi(p) - \pi(\hat{p})\right]/\partial p = q(p)$ by Hotelling's Lemma, and so this term does not go to zero under this scenario.

exporters, both of these characteristics of the model must be present. In the absence of either, the normative implications of the model are no different from the standard analysis for a small country.

4.4 Export Taxes/Subsidies

While the foregoing analysis studies the incentives to impose a tariff in this setting, it is natural to wonder whether either export taxes or export subsidies may also be optimal here. In the standard small country perfect competition analysis, the optimal tax/subsidy on exports is equal to zero just as the optimal tariff is equal to zero. For a large country, the standard framework implies a positive optimal tariff and a positive optimal export tax, both driven by term-of-trade considerations. Finally, in models with imperfect competition, countries can have incentives to impose a positive tariff – due to a terms-of-trade/rent-extraction rationale similar to the one in the current paper – while also having an incentive to subsidize exports (e.g. Helpman and Krugman, 1989). Export subsidies can be optimal in such settings because they are a means of transferring rents from foreign firms to domestic ones. The model studied in this paper has some similarities to all of these settings and so its implication for the optimality of export taxes/subsidies may not be immediately obvious.

We can consider a setup where domestic firms in a small country produce both for the domestic market and for export to a large rest of the world. To make the small country assumption meaningful, the rest of the world would have import-competing firms in the industry under study. Given these assumptions, the optimal tax/subsidy policy in this framework turns out to be the same as in the standard small country case: the optimal rate is equal to zero. This is because the small country's firms would be collectively small relative to the mass of import-competing firms, and so the small country has no power to affect the consumer price in the foreign market. A tariff was justified for a small country because with heterogeneous fixed costs, the domestic price in the importing country was endogenous to the country's policies. However, even with heterogeneous fixed costs, a small country would simply have no ability to affect either supply or demand in the foreign market.

Thus, we have in this setting a fundamental asymmetry between the partial equilibrium optimal policy towards imports and exports. This is potentially an attractive feature of this model because in reality, tariffs are much more widespread than either export taxes or export subsidies. The current model is thus able to provide a purely economic – as opposed to political – explanation for why this might be the case: countries may have more power to affect the producer price in their domestic market than to affect the consumer price in foreign markets.

5 Full Model

The paper so far has studied a simplified setting where the only dimension of firm heterogeneity is in the fixed costs of exporting. It is thus not able to account for some empirical regularities that motivate the heterogeneous firms literature in international trade. In the simplified model, firms will either produce for their domestic market or export, but will never do both. Furthermore, the simplified model also cannot explain why only the largest and most productive firms tend to select into exporting, a fact that is at the heart of heterogeneous firms literature (e.g. Bernard et al., 2012).

In this section, I introduce two features to the model that will allow us to match these empirical patterns while retaining perfect competition. First, I introduce firm heterogeneity in production costs in addition to the earlier heterogeneity in the fixed costs of exporting. Second, I introduce increasing costs of serving a market. These increasing costs give exporting firms an incentive to also produce for their domestic market by making it relatively costly to sell too much in the export market.

The increasing costs here are similar in spirit to the market penetration costs in Arkolakis (2010), which are generally required in order for the Melitz model to match the data to a satisfactory extent (e.g. Eaton et al., 2011). Arkolakis motivates these types of costs on the basis of diminishing returns to the marketing expenses required in order to reach more consumers in any given market. In addition to such marketing considerations, it may also be more costly to reach a larger number of customers in a market because of geographic variation in the quality of transportation and distribution infrastructure within a country.

A natural question in this context is whether the heterogeneity in the fixed costs of exporting is still necessary given the heterogeneity in production costs. In this two-country setting, having a uniform fixed cost together with heterogeneity in production costs would suffice to generate exporter rents and a positive optimal tariff. However, as discussed in 2.1, if the model were extended to allow for more than two countries, we would require some means of generating destination-specific rents. Fixed costs that are specific to each destination country would be naturally suited for this purpose. Fixed cost heterogeneity is therefore conceptually important for this framework.

5.1 New Setup

We can now turn to the analytics of the extended version of the model. To capture heterogeneity in the cost of production, I introduce an additional firm-specific cost parameter, a, that shifts each firm's cost function. Firms will now be indexed by a vector (f, a) that is drawn from a bivariate distribution,

$G(f,a)$. For simplicity, I assume that f and a are independent so that $G(f,a) = G_1(f)\,G_2(a)$. I assume, further, that the support of a is $[0,\infty)$. With these assumptions, it is now a combination of f and a that determines whether a given firm will export or not.

The second extension is the introduction of an additional cost of serving a market that is increasing in the amount sold in the market. For the home country's market, I assume that these costs take the form $T(.)$ with $T'(.) > 0$ and $T''(.) > 0$. With this modification, even after paying a fixed cost of exporting, firms will have some incentive to produce for their domestic market because they face increasing costs as they export more. The equivalent costs to serve the foreign domestic market are $\hat{T}(.)$.

With this setup in mind, the profit-maximization problem faced by a firm with cost a that chooses to produce only for the foreign domestic market is:

$$\max_{\hat{q}} \quad \hat{p}\hat{q} - aC(\hat{q}) - \hat{T}(\hat{q})$$

This problem yields a variable profit function that we can define as $\hat{\pi}(\hat{p};a)$. If a firm chooses to export, its problem becomes more complex because it now needs to decide jointly how much to produce for each market. It now solves the following:

$$\max_{\hat{q},q} \quad \hat{p}\hat{q} + pq - aC(q+\hat{q}) - T[q] - \hat{T}[\hat{q}] - f$$

In Appendix B.1, I show that the optimal choice of q is still increasing in p despite the additional complexity. In addition to the standard factors that lead to an upward sloping supply curve, there is now an additional effect that is embedded in this relationship: a higher price in the export market will induce inframarginal exporters to switch more of their output from the foreign domestic market to the export market. Again, we can define the variable profit function corresponding to this problem, $\pi(p, \hat{p}; a)$.

A firm with fixed cost f and production cost parameter a will export if it would make more profits by becoming an exporter than if it were to produce exclusively for the foreign domestic market:

$$\pi(p, \hat{p}; a) - f > \hat{\pi}(\hat{p}; a)$$

At any given fixed cost, f, for a firm with a sufficiently high cost of production, a, the exporting profits net of the fixed cost will be negative. Thus, for these high-cost firms, producing exclusively for the domestic market will be preferable to exporting. As in Melitz (2003), we have a selection effect here, whereby relatively high cost firms are unlikely to export.

Firms that are indifferent about becoming exporters will satisfy:

$$f = \pi(p, \hat{p}; a) - \hat{\pi}(\hat{p}; a) \equiv \zeta(a, p, \hat{p}) \tag{4}$$

We saw that firms with a sufficiently high cost of production will not export. Is it also the case that for a given fixed cost, a firm with a lower cost of production will necessarily have a greater incentive to be an exporter than one with a higher cost? Appendix B.2 shows that the function defined here, $\zeta(a, p, \hat{p})$, is decreasing in a, and so this would indeed the case. The intuition for this is that since low cost firms produce more output, they also benefit more from not having to incur the high marginal costs of selling all of their output in the foreign domestic market. In this setting, we thus have an extra reason for positive selection into exporting in addition to the fixed costs.[13]

Since firms with lower a will become exporters at any given level of f, the

[13]This additional mechanism is not essential, however, and the analysis would be largely unchanged even if the costs of serving the foreign domestic market, $\hat{T}(.)$, were absent.

independence of f and A implies immediately that exporters have a lower a on average than non-exporters. Note, however, that while exporters are more productive on average, there can be firms with a relatively high production cost that may export because they also have a relatively low fixed cost of exporting. The model is thus able to naturally account for the presence of small exporters that is observed in the data (e.g. Eaton et al., 2011).

The market clearing conditions in the home and foreign country, respectively, are now given by:

$$\begin{aligned} D(p+\tau) &= \hat{n}\int_{0}^{\infty}\int_{\underline{f}}^{\zeta(a,p,\hat{p})} q(p,\hat{p};a)\, g_1(f)\, g_2(a)\, df\, da \\ &= \hat{n}\int_{0}^{\infty} q(p,\hat{p};a)\, G_1[\zeta(a,p,\hat{p})]\, g_2(a)\, da \end{aligned} \tag{5}$$

$$\begin{aligned} \hat{D}\left(\hat{p},\hat{\Pi}\right) &= \hat{n}\int_{0}^{\infty}\int_{\zeta(a,p,\hat{p})}^{\infty} \hat{q}(\hat{p};a)\, g_1(f)\, g_2(a)\, df\, da + \hat{n}\int_{0}^{\infty}\int_{\underline{f}}^{\zeta(a,p,\hat{p})} \hat{q}(p,\hat{p};a)\, g_1(f)\, g_2(a)\, df\, da \\ &= \hat{n}\int_{0}^{\infty} \hat{q}(\hat{p};a)\{1-G_1[\zeta(a,p,\hat{p})]\}\, g_2(a)\, da + \hat{n}\int_{0}^{\infty} \hat{q}(p,\hat{p};a)\, G_1[\zeta(a,p,\hat{p})]\, g_2(a)\, da \end{aligned}$$

Once again, a small country can only affect its own market clearing condition.

5.2 Inverse Export Supply Elasticity

While more complex now because of the additional dimension of heterogeneity and the costs of serving each market, the qualitative aspects of the model that give rise to a positive optimal tariff remain largely unchanged. The foreign export supply elasticity is now:

$$\frac{dM}{dp}\frac{1}{M} = \frac{\int_0^\infty \frac{dq}{dp} G_1\left[\zeta\left(a,p,\hat{p}\right)\right] g_2\left(a\right) da}{\int_0^\infty q\left(p,\hat{p},a\right) G_1\left[\zeta\left(a,p,\hat{p}\right)\right] g_2\left(a\right) da} + \frac{\int_0^\infty q\left(p,\hat{p},a\right) g_1\left[\zeta\left(a,p,\hat{p}\right)\right] \frac{\partial \zeta}{\partial p} g_2\left(a\right) da}{\int_0^\infty q\left(p,\hat{p},a\right) G_1\left[\zeta\left(a,p,\hat{p}\right)\right] g_2\left(a\right) da}$$

This formula is again governed by two basic terms. The first term captures the change in firm-level supply to the home market in response to a change in p. The second term captures the extensive margin response. Using Hotelling's Lemma on (4), we can see that $d\zeta/dp = q\left(p\right)$. Hence, the export supply elasticity is finite, and in turn, the optimal tariff is positive.

If there were no heterogeneity in a and f, then the extensive margin term would become infinite, causing the export supply elasticity to also become infinite. If the fixed costs of exporting were to go to zero for all firms, (4) implies that $d\zeta/dp$ becomes infinite, and so the export supply elasticity would again be unbounded. Thus, as in Section 4, it is the presence of inframarginal firms – which requires both firm heterogeneity and fixed costs of exporting – that makes the export supply elasticity finite, and therefore leads to a positive optimal tariff.

6 Conclusion

This paper shows that a small country can have an incentive to impose a tariff to capture rents earned by foreign exporters even in a perfectly competitive setting. To show this, I develop a new model of trade with firm heterogeneity and fixed costs of exporting that preserves perfect competition. In this setting, the optimal tariff is positive but approaches zero as either firm heterogeneity or the fixed exporting costs vanish. This demonstrates the key role of the extensive margin of trade and inframarginal exporters in generating a positive optimal tariff.

While the rent-extraction rationale for a tariff is well-known in the international trade literature, the current paper shows that this rationale is not merely a byproduct of imperfect competition. This point is substantively important because the existing arguments in favor of a tariff made under imperfect competition are subject to the objection that trade policies are dominated by instruments that directly address the underlying distortion. In the setting studied in this paper, there are no pre-existing distortions and so such an objection would not apply.

A Proofs for the Simplified Model

A.1 A small tariff improves welfare

We can define a relationship implied by the market clearing condition, (2), as $f^* = \Gamma(p, \tau)$. We can sign this relationship using the implicit function theorem:

$$\frac{\partial \Gamma(.)}{\partial p} = -\frac{D'(.) - \hat{n}q'(p)\, G(f^*)}{-\hat{n}q(p)\, g(f^*)}$$

Since $D'(.) < 0$ and $q'(p) > 0$, $\partial \Gamma(.)/\partial p < 0$. Intuitively, an increase in the price decreases quantity demanded and increases quantity supplied at a fixed number of exporters. To clear the market, we require there to be fewer exporters, and therefore a lower f^*. The relationship between $\Gamma(.)$ and τ is given by:

$$\frac{\partial \Gamma(.)}{\partial \tau} = -\frac{D'(.)}{-\hat{n}q(p)g(f^*)} < 0$$

At a constant p, an increase in τ decreases f^*. This is because the increase in τ reduces quantity demanded to below quantity supplied, and so the number of exporting firms must fall in order to restore equilibrium.

With this function defined, the equilibrium p is determined by:

$$\Phi(p) = \Gamma(p, \tau)$$

Using the implicit function theorem once again, we can obtain the total effect of τ on p:

$$\frac{dp}{d\tau} = -\frac{-\partial \Gamma(.)/\partial \tau}{\partial \Phi(.)/\partial p - \partial \Gamma(.)/\partial p} < 0$$

The graphical analysis in the text provides the intuition for this result.

To see that a sufficiently small tariff improves welfare, we can differentiate the indirect utility function – which we will call $W[p + \tau, \tau D(.)]$ – with respect to τ and evaluate at $\tau = 0$ to obtain:

$$\begin{aligned}\left.\frac{dW}{d\tau}\right|_{\tau=0} &= -D(.)\left(\frac{dp}{d\tau}+1\right)+D(.)+\tau\left.\frac{dD\,(.)}{d\tau}\right|_{\tau=0} \\ &= -D\,(.)\,\frac{dp}{d\tau} > 0\end{aligned}$$

A.2 Optimal Tariff Formula

The government solves:

$$\max_{\tau} \quad W\,[p+\tau, \tau D(.)]$$

Taking the first-order condition and using Roy's identity, we obtain:

$$-D(.)\left[\frac{dp}{d\tau}+1\right]+D(.)+\tau\frac{dD(.)}{d\tau}=0$$

$$-D(.)\frac{dp}{d\tau}+\tau\frac{dD(.)}{d\tau}=0$$

Since there are no domestic firms, $D\,(.) = M\,(.)$, and so:

$$\begin{aligned}\frac{\tau^*}{p} &= \frac{dp}{d\tau}\frac{1}{p}\left(\frac{dM\,(.)}{d\tau}\frac{1}{M\,(.)}\right)^{-1} \\ &= \left[\frac{dM\,(p)}{dp}\frac{p}{M\,(p)}\right]^{-1}\end{aligned}$$

A.3 Formula for the Foreign Export Supply Elasticity

We can derive the foreign export supply elasticity by differentiating the export supply function:

$$
\begin{aligned}
\frac{dM}{dp} &= \frac{d}{dp}\left\{\hat{n}q\left(p\right)G\left[\Phi\left(p\right)\right]\right\} \\
&= \hat{n}q'(p)G\left(f^{*}\right)+\hat{n}q(p)g\left(f^{*}\right)\frac{\partial\Phi\left(p\right)}{\partial p} \\
\frac{dM}{dp}\frac{p}{M} &= q'(p)\frac{p}{q\left(p\right)}+\frac{g\left(f^{*}\right)}{G\left(f^{*}\right)}\frac{\partial\Phi\left(p\right)}{\partial p}p \\
&= q'(p)\frac{p}{q\left(p\right)}+g\left(f^{*}\right)\frac{f^{*}}{G\left(f^{*}\right)}\frac{\partial\Phi\left(p\right)}{\partial p}\frac{p}{f^{*}} \\
&= q'(p)\frac{p}{q\left(p\right)}+g\left(f^{*}\right)\frac{f^{*}}{G\left(f^{*}\right)}\frac{\partial\left[\pi(p)-\pi\left(\hat{p}\right)\right]}{\partial p}\frac{p}{\pi(p)-\pi\left(\hat{p}\right)},
\end{aligned}
$$

where the last step uses the fact that $\Phi\left(p\right)=f^{*}=\left[\pi\left(p\right)-\pi\left(\hat{p}\right)\right]$.

B Proofs for the Extended Model

B.1 $q\left(p,\hat{p}\right)$ is increasing in p

For an exporting firm, the first-order conditions for $\hat{q}$ and q are:

$$\hat{p}-aC'\left(q+\hat{q}\right)-\hat{T}'\left(\hat{q}\right)=0 \tag{6}$$

$$p-aC'\left(q+\hat{q}\right)-T'\left(q\right)=0 \tag{7}$$

First, we can think of (6) as defining a function $\hat{q}=\psi_1\left(q\right)$ and (7) as defining a function $\hat{q}=\psi_2\left(q,p\right)$. Using the implicit function theorem, we obtain the following:

$$\frac{\partial\psi_1\left(q\right)}{\partial q}=-\frac{-aC''\left(q+\hat{q}\right)}{-aC''\left(q+\hat{q}\right)-\hat{T}''\left(\hat{q}\right)}<0$$

$$\frac{\partial \psi_2 (q, p)}{\partial q} = -\frac{-aC'' (q + \hat{q}) - T'' (q)}{-aC'' (q + \hat{q})} < 0$$

$$\frac{\partial \psi_2 (q, p)}{\partial p} = -\frac{1}{-aC'' (q + \hat{q})} > 0$$

Note, further, that:

$$\frac{aC'' (q + \hat{q})}{aC'' (q + \hat{q}) + \hat{T}'' (\hat{q})} < \frac{aC'' (q + \hat{q}) + T''(q)}{aC'' (q + \hat{q}) + \hat{T}'' (\hat{q})} < \frac{aC'' (q + \hat{q}) + T''(q)}{aC'' (q + \hat{q})}$$

This means that $-\partial \psi_1 (q) / \partial q < -\partial \psi_2 (q, p) / \partial q$ and so $\partial \psi_1 (q) / \partial q > \partial \psi_2 (q, p) / \partial q$.

Since at the optimum, $\psi_1 (q) - \psi_2 (q, p) = 0$, we can use the implicit function theorem again to get:

$$\frac{\partial q}{\partial p} = -\frac{-\partial \psi_2 (q, p) / \partial p}{\partial \psi_1 / \partial q - \partial \psi_2 / \partial q} > 0$$

The quantity supplied by the firm to the export market is therefore increasing in the price that is available in the export market.

B.2 $\zeta (a, p, \hat{p})$ is decreasing in a

Recall that $\zeta (a, p, \hat{p}) \equiv \pi (p, \hat{p}; a) - \hat{\pi} (\hat{p}; a)$. I will denote the optimal choices of q and $\hat{q}$ for a given firm – suppressing the arguments of the function – as q_E and $\hat{q}_E$. The optimal choice of q for a firm that only serves the foreign domestic market will be denoted $\hat{q}_D$.

The envelope theorem implies that:

$$\frac{d\zeta (a, p, \hat{p})}{da} = -C (q_E + \hat{q}_E) + C (\hat{q}_D)$$

From this, it follows that $d\zeta (a, p, \hat{p}) / da$ will be negative as long as the optimal choice of total production for an exporter is greater than the optimal choice of production for a non-exporter with the same cost parameter, i.e. $q_E + \hat{q}_E > \hat{q}_D$.

To see why this will be the case, note that the first-order condition for a non-exporter is:

$$\hat{p} - aC'(\hat{q}_D) - \hat{T}'(\hat{q}_D) = 0$$

At an arbitrary choice of domestic and export production, the difference between the marginal revenue and the marginal cost of producing for the domestic market for an exporter is:

$$\hat{p} - aC'(q + \hat{q}) - \hat{T}'(\hat{q}) > \hat{p} - aC'(q + \hat{q}) - \hat{T}'(q + \hat{q})$$

If an exporting firm produced at a total output level equal to the optimal output level of a domestic firm – so that $q + \hat{q} = \hat{q}_D$ – the following would be true:

$$\hat{p} - aC'(q + \hat{q}) - \hat{T}'(\hat{q}) > \hat{p} - aC'(\hat{q}_D) - \hat{T}'(\hat{q}_D) = 0$$

Thus, for an exporter that produces a total quantity that is optimal for a non-exporter, the marginal revenue from producing for the domestic market would exceed the marginal cost. This means that the exporter will want to increase total output. Hence, the optimal total output of an exporter must be greater than that of a non-exporter, i.e. $\hat{q}_E + q_E > \hat{q}_D$. As discussed earlier, this in turn implies that $\zeta(a, p, \hat{p})$ must be decreasing in a.

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