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Optimal Tariffs with Inframarginal Exporters

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Abstract

This paper shows that the presence of inframarginal exporters can itself be a reason for a positive optimal tariff. 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, even a small importing country with no world market power has an incentive to optimally impose a tariff. In the limit, as either firm heterogeneity or the fixed costs of exporting vanish – so that there are no inframarginal firms – the optimal tariff approaches zero. The importing country is able to benefit from a tariff because part of the burden falls on the exporter rents earned by foreign inframarginal firms.

JEL Classification: F13

Keywords: optimal tariff; inframarginal firms; firm heterogeneity; exporter rents

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1 Introduction

The presence of inframarginal exporters is a central theme in the recent literature on international trade with heterogeneous firms that follows Melitz (2003). Inframarginal firms make more profits by exporting to a market than they would if they did not export. They therefore earn rents by exporting. For an importing country, policies that would allow a portion of these rents to be transferred to domestic agents would clearly be an attractive possibility.

The current paper develops this point by explaining how the presence of inframarginal exporters can itself be a reason for optimally imposing an import tariff. In order to demonstrate this clearly, I first develop a new model of international trade that features heterogeneous firms and fixed costs of exporting while retaining a perfectly competitive market structure. Firm heterogeneity and fixed costs are compatible with perfect competition in this setting because the marginal costs of production are increasing in output, as in Hopenhayn (1992).

In this model, the optimal tariff is positive even for a small country that has no power in the world market for any good. The importing country is able to benefit from a tariff because part of the burden of the tariff falls on the exporter rents earned by foreign inframarginal firms. In the limit, as either firm heterogeneity or the fixed costs of exporting vanish – so that there are no inframarginal firms – the optimal tariff approaches zero. Hence, this analysis clearly shows how the presence of inframarginal firms can itself lead to a positive optimal tariff.

The trade policy implications of inframarginal exporters that this paper identifies are absent in settings such as Melitz (2003). While there are inframarginal firms that earn rents in the Melitz model, a tariff would not be an effective means of capturing these rents. This is because with constant marginal costs and CES preferences, the producer price of each monopolist is fixed. By contrast, in the perfectly competitive setting studied in this paper, an import tariff induces a movement along the foreign export supply curve as marginal exporters – who require a relatively higher price in order to be willing to serve a market – drop out, leading to a lower pre-tariff price in the importing country.

While the optimal tariff incentive identified in this analysis does not rely on the importing country having any monopoly power in the world market, it is still a type of terms-of-trade argument. Owing to the fixed costs of exporting, the price in the importing country is higher than in the exporting country. While 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 pre-tariff price in its domestic market. This analysis therefore provides a new rationale for why small countries may find it optimal to affect their terms-of-trade through the use of tariffs, viz. to indirectly tax foreign inframarginal exporters. Though this paper focuses on unilateral trade policy in the context of a small country, this new version of the terms-of-trade argument does indirectly strengthen the case for the terms-of-trade theory of trade agreements (Bagwell and Staiger, 1999).[1]

This paper is closely related to two strands of the literature on trade policy. First, it is related to several recent papers that study trade policy in settings with heterogeneous firms. Demidova and Rodriguez-Clare (2010) analyze optimal tariffs in a small-country Melitz model. Felbermeyer et al. (2013) extend this analysis to the case of large countries. Haaland and Venables (2016) analyze optimal domestic and trade policies in a general framework that nests the heterogeneous firms model. Costinot et al. (2016) characterize optimal trade policy when the government has access to firm-specific import and export policy instruments. These papers study variants of the Melitz model where, as discussed earlier, the rent motive for imposing a tariff is absent due to the combination of CES preferences and constant marginal costs. The current paper therefore complements this existing body

[1]See Bagwell and Staiger (2004) and Broda et al. (2010) for more discussion about small countries and the terms-of-trade argument.

of work by developing a new framework that provides a distinct perspective about the policy implications of firm heterogeneity in international trade.

Second, this paper is connected to a strand of the literature that emphasizes incentives to use a tariff as a means of taxing exporter rents. In particular, Katrak (1977) and Svedberg (1979) show that a tariff can be beneficial for this reason when the importing country is supplied by a foreign monopolist. This argument is generalized by Brander and Spencer (1984), who show that the result depends crucially on assumptions about the concavity of the demand function. The literature has consistently interpreted this rent extraction motive as a second-best case for a tariff that rests on the pre-existing distortion created by imperfect competition (e.g. De Meza, 1979).

My analysis too emphasizes the role of tariffs in extracting exporter rents, but it also shows that such a motive need not be a byproduct of imperfect competition. Rather, it can simply be a consequence of firm heterogeneity and fixed costs of exporting. This point is substantively important because the standard objection to many optimal tariff arguments made under imperfect competition is that a tariff is dominated by policies that directly address the pre-existing distortion (e.g. Helpman and Krugman 1989) – an objection that would not apply in the setting studied here. Furthermore, unlike with imperfect competition, the argument here does not depend on assumptions about the concavity of the demand function.

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 Bernard et al. (2003) and Melitz (2003). I initially study a simplified version of the model where the only dimension of firm heterogeneity is in the fixed costs of exporting. I then present an extended model that also incorporates heterogeneity in production costs and increasing costs of serving a market. The extended model is consistent with some of the key facts that motivate the firm heterogeneity literature in international trade.[2] In particular, it can account for the selection of relatively large and more productive firms into exporting.

The rest of the paper is organized as follows. Section 2 presents the model. Section 3 analyzes the welfare effects of a tariff and characterizes the optimal tariff. Section 4 considers an extended version of the model, and Section 5 concludes.

2 Model

2.1 Basics

I study a partial equilibrium setting with a small home country and a large foreign country. The main points made in this paper do not rely on having a partial vs. a general equilibrium setting or on considering a small vs. a large country, but these assumptions will allow us to focus sharply on what is new in this analysis relative to the existing literature.

Households consume a numeraire good m and the good of interest x, and have a utility function that takes a quasi-linear form:

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

I assume that $\lim_{x->0} V'(x) = \infty$ to ensure that there will always be some consumption of x in the home country in equilibrium.

For clarity of exposition, I assume that x is produced only in the foreign country. The mass of firms that produce x will be denoted $\hat{n}$. For this analysis, it will not matter 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 (see the end of 3.1 for more discussion on this point).

Each firm can choose to pay a firm-specific fixed cost f in order to export.

[2] See Bernard et al. (2007) for a discussion of some of these facts in relation to the theoretical literature.

These fixed costs are drawn from a distribution $G(f)$ with density $g(f)$, with $f \in [\underline{\mathrm{f}}, \infty]$. In the baseline 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 4, where I introduce heterogeneity in production costs as well as increasing costs of serving a market.

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 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.

2.2 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 that satisfies $C'(x) > 0$ and $C''(x) > 0$.[3] This problem yields a profit function $\pi(\hat{p})$ and a supply function $q(\hat{p})$.

If a firm with fixed cost f chooses to produce for export, it maximizes:

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

[3] This is equivalent here to assuming a decreasing returns to scale production function.

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

A firm will choose to either produce for its domestic market or 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. Given this setup, firms have no incentives to simultaneously export and produce for the domestic market – an outcome that will be relaxed in Section 4.

Next, we can define a marginal firm f^* that is indifferent between producing for the domestic market and exporting:

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

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

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

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

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

where $D(.)$ and $\hat{D}(.)$ are demand functions, and τ is a specific tariff. 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.[4]

[4]As in other models with fixed costs of exporting such as Melitz (2003), the current

Since the home 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 market clearing condition as:

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

This condition determines the equilibrium in the home market.

3 Tariff Analysis

3.1 The Foreign Export Supply Curve

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

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

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

model implicitly requires limits to cross-border shopping and intermediation; otherwise, the fixed costs would simply be irrelevant.

Figure 1: Foreign export supply function and its components

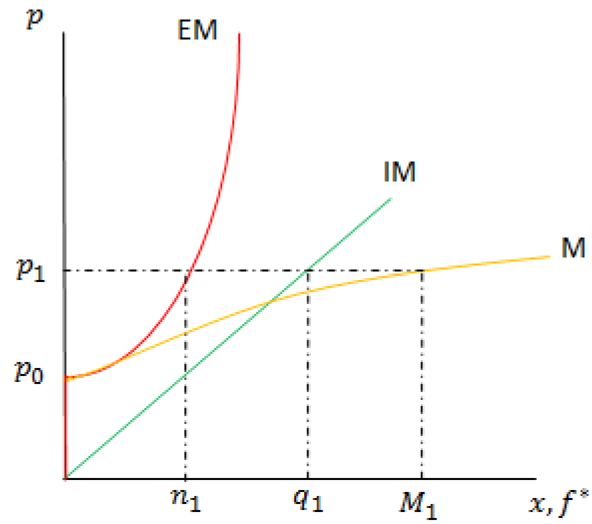


Figure 1 illustrates the export supply curve and its two components graphically. The IM curve depicts $q(p)$, which is upward sloping because an individual firm that produces under increasing marginal costs will supply more when the price it receives is higher. The EM curve depicts the second term, $\hat{n}G[\Phi(p)]$. 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 – is 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.[5] As a

[5] 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.

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 firm-level and at the extensive margin level. This diagram allows us to see the intensive and extensive margins of exports at any given price. At p_1, for example, the total export supply is M_1, the supply of an individual firm is q_1 and the number of firms supplying the export market is n_1.

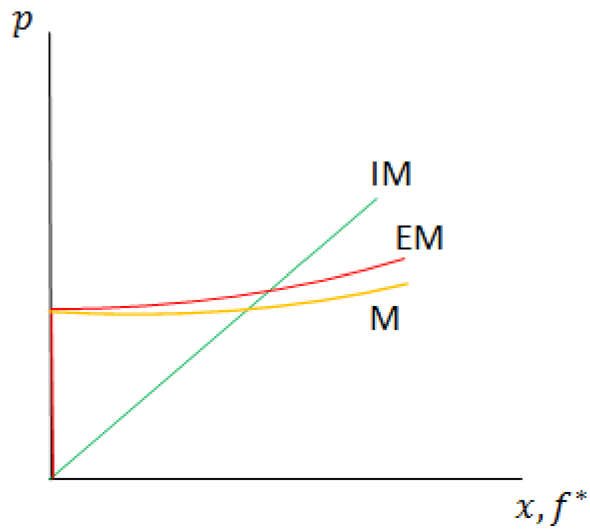
Consider now what happens as firm heterogeneity vanishes. First, note that the slope of the EM curve is $\hat{n}g\left(f^*\right)\Phi'\left(p\right)$. When firm heterogeneity vanishes, the probability distribution $G\left(.\right)$ approaches a degenerate distribution with a mass point at f^*. This means that the probability density function, $g\left(.\right)$, 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 horizontally in order to obtain the M curve, the export supply curve also flattens out. Hence, as firm heterogeneity vanishes, the export supply curve becomes infinitely elastic, as in the traditional small open economy analysis.

3.2 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 $D\left(p,\tau\right)$.[6] An increase in the tariff rate shifts the demand curve down to D'. 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 in the quantity supplied by individual firms and in the total number of firms serving the market. This analysis illustrates how the tariff forces out relatively high-cost exporters and induces a positive selection of firms into

[6]Note that this is also the import demand curve here because we assumed that there are no import-competing firms.

Figure 2: Foreign export supply as firm heterogeneity vanishes

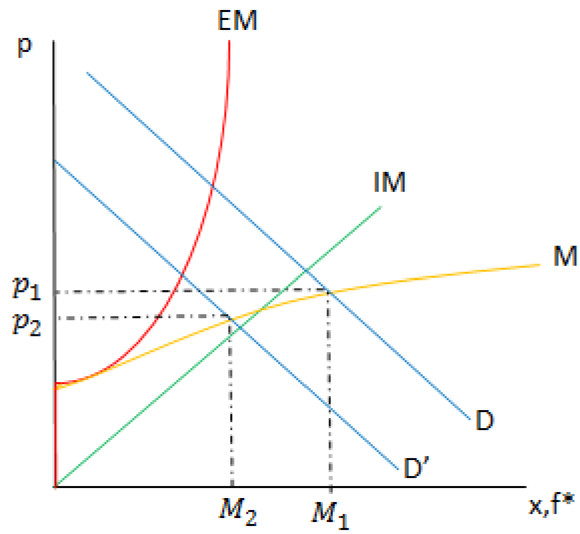


the home market.

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

Figure 3: Effect of a tariff increase



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 precisely because it is able to capture a portion of these rents.

Another point to note here 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 would break even in expectation. However, a small country would not affect the expected profits of potential entrants in the foreign 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.[7]

3.3 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 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 regarding the optimal tariff in this model. First, as discussed in 3.1, if the heterogeneity among

[7]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 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.

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 become infinite.[8] 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 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 Extended Model

The paper so far has studied a 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 (see Bernard et al., 2007 for a review). First, in the setting studied so far, firms will either produce for their domestic market or export but will never do both. This is counterfactual because exporters generally do, in fact, produce for their domestic market. Furthermore, the baseline 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.

In this section, I introduce two features to the model that will allow it

[8] 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.

to match these empirical patterns while remaining within a perfectly competitive framework. First, I introduce heterogeneity in firm productivity in addition to the earlier heterogeneity in the fixed costs of exporting. Second, I introduce increasing costs of serving a market. Introducing increasing costs of serving a market into the model gives exporting firms an incentive to also produce for their domestic market. Though a firm receives a higher price by selling in the foreign market, it will not want to produce exclusively for the foreign market because the increasing marginal costs of serving the market means that it will eventually become very expensive to do so.

These increasing costs are similar in spirit to the market penetration costs in Arkolakis (2010). Arkolakis motivates these types 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 concerns, the costs of serving a country might be increasing in output because of the geographic variation in the quality of transportation or communications infrastructure within a country. This would be particularly relevant in the context of developing countries, where infrastructure is typically much better developed in major urban centers than elsewhere 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 be enough to generate exporter rents and a positive optimal tariff. However, as discussed in Section 2, 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 general framework.

4.1 New Setup

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 this change, it will now be 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. As before, 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 exporting than if it produced 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. We therefore have selection effect here, whereby relatively high cost firms are unlikely to export (as in Melitz, 2003).

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.[9]

Since firms with a lower a will become exporters at any given level of f, the independence of f and A implies immediately that exporters have a

[9]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.

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 (Eaton et al., 2011).

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

$$\begin{aligned} D(p+\tau) &= \hat{n}\int_0^\infty \int_{\underline{\mathrm{f}}}^{\zeta(a,p,\hat{p})} q(p,\hat{p};a)\, g_1(f)\, g_2(a)\, df\, da \\ &= \hat{n}\int_0^\infty q(p,\hat{p};a)\, G_1[\zeta(a,p,\hat{p})]\, g_2(a)\, da \end{aligned} \tag{5}$$

$$\begin{aligned} \hat{D}\left(\hat{p},\hat{\Pi}\right) &= \hat{n}\int_0^\infty \int_{\zeta(a,p,\hat{p})}^\infty \hat{q}(\hat{p};a)\, g_1(f)\, g_2(a)\, df\, da + \hat{n}\int_0^\infty \int_{\underline{\mathrm{f}}}^{\zeta(a,p,\hat{p})} q(p,\hat{p};a)\, g_1(f)\, g_2(a)\, df\, da \\ &= \hat{n}\int_0^\infty \hat{q}(\hat{p};a)\{1-G_1[\zeta(a,p,\hat{p})]\}\, g_2(a)\, da + \hat{n}\int_0^\infty q(p,\hat{p};a)\, G_1[\zeta(a,p,\hat{p})]\, g_2(a)\, da \end{aligned}$$

4.2 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 gave rise to a positive optimal tariff remain largely unchanged. The foreign export supply elasticity is now:

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

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) implies that $d\zeta/dp = q(p)$. Hence, the export supply elasticity is finite, and in turn, the optimal tariff is positive.

If there were no heterogeneity in a or f, then one of the density functions would approach a delta function, and the supply elasticity would become infinite. If the fixed cost 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 3, 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.

A graphical analysis of this extended model would qualitatively look the same as the analysis in Section 3. Since firms are now heterogeneous in terms of their productivity, the curve representing the intensive margin response would now capture an average of the supply functions of exporting firms. The curve representing the extensive margin would still capture the willingness of firms to enter into the export market, but now taking into account the productivity of the firms that are on the margin.

5 Conclusion

This paper shows that the presence of inframarginal exporters can itself be a reason for a positive optimal tariff. A tariff allows an importing country to capture a portion of the rents earned by these inframarginal firms. To show this, the paper develops a new model of trade with firm heterogeneity and fixed costs of exporting that preserves perfect competition. In this setting, the optimal tariff goes to zero as either firm heterogeneity or the fixed exporting costs vanish, demonstrating the key role of inframarginal firms in generating the positive optimal tariff result.

While the rent-extraction motive for a tariff is well-known in the international trade literature, the current paper shows how this motive is not merely a byproduct of imperfect competition. The exporter rents here arise purely because of firm heterogeneity and selection into exporting. This point is substantively important from a policy perspective because the existing arguments made under imperfect competition are subject to the objection trade policies are dominated by instruments that directly address the market distortion. In the setting studied in this paper, there are no pre-existing distortions and so this type of objection would not apply.

The new model developed here allows us to study the implications of firm heterogeneity in international trade without otherwise departing from the perfect competition analysis that has served as the benchmark in the trade policy literature. While the current paper focuses on studying the unilateral imposition of a tariff in a small country, this framework is naturally suited to analyze other questions in trade policy as well. A natural avenue for future work would be to study how the incentives to the extract rents of inframarginal firms identified in this setting would affect the nature and interpretation of trade agreements between countries.

A Proofs for the Baseline 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 these functions 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 overall intuition for this result.

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

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

A.2 Optimal Tariff Formula

The government solves:

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

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, $D\left(.\right) = M\left(.\right)$, and so:

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

A.3 Formula for the Foreign Export Supply Elasticity

$$\frac{dM}{dp}=\frac{d}{dp}\left\{\hat{n}q\left(p\right)G\left[\Phi\left(p\right)\right]\right\}$$

$$\frac{dM}{dp}=\hat{n}q'(p)G\left(f^*\right)+\hat{n}q(p)g\left(f^*\right)\frac{\partial\Phi\left(p\right)}{\partial p}$$

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

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 $q(p,\hat{p})$ is increasing in p

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

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

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

First, we can think of (6) as defining a function $\hat{q} = \Gamma_1(q)$ and (7) as defining a function $\hat{q} = \Gamma_2(q,p)$. Using the implicit function theorem, we obtain the following:

$$\frac{\partial \Gamma_1(q)}{\partial q} = -\frac{-aC''(q+\hat{q})}{-aC''(q+\hat{q}) - \hat{T}''(\hat{q})} < 0$$

$$\frac{\partial \Gamma_2(q,p)}{\partial q} = -\frac{-aC''(q+\hat{q}) - T''(q)}{-aC''(q+\hat{q})} < 0$$

$$\frac{\partial \Gamma_2(q,p)}{\partial p} = -\frac{1}{-aC''(q+\hat{q})} > 0$$

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 implies that $-\partial\Gamma_1(q)/\partial q < -\partial\Gamma_2(q,p)/\partial q$ and so $\partial\Gamma_1(q)/\partial q > \partial\Gamma_2(q,p)/\partial q$.

Since in equilibrium, $\Gamma_1(q) - \Gamma_2(q,p) = 0$, we can use the implicit function theorem again to get that:

$$\frac{\partial q}{\partial p} = -\frac{-\partial\Gamma_2(q,p)/\partial p}{\partial\Gamma_1/\partial q - \partial\Gamma_2/\partial q} > 0$$

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. $q_E + \hat{q}_E > \hat{q}_D$.

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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