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Welfare-Reducing Trade Liberalization

by

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Abstract

Recent literature on the workhorse model of intra-industry trade has explored heterogeneous cost structures at the firm level. These approaches have proven to add realism and predictive power. This paper shows, however, that this added realism also implies that there may exist a positive bilateral tariff that maximizes national and world welfare. Applying one of the simplest specifications possible, namely a symmetric two-country intra-industry trade model with fixed export costs that are heterogeneous across firms, we find that the reciprocal reduction of small tariffs reduces welfare.

JEL classification: F12, F13, F15

Keywords: Intra-industry trade, monopolistic competition, heterogeneous firms, welfare, protectionism.

Outline

Non-Technical Summary

The literature on international trade has recently been modernized by the introduction of firm-level heterogeneity into intra-industry trade models. These new types of specifications, where firms are heterogeneous with respect to their cost structures, have provided important new insights that reconcile trade theory with the stylized facts of international trade.

Thus far, the literature has not fully examined the mechanics and effects of trade policies within these new -- and more realistic – modelling frameworks. The present paper deals with this issue by introducing bilateral ad valorem tariffs – i.e. countries charge the same tariff -- into a symmetric two-county intra-industry trade model where firms are heterogeneous with respect to their fixed costs of exporting (Schmitt and Yu, 2001). Such fixed costs of exporting represent, for example, the cost of building up a distribution network abroad or additional costs of adapting a product to foreign specifications or tastes and are empirically known to vary for different products. Furthermore, we extend this model by introducing a firm entry mechanism in the manner of Melitz (2003), i.e. firms make their entry decisions subject to sunk costs and based on expected profits, knowing only the distribution of firm heterogeneity in the population but not their own realization. Finally, we equip the model with several assumptions that ought to promote free trade as the welfare optimum, e.g. there are no transport costs.

Solving for the welfare effect of the bilateral tariffs, it turns out that within the model there is in fact too much trade in the free trade (zero tariffs) equilibrium. Even though free trade welfare exceeds the welfare level under autarky, we establish the existence of a welfare maximizing bilateral tariff that is strictly positive. Accordingly, reciprocal trade liberalization, in particular the reduction of small tariffs, will be welfare-reducing. This finding contradicts much of the existing literature. Thus the paper illustrates, that with the introduction of firm-level heterogeneity such as heterogeneous fixed export costs, existing results for the welfare effects of trade policies may have to be revised.

The underlying mechanism for the present finding is as follows. Any tariff reduces both the number and the volume of traded varieties. In case of a small tariff, fairly inefficient exporters cease their trading activity, i.e. inefficient in the sense of having high fixed export costs. This exit, paired with the volume reduction in exports/imports, results in a total of saved resources that more than compensates consumers via the entry and larger volumes of home varieties. However, for large tariffs, a further increase in the tariff forces fairly efficient exporters out of the trading activity, replacing cheaply generated varieties (i.e. varieties imported from abroad) with expensively generated varieties (i.e. varieties produced at home).

1 Introduction

Recently, firm-level heterogeneity has been introduced to intra-industry trade models, e.g. by Schmitt and Yu (2001), Montagna (2001), Melitz (2003), Helpman, Melitz and Yeaple (2004) or Yeaple (2005). These specifications, where firms are heterogeneous with respect to their cost structures, have provided important new insights, frequently reconciling theory with the stylized facts of international trade. For example Schmitt and Yu (2001) resolve the puzzle of scale economies and the volume of intra-industry trade by introducing firm-level heterogeneous fixed exporting costs. Montagna (2001) examines trade between countries with efficiency asymmetries when firms are heterogeneous with respect to marginal costs. Melitz (2003) features firm-level heterogeneous marginal costs and analyzes intra-industry reallocations, showing that additional gains from trade stem from the induced productivity improvements. Helpman, Melitz and Yeaple (2004) introduce firm-level heterogeneities and are able to capture the exporting-versus-FDI decisions of firms. Finally, Yeaple (2005) derives firm heterogeneity from labor force heterogeneities and arrives at realistic predictions concerning the productivity of exporting firms and the effects of trade on the skill premium.

However, thus far the literature has not fully examined the implications of these new – and more realistic – assumptions for the welfare effects of trade policies such as tariffs.[1] In this paper, we examine this issue by introducing bilateral ad valorem tariffs into a simple symmetric two-county Krugman-type (1980) intra-industry trade model with firm-level heterogeneous fixed costs of exporting as in Schmitt and Yu (2001). A second contribution of the present paper is it to extend the literature by presenting the case of firm-level heterogeneous fixed export costs (i.e. Schmitt and Yu, 2001) with an entry mechanism in the manner of Melitz (2003), i.e. firms make their entry decisions subject to sunk costs and based on expected profits, knowing only the distribution of firm heterogeneity in the population but not their own realization.[2] The present model employs several assumptions that promote free trade as a welfare optimum: there are no wasteful (e.g. iceberg) trade costs, the firm-specific fixed costs of exporting are less than the cost of creat-

[1]Melitz (2003), Falvey, Greenaway and Yu (2004) and Baldwin and Forslid (2004), examine the welfare effects of reducing iceberg and fixed export costs in a Melitz-type (2003) setting with firm-level heterogeneous marginal costs.

[2]Arguably, the entry mechanism in Schmitt and Yu (2001), where firms' entry decisions are based on reaching breakeven on their home market operation alone, is problematic because in equilibrium export profits exist that do not trigger industry entry. Jørgensen and Schröder (2005b) find, inter alia, that the possibility of a welfare increase from bilateral tariffs established in the present paper for the Meltiz (2003) entry mechanism does also occur for the Schmitt and Yu (2001) entry mechanism.

ing a new variety, and all firm profits and tariff revenues are redistributed in a lump sum fashion to consumers. Still, we find that in this model there is in fact too much trade in the free trade equilibrium. More resources are used on the exporting/importing activity than is welfare-optimal, measured as total consumer utility. National and world welfare increases when imposing small bilateral tariffs. The welfare maximizing tariff is strictly positive, less than 1 and increases in the degree of product differentiation (love of variety). Thus, reciprocal trade liberalization, in particular the reduction of small tariffs, will be welfare-reducing. The underlying mechanism is that even though small bilateral tariffs reduce the number of traded varieties, the total number of available varieties in both countries is maintained or rather increases slightly. Any tariff reduces the number and volume of traded varieties. In case of a small tariff, fairly inefficient exporters cease their trading activity, and paired with the volume reduction in exports/imports, the total of saved resources more than compensates consumers via the entry and larger volumes of home varieties. However, for large tariffs, a further increase in the tariff forces fairly efficient exporters out of the trading activity, replacing cheaply generated varieties (i.e. imported from abroad) with expensively generated varieties (i.e. produced at home).

The finding of welfare-reducing tariff liberalization contradicts much of the existing literature, see e.g. Markusen and Venables (1988), Fukushima and Kim (1989), Lockwood and Wong (2000). Also in intra-industry trade models, bilateral tariffs are usually welfare-reducing, e.g. Gros (1987), Jørgensen and Schröder (2005a).[3] The main difference between the above models and the present model is that the earlier work assumes firms to be homogeneous in their cost structure. However, Melitz (2003), Falvey, Greenaway and Yu (2004) and Baldwin and Forslid (2004), all using a Melitz-type (2003) framework with firm-level heterogeneous marginal costs, examine, inter alia, iceberg trade cost reductions, which are often interpreted to represent trade liberalization, and find, in line with earlier literature, an overall welfare gain. Furthermore, Melitz (2003) and Baldwin and Forslid (2004) note the possibility for an anti-variety effect. In contrast to the anti-variety effect in the present model, this situation only emerges once the fixed costs of exporting are larger than the fixed costs of pure domestic production, and thus the export activity of a firm ties up more resources than would be required for an additional domestic variety. This case is explicitly ruled out in the present model. The possibility of welfare-reducing trade liberalization is, however,

[3]On the other hand, small unilateral tariffs may increase welfare (Gros, 1987), and unilateral tariffs can induce a home market effect in the presence of transportation costs (Helpman and Krugman, 1989). Furthermore, similar situations occur in Brander-Spencer-type settings.

found in Montagna (2001), in a framework where firms have heterogeneous marginal costs. Yet, a welfare loss occurs in circumstances when trade allows relatively inefficient firms to enter and when consumers' taste for variety is sufficiently low.

The next section presents the model. In Section 3, we derive the welfare effect of imposing bilateral ad valorem tariffs, and discuss the results. Section 4 concludes.

2 The Model

The starting point is a standard Krugman-type (1980) model of intra-industry trade, yet with the feature of firm-level heterogeneous fixed costs of exporting as in Schmitt and Yu (2001). Consumers in two identical countries, home and foreign, love variety and have identical preferences, in which all consumption goods, c, enter symmetrically. Utility is given by

$$\begin{aligned} U &= \sum v(c_i) \\ &= \sum c_i^{\theta} \ , \quad \theta \in (0,1) \ . \end{aligned} \tag{1}$$

More specifically we can write (1) as

$$U = \sum_{i_d=1}^{N_d} c_{d,i_d}^{\theta} + \sum_{i_t=1}^{N_t} c_{t,i_t}^{\theta} + \sum_{i_f=1}^{N_f} c_{f,i_f}^{\theta} \ , \tag{2}$$

where c_{d,i_d} is consumption of variant i_d of non-exported domestic products, c_{t,i_t} is consumption of variant i_t of the exported domestic products and c_{f,i_f} is consumption of variant i_f of imported products.[4] The number of variants actually produced (n_d, n_t, and n_f) is assumed to be large, although smaller than N_d, N_t and N_f. Furthermore, denoting foreign variables by *, the symmetry of the setup implies $n_t = n_f^* = n_f = n_t^*$ and that trade is balanced.

Firms

Firms can produce their specific variant for the home market alone or for both the home and foreign market. The decision to export is firm-endogenous, where some but not all firms will export. Each firm produces with the same constant marginal cost β and a fixed cost α, both expressed in terms of labor,

[4] Since all goods enter symmetrically and since all firms behave identically within the two categories trading and non-trading, we can omit subscript i where unnecessary.

L, which is the only factor of production and is remunerated at the economy-wide wage rate w. When exporting, a firm faces an additional firm-specific fixed export cost, a_i, heterogeneous across firms and, for simplicity, assumed to be uniformly distributed on the interval $[0, \alpha]$, with $F(.)$ denoting the distribution function which is public knowledge. The fixed costs of exporting represent, for example, the cost of building up a distribution network abroad or additional costs of adapting a product to foreign specifications or tastes. Finally, to enter, firms face an initial fixed entry cost f, which is measured in monetary units and sunk, and where $0 < f < \frac{\alpha}{2}$.[5] In order to focus on the problem at hand, we avoid several of the complexities of modelling sunk entry costs and the probability of firm 'death' as presented in Melitz (2003), and instead apply an alternative version, simply envisaging two separate rounds. In particular, production and sales for the home market (and the fixed costs α and f) are sunk in the sense that they are assumed to occur prior to an exporting round, in which the individual a_i's are revealed and export production – if the firm chooses so – and sales take place.[6]

Trade is costly. Both countries charge the same ad valorem tariff $\tau \in (0, 1)$ on imports, i.e. a bilateral tariff. The presence of fixed export costs and the tariff creates an asymmetry between trading and non-trading firms, and hence, the profit functions of a pure domestic firm only servicing the home market, and an exporting home firm servicing both markets, are

$$\pi_d = p_d x_d - (\alpha + \beta x_d) w \tag{3}$$

$$\pi_z = p_t x_t + (1 - \tau) p_z x_z - (\alpha + a_i + \beta(x_t + x_z)) w \ , \tag{4}$$

where x_d is the production of a pure domestic firm, and x_t and x_z are the output of an exporting firm to the home and the foreign market respectively. Finally, various market-clearing relations complete the model: goods market clear $Lc_{d,i_d} = x_{d,i_d}$, $Lc_{t,i_t} = x_{t,i_t}$ and $L^* c^*_{f,i_f} = x_{z,i_t}$, where the foreign index i_f and the home index i_t denote one and the same variant; income expenditure clearing $Lw + R = p_d x_d n_d + p_t x_t n_t + p_f x_f n_f$, where R denotes the profits of all domestic firms (excluding f) and all tariff revenues assumed to be lump-sum redistributed to consumers; and similar relations for the foreign country.

[5]The fixed entry costs capture some form of fee payment required in order to enter the industry and are bound by the maximum expected profits of export activity, which – as will become clear below – are equal to $\frac{\alpha}{2}$. The costs f could also represent the threshold return (premium) demanded by entrepreneurs in order to cover the risk (since a_i draws are uncertain) they take when establishing a firm, or the costs of bank lending.

[6]We are grateful to Marc Melitz for pointing out this short-cut.

Prices and quantities

Maximization of (2) leads to the familiar inverse demand functions, e.g. $p_d = \frac{\theta c_d^{\theta-1}}{\lambda}$ for any non-traded home good i_d, and similar for traded products, given that the number of products is large. Then, profit maximization of (3) with respect to x_d and maximizing (4) with respect to x_t and x_z results in the price

$$p_d = p_t = \frac{\beta w}{\theta} \tag{5}$$

$$p_z = \frac{\beta w}{(1-\tau)\theta} = \frac{p_d}{1-\tau} \tag{6}$$

for sales on the home and the foreign market respectively. Since $p_t = p_d$, consumers do not distinguish between non-traded home products and traded home products; and hence, sales quantities of trading firms on their home market must be identical to that of non-trading firms, i.e. $x_d = x_t$. Yet, exported goods are more expensive than domestically produced goods and by symmetry $p_z = p_z^*$, i.e. the price that a home firm charges abroad is the same as the price charged by foreign exporters on our home market. In equilibrium, maximization of utility (2) requires that the ratio of the marginal utility of an extra consumption unit equals the price ratio, i.e. $\frac{\theta c_d^{\theta-1}}{\theta c_f^{\theta-1}} = \frac{p_d}{p_z^*} = 1-\tau$. Utilizing the goods market clearing conditions, this implies

$$x_z = x_z^* = x_d(1-\tau)^{\frac{1}{1-\theta}} \ . \tag{7}$$

Thus exporting firms charge the same price on their home market and have the same sales volume as non-trading firms, but charge higher prices and sell less of their variety on the foreign market. By the same token, domestic consumers pay more and consume less of imported product varieties compared to domestically produced varieties.

With these relations in place, production scale can be determined as driven by free entry/exit. Firms know the distribution of a_i's and the relation given in (7). Furthermore, there must exist some cut-off level, $\bar{a}$, of the firm specific fixed export costs denoting the firm that is exactly indifferent between engaging in exports and being a non-trading firm. Then, entry of firms occurs until expected profits equal fixed entry cost f, in particular $\pi^{exp} = F(\bar{a})\pi_d + ((1-F(\bar{a}))\pi_z = f$.[7] Using (3) and (4) and realizing that

[7] Here, we depart significantly from Schmitt and Yu (2001), where firms determine entry subject to reaching breakeven on their home market operation. Instead, we follow Melitz (2003), namely firms determine their entry subject to expected profits and sunk cost, accordingly some firms will make profits and some losses in equilibrium.

the expected fixed costs of exporting must be $\frac{\bar{a}}{2}$, the equation reads:

$$\frac{\bar{a}}{\alpha}\left(p_t x_t + (1-\tau)p_z x_z - \left(\alpha + \frac{\bar{a}}{2} + \beta(x_t + x_z)\right) w\right) + \left(1 - \frac{\bar{a}}{\alpha}\right)\left(p_d x_d - (\alpha + \beta x_d)\, w\right) = f\ . \tag{8}$$

Inserting from above (8) can be solved for x_d to yield:

$$x_d = \frac{\theta}{(1-\theta)\beta}\,\frac{\bar{a}^2 + 2f\alpha + 2\alpha^2}{2(\alpha + \bar{a}(1-\tau)^{\frac{1}{1-\theta}})}\ , \tag{9}$$

which is also the home market production scale of exporting firms (x_t) and can be plugged into (7) to determine x_z. Note that in autarky (where the tariff is the prohibitive $\tau = 1$ and accordingly $\bar{a} = 0$), the production scale reaches the textbook case, namely $x_d|_{autarky} = \frac{\theta}{(1-\theta)\beta}(\alpha + f)$.

The indifferent firm

With the prices and quantities derived above, it is straightforward to identify the firm which is indifferent as to becoming an exporting firm or becoming a pure domestic firm. This firm is characterized by a fixed cost of exporting $\bar{a}$ such that $\pi_{z,\bar{a}} = \pi_d$ must hold. Since profits (losses) stemming from home market sales are the same for both types of firms, the condition becomes $(1-\tau)p_z x_z - (\bar{a} + \beta x_z)w = 0$, i.e. the indifferent firm makes zero profits from the exporting activity. After setting in p_z, and x_z from above, one can solve:

$$\bar{a} = \left(\sqrt{\alpha^2 + 2\alpha(f+\alpha)(1-\tau)^{\frac{2}{1-\theta}}} - \alpha\right)(1-\tau)^{\frac{-1}{1-\theta}}\ . \tag{10}$$

All firms i such that $a_i \in [0, \bar{a}]$ make non-negative profits from exporting, while all firms i such that $a_i \in]\bar{a}, \alpha]$ are non-trading firms. Notice that by (10) we have $\bar{a} > 0$ and that in the free trade situation ($\tau = 0$) we have $\bar{a}|_{\tau=0} < \alpha$. The reason for $\bar{a}|_{\tau=0} < \alpha$ is as follows. With zero tariffs, the sales scale on the home and the foreign market respectively are identical ($x_d = x_z$). Since exporting promises expected profits, this scale is competed so small (via entry) that the home sales will not breakeven, accordingly the exporting activity of a firm with fixed export costs $a_i = \alpha$ must also result in negative profits, hence also with free trade ($\tau = 0$) some firms are non-trading firms choosing to minimize their losses by refraining from exporting. Furthermore, $\bar{a}$ decreases in the tariff rate (see appendix A.1), implying that the least efficient (high a_i) firms will cease their trading activity in response to a tariff increase.

The number of firms

The total number of firms at home, $n = n_t + n_d$, is determined via the income expenditure clearing condition $Lw + R = p_d x_d n_d + p_t x_t n_t + p_f x_f n_f$, where $n_t = n_f$, where $n_t = F(\bar{a})n$, $n_d = (1 - F(\bar{a}))n$, and where R is the redistributed tariff income and fixed entry cost f – or equivalently total firm profits excluding entry investment (see (8)). One gets:

$$n = \frac{L(1-\theta)}{\alpha + f\theta + \frac{\bar{a}^2}{2\alpha}} \ . \tag{11}$$

Because of trade, consumers also have access to foreign varieties, in particular due to symmetry $n_t = n_t^* = n_f = F(\bar{a})n$ and accordingly the number of varieties available on the home market are given by $\tilde{n} = n + n_f$.

3 Welfare Results

Consumer utility is our measure of welfare. Given goods market clearing and (2), we can write $U = n_d(\frac{x_d}{L})^\theta + n_t(\frac{x_t}{L})^\theta + n_f(\frac{x_f}{L})^\theta$, and setting in values from above and simplifying gives:

$$U = \frac{L(1-\theta)}{\alpha} \frac{\left(\sqrt{g}\,(1-\tau\,)^{\frac{1}{\theta-1}} + \alpha\,(1-\tau\,)^{\frac{\theta}{\theta-1}} - \alpha\,(1-\tau\,)^{\frac{1}{\theta-1}}\right) h^\theta}{f(1+\theta) + \alpha(2 + (1-\tau)^{\frac{2}{\theta-1}}) - \sqrt{g}\,(1-\tau\,)^{\frac{2}{\theta-1}}} \ , \tag{12}$$

$$\text{where } \ g = \alpha\left(\alpha + 2(f+\alpha)(1-\tau)^{\frac{2}{1-\theta}}\right) ,$$

$$\text{and } \ h = \frac{\theta(\sqrt{g} - \alpha)}{L\beta(1-\theta)(1-\tau)^{\frac{1}{1-\theta}}} \ .$$

The following results can be stated.

Proposition 1. *Consumer utility under free trade exceeds that under autarky, yet, there exists a strictly positive bilateral tariff, $\hat{\tau}$, that maximizes total national (and world) consumer utility. In particular, $U|_{\tau=0} > U|_{autarky}$ and $\frac{\partial U}{\partial \tau}|_{\tau=0} > 0$.*

For proof, see appendix A.2. To illustrate proposition 1, consider figure 1 which plots utility (12) normalized by autarky utility $U|_{autarky}$ as a function of τ for various values of θ, i.e. thus representing the welfare gains from trade.[8] To the right, for τ close to 1, we are in the autarky situation and

[8] The expression for $U|_{autarky}$ is given in appendix A.2 equation (A.3). The parameter values for the plot are $\alpha = 2.5$, $\beta = 0.5$, $f = 1$, $L = 100$

accordingly $U/(U|_{autarky}) = 1$. To the left, for $\tau = 0$, we are in the free trade situation, and welfare in both countries is clearly above the autarky level. However, imposing a small bilateral tariff increases welfare until we reach the welfare maximizing bilateral tariff, $\hat{\tau}$, beyond which welfare starts to decrease towards the autarky level. What proposition 1 implies is in fact that there is too much trade in the free trade situation. National and world welfare increases when imposing small bilateral tariffs. The welfare maximizing bilateral ad valorem tariff is strictly positive, less than 1 and increases in the degree of product differentiation, θ, (love of variety). Accordingly, trade liberalization, in particular the bilateral reduction of tariffs smaller than $\hat{\tau}$, will be welfare-reducing.

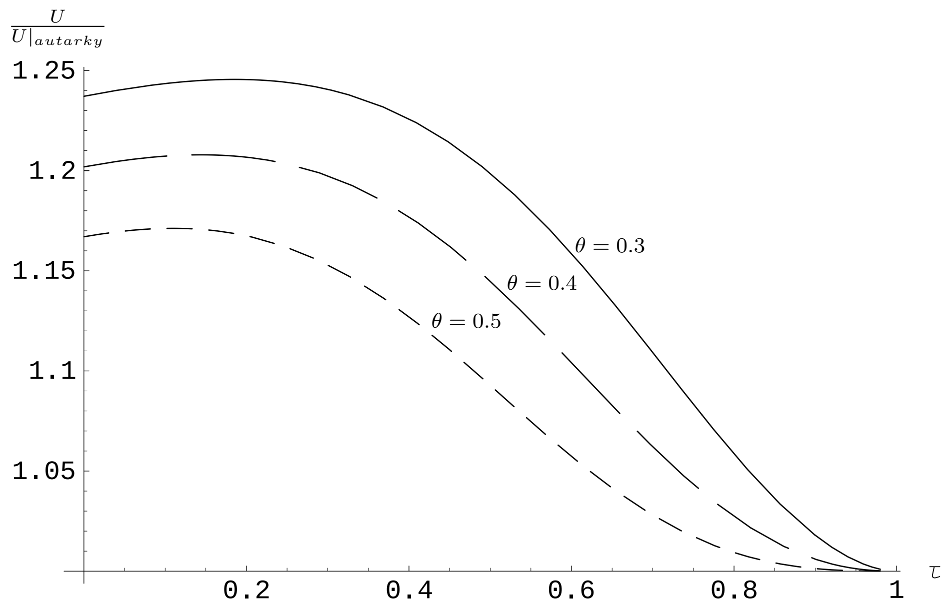

Figure 1: The welfare effect of bilateral tariffs

To illustrate the intuition for the result, it is useful to break down the contributing factors. First, examine the number of firms given in (11) and in particular the number of varieties available on the home market given by $\tilde{n} = n + n_f$. It turns out that with the imposition of a small bilateral tariff, the exit of trading firms and therewith the loss of n_t and n_f is compensated by the entry of additional pure domestic firms n_d, in fact slightly increasing $\tilde{n}$ at first before it falls for larger tariffs.[9] Accordingly, within the consumption

[9] Formal proof of $\frac{\partial \tilde{n}}{\partial \tau}|_{\tau=0} > 0$ is given in appendix A.3. Appendix A.4 shows a plot of the number of firms and $\tilde{n}$.

basket foreign products have been replaced with home products. The second contribution to an utility increase stems from the changes in the output volumes, x_d and x_z that can be consumed. As can be seen from (9) and (7), a tariff increases the output volume of domestic varieties available to domestic consumers and reduces the output volume directed at the foreign market (and hence, the consumption volume of each imported variety).[10] Thus even if the number of available varieties was just constant (and not increasing), then the pure shift from foreign varieties to home varieties paired with an increase in the amounts consumed of each home variety would constitute an utility increase.

To see the logic of these changes in the number of available varieties and the consumption volumes, consider the following reasoning. A small bilateral tariff reduces the number of imported varieties and – via the imposed price increase of foreign products – the import volume of all remaining varieties. However, overall a small tariff still increases welfare because the least efficient exporters are the first to cease their trading activity. Paired with the additional resources saved by reducing the trading activity of all remaining exporting firms, enough resources are freed for the production of more home varieties in larger quantities. That is, the tariff reduces the volume of each remaining importer/exporter but converts it into additional domestic entry and consumption. However, beyond the welfare maximizing bilateral tariff, $\hat{\tau}$, an additional increase in the tariff further cuts imported volumes, and more importantly, it forces fairly efficient exporters out of the trading activity. Thus, additional variants produced relatively cheaply (i.e. by foreign exporters who have fairly low fixed export costs) are replaced with variants produced relatively expensively (i.e. by new home producers incurring the fixed production costs, α).

In line with this reasoning, it turns out that the total fixed costs per available variety that occur to a country $((n\alpha + n_t\frac{\bar{a}}{2})/\tilde{n})$ as a function of τ are U-shaped. Thus a small bilateral tariff, by forcing expensive (high a_i) exporters/importers out reduces the amount of fixed costs that society has to tie up in order to generate variety.

4 Conclusion

This paper examines the welfare impact of trade policy in an intra-industry trade model with firm-level heterogeneity. This new type of specifications, where firms are heterogeneous with respect to their cost structures, has generated important new insights, frequently reconciling theory with the stylized

[10] Appendix A.5 shows a plot of the output volumes x_d and x_z.

facts of international trade, e.g. Schmitt and Yu (2001), Montagna (2001), Melitz (2003), Helpman, Melitz and Yeaple (2004) or Yeaple (2005), but has not yet been used to examine trade policies systematically.

Our model examines bilateral ad valorem tariffs in a symmetric two-country intra-industry trade model, with firm-level heterogeneous fixed costs of exporting. We find that in this model there is in fact too much trade in the free trade equilibrium. More resources are used on the exporting/importing activity than is welfare-optimal, measured as total consumer utility. There exists a strictly positive bilateral tariff that maximizes national and world welfare. Accordingly, trade liberalization, in particular the reciprocal reduction of small tariffs, is welfare-reducing. This contradicts much of the existing literature. The underlying mechanism for our result is that even though small bilateral tariffs reduce the number of traded varieties, the number of available varieties in both countries is maintained and consumption volumes of home products increase. This mechanism is at work even though the fixed costs of creating a new domestic variety are always larger than the firm-specific fixed costs of exporting and even though there are no wasteful (e.g. iceberg) trade costs. Thus, the application of more realistic and powerful specifications for the workhorse model of intra-industry trade dose not only answer many of the conflicts between stylized facts and theory, it also raises important new issues. Future research should address the welfare effects of trade policies for different forms of firm-level heterogeneity and for more types of trade barriers.

A Appendix

A.1 Derivative of $\frac{\partial \bar{a}}{\partial \tau}$

From (10) we have $\bar{a} = \left(\sqrt{\alpha^2 + 2\alpha(f+\alpha)(1-\tau)^{\frac{2}{1-\theta}}} - \alpha\right)(1-\tau)^{\frac{-1}{1-\theta}}$. It follows immediately that:

$$\frac{\partial \bar{a}}{\partial \tau} = \frac{\alpha\left(\sqrt{\alpha(\alpha + 2(f+\alpha)(1-\tau)^{\frac{2}{1-\theta}})} - \alpha\right)(1-\tau)^{\frac{2-\theta}{\theta-1}}}{(-1+\theta)\sqrt{\alpha\left(\alpha + 2(f+\alpha)(1-\tau)^{\frac{2}{1-\theta}}\right)}} < 0. \tag{A.1}$$

A.2 Proof of Proposition 1.

Proof. Total consumer utility under free trade exceeds that under autarky; in particular, $U|_{\tau=0} > U|_{autarky}$.
Evaluating (12) at $\tau = 0$ gives:

$$U|_{\tau=0} = \frac{L(1-\theta)}{\alpha}\frac{\sqrt{\alpha(2f+3\alpha)}\left(\frac{\sqrt{\alpha(2f+3\alpha)} - \alpha\ \theta}{L\beta(1-\theta)}\right)^{\theta}}{f + 3\alpha + f\theta - \sqrt{\alpha(2f+3\alpha)}} \tag{A.2}$$

Under autarky (where the tariff is prohibitive and accordingly $\bar{a} = 0$) we have $x_d|_{autarky} = \frac{\theta(\alpha+f)}{(1-\theta)\beta}$ and accordingly $n_d|_{autarky} = n|_{autarky} = \frac{L(1-\theta)}{\alpha+f\theta}$. Setting in these values, total utility under autarky is given by:

$$U|_{autarky} = \frac{L(1-\theta)\left(\frac{(f+\alpha)\theta}{L\beta(1-\theta)}\right)^{\theta}}{\alpha + f\theta} \tag{A.3}$$

Hence, we want to show that for all $\alpha > 0, 0 < f < \frac{\alpha}{2}, \theta \in [0,1]$:

$$\frac{\sqrt{\alpha(2f+3\alpha)}\left(\sqrt{\alpha(2f+3\alpha)} - \alpha\right)^{\theta}}{\alpha\left(f + 3\alpha + f\theta - \sqrt{\alpha(2f+3\alpha)}\right)} > \frac{(f+\alpha)^{\theta}}{\alpha + f\theta} \tag{A.4}$$

Step 1: Define $s = \frac{f}{\alpha} \Leftrightarrow f = \alpha s$ and insert in (A.4), which leads to:

$$\frac{\sqrt{2s+3}\left(\sqrt{2s+3} - 1\right)^{\theta}}{s + 3 - \sqrt{2s+3} + s\theta} > \frac{(s+1)^{\theta}}{1 + s\theta} \tag{A.5}$$

Step 2: Define $v = \sqrt{2s+3} \Leftrightarrow s = \frac{v^2-3}{2}$. As $0 < f < \frac{\alpha}{2}$ and $s = \frac{f}{\alpha}$ we have that $\sqrt{3} < v < \sqrt{4}$. By substituting for s in (A.5) we get:

$$\frac{v2^\theta (v-1)^\theta}{v^2 + 3 - 2v + \theta v^2 - 3\theta} > \frac{(v^2-1)^\theta}{\theta v^2 - 3\theta + 2} \tag{A.6}$$

Note, that $(v^2-1)^\theta = (v+1)^\theta (v-1)^\theta$. Since $v > \sqrt{3} > 1$, we have that $(v-1)^\theta > 0$ and (A.6) leads to:

$$\frac{v2^\theta}{v^2 + 3 - 2v + \theta v^2 - 3\theta} > \frac{(v+1)^\theta}{\theta v^2 - 3\theta + 2} \tag{A.7}$$

$$\Updownarrow$$

$$v\left(v^2-3\right)\theta + 2v > \left(\frac{v+1}{2}\right)^\theta \left(v^2-3\right)\theta + \left(\frac{v+1}{2}\right)^\theta \left(v^2-2v+3\right) \tag{A.8}$$

Step 3: Define $LHS(\theta) = v(v^2-3)\theta + 2v$ and $RHS(\theta) = \left(\frac{v+1}{2}\right)^\theta (v^2-3)\theta + \left(\frac{v+1}{2}\right)^\theta (v^2-2v+3)$.

$LHS(\theta)$ is linear in θ with a slope and an intercept that depend on v. Furthermore, $LHS(0) = 2v$ and $LHS(1) = v^3 - v$. $RHS(\theta)$ looks linear in θ but it is multiplied with the factor $\left(\frac{v+1}{2}\right)^\theta$. It is evident that $RHS(0) = v^2 - 2v + 3$ and that $RHS(1) = v^3 - v$. Hence, $LHS(1) = RHS(1)$.

Now we want to show that $LHS(0) > RHS(0)$ for all relevant v. It is true since, $LHS(0) > RHS(0) \Leftrightarrow 2v > v^2 - 2v + 3 \Leftrightarrow (1-v)(v-3) > 0$ and $\sqrt{3} < v < \sqrt{4}$.

Step 4: We want to show that $RHS(\theta)$ is convex in θ where $\theta \in [o, 1]$ and $\sqrt{3} < v < \sqrt{4}$. Differentiating $RHS(\theta)$ with respect to θ we get:

$$\begin{aligned} RHS'(\theta) = \left(v^2-3\right)\left(\theta\left(\frac{v+1}{2}\right)^\theta \ln\left(\frac{v+1}{2}\right) + \left(\frac{v+1}{2}\right)^\theta\right) \\ + \left(v^2-2v+3\right)\left(\frac{v+1}{2}\right)^\theta \ln\left(\frac{v+1}{2}\right) \end{aligned} \tag{A.9}$$

From (A.9) it follows that:

$$\begin{aligned} &RHS''(\theta) \\ &= \left(v^2-3\right)\left(\ln\left(\frac{v+1}{2}\right)\left(\theta\left(\frac{v+1}{2}\right)^\theta \ln\left(\frac{v+1}{2}\right) + \left(\frac{v+1}{2}\right)^\theta\right)\right) \\ &+ \left(v^2-3\right)\left(\left(\frac{v+1}{2}\right)^\theta \ln\left(\frac{v+1}{2}\right)\right) \\ &+ \left(v^2-2v+3\right)\ln\left(\frac{v+1}{2}\right)\left(\frac{v+1}{2}\right)^\theta \ln\left(\frac{v+1}{2}\right) \end{aligned} \tag{A.10}$$

From (A.10) it follows that $RHS''(\theta) > 0$ for all $\sqrt{3} < v < \sqrt{4}, \theta \in [0,1]$. Hence, $RHS(\theta)$ is convex, and therefor $LHS(\theta) > RHS(\theta)$. We have now shown that $U|_{\tau=0} > U|_{autarky}$.

□

Proof. There exists a strictly positive bilateral tariff that maximizes total national and world consumer utility; in particular $\frac{\partial U}{\partial \tau}|_{\tau=0} > 0$.
By differentiation (12) with respect to τ and evaluating the expression in $\tau = 0$ we get:

$$\frac{\partial U}{\partial \tau}|_{\tau=0} = \frac{2fL\alpha\left(f+2\alpha-\sqrt{\alpha(2f+3\alpha)}\right)(1-\theta)\left(\frac{\sqrt{\alpha(2f+3\alpha)}-\alpha\ \ \theta}{L\beta(1-\theta)}\right)^{\theta}}{\sqrt{\alpha(2f+3\alpha)}\left(\sqrt{\alpha(2f+3\alpha)}-\alpha\right)\left(f+3\alpha-\sqrt{\alpha(2f+3\alpha)}+f\theta\right)^2} \tag{A.11}$$

(A.11) is positive as:

$$f+2\alpha > \sqrt{\alpha(2f+3\alpha)}$$
$$\Downarrow$$
$$f^2+\alpha^2+2f\alpha > 0$$

□

A.3 Proof of $\frac{\partial \tilde{n}}{\partial \tau}|_{\tau=0} > 0$.

Proof. The number of available varieties increases for a small tariff.
The number of varieties available on the home market is given by $\tilde{n} = n + n_f$. From (11) and using the fact that $n_t = n_t^* = n_f = F(\bar{a})n$ it follows that

$$\tilde{n} = \frac{L(1-\theta)}{\alpha}\frac{\alpha-\alpha(1-\tau)^{\frac{1}{\theta-1}}+\sqrt{\alpha(\alpha+2(f+\alpha)(1-\tau)^{\frac{2}{1-\theta}})}(1-\tau)^{\frac{1}{\theta-1}}}{f(1+\theta)+\alpha(2+(1-\tau)^{\frac{2}{\theta-1}})-\sqrt{\alpha(\alpha+2(f+\alpha)(1-\tau)^{\frac{2}{1-\theta}})}(1-\tau)^{\frac{2}{\theta-1}}} \tag{A.12}$$

The derivative of $\tilde{n}$ in (A.12) with respect to τ, and evaluated at the free trade situation, $\tau = 0$, gives:

$$\frac{\partial \tilde{n}}{\partial \tau}|_{\tau=0} = \frac{L(1-\theta)f\left(\sqrt{\alpha(2f+3\alpha)}-\alpha\right)}{\sqrt{\alpha(2f+3\alpha)}\left(f+3\alpha-\sqrt{\alpha(2f+3\alpha)}+f\theta\right)^2} > 0. \tag{A.13}$$

□

A.4 The number of firms and available varieties

Figure A.1 plots the number of firms, n, the number of pure domestic producers, n_d, and exporting producers, n_t, and the total number of available varieties, $\tilde{n}$, as a function of τ. Other parameter values are $\alpha = 2.5$, $\beta = 0.5$, $\theta = 0.4$, $f = 1$, $L = 100$.

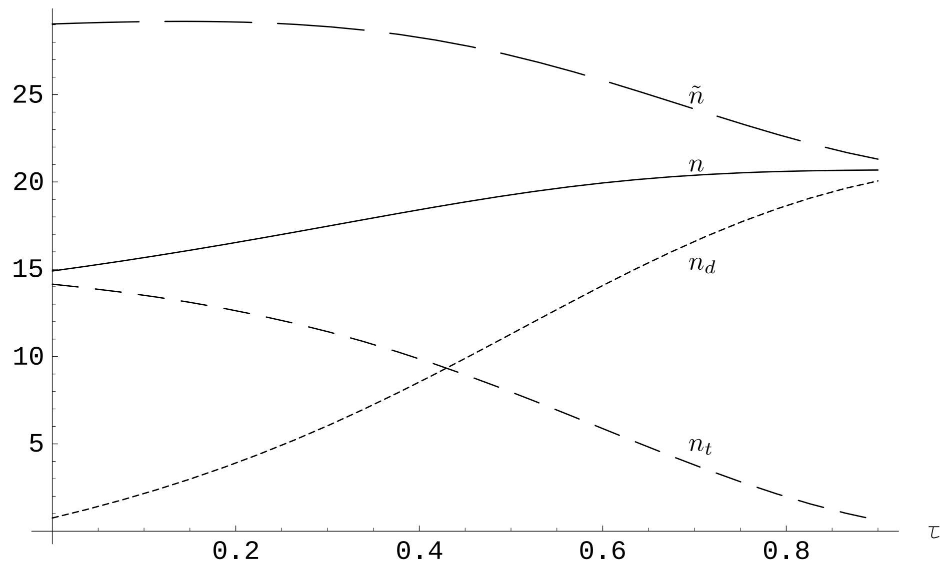

Figure A.1: Number of firms and available varieties

A.5 Production scale

Figure A.2 plots the production scale, x_d, that is sold by domestic non-exporting and exporting firms on the domestic market, and the production scale, x_z, sold by foreign exporters on the domestic market (which is identical to the sales that domestic exporters have on the foreign market). Other parameter values are $\alpha = 2.5$, $\beta = 0.5$, $\theta = 0.4$, $f = 1$, $L = 100$.

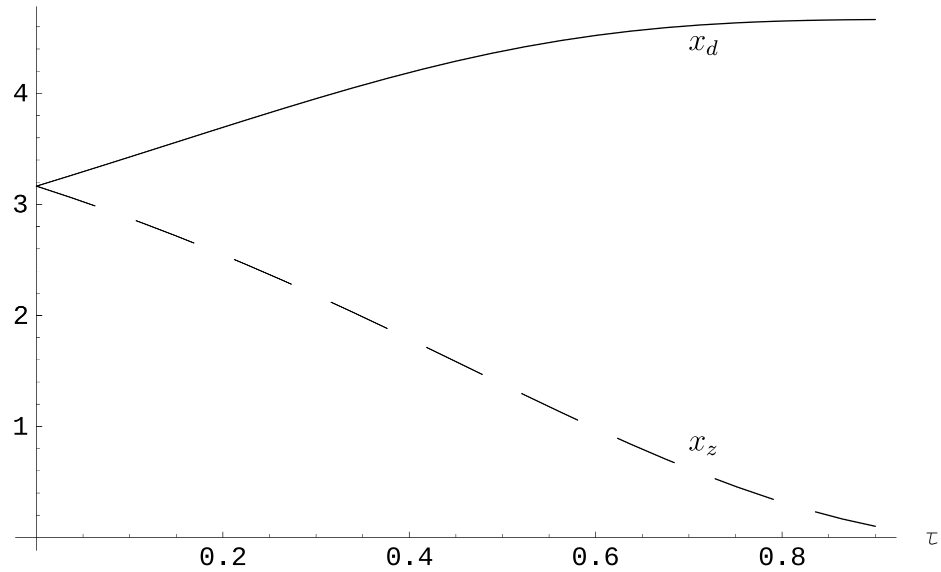

Figure A.2: Output (production scale)

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