Economics Working Paper

2011-18

A welfare ranking of multilateral reductions in real and tariff trade barriers when firms are heterogenous

Philipp J.H. Schröder and Allan Sørensen

Department of Economis and Business
Business and Social Sciences
Aarhus University
Bartholins Allé 10, Building 1322
DK-8000 Aarhus C - Denmark
Phone +45 8942 1610
Mail: oekonomi@econ.au.dk
Web: www.econ.au.dk

A welfare ranking of multilateral reductions in real and tariff trade barriers when firms are heterogenous.

Philipp J.H. Schröder* Allan Sørensen†

Abstract

Trade liberalization comes about through reductions in various types of trade costs. This paper introduces, apart from real variable (i.e. iceberg) and fixed export costs, two partially redistributed tariffs into a Melitz (2003) model. We present comparable results for welfare effects and changes in industry structure by analyzing the different liberalization channels for an equal effect on openness. The welfare ranking is sensitive to the degree of efficiency in tariff redistribution, e.g. the share of tariff revenues wasted on rent-seeking activities. Ad valorem tariff cuts switch from the least to the most preferred mode of liberalization as the fraction of tariffs wasted moves from zero to unity. Apart from a situation with no tariff redistribution, reductions in iceberg trade costs are preferred to reductions in real fixed trade costs which again are preferred to cuts in unit tariffs.

JEL: F12, F13, F15
Key Words: Real Trade Costs, Non-Tariff Barriers, Tariffs, Frictional Trade Costs, Iceberg Costs, Integration.

*Corresponding author: Aarhus University, Business and Social Sciences, Department of Economics and Business, Denmark. Tel.: +45 8948 6392, psc@asb.dk.

†Aarhus University, Business and Social Sciences, Department of Economics and Business, Denmark.

Acknowledgements: Philipp Schröder acknowledges financial support from the Danish Social Sciences Research Council (grant no. 275-06-0025) and the Tuborg Foundation. The usual disclaimer applies.

1 Introduction

The wake of a new consensus model of intra-industry trade, e.g. Melitz (2003), has had ample consequences for the way economists think about empirical patterns of trade and export behavior (see Greenaway and Kneller, 2007, and Wagner, 2007, for surveys), yet it has so far had little impact on the way economists think about the policies surrounding international trade and economic integration. A key problem being, that to date most theory attempts to capture trade barriers, and hence trade liberalization, by simple measures, such as iceberg trade costs. In contrast, real world trade costs are a vast and complex selection of different barriers, they are large, richly linked to economic policy and have ample welfare implications. This is forcefully illustrated by Anderson and Wincoop (2004). In their broad definition of trade costs they include costs like transportation costs, policy barriers (tariffs and non-tariff barriers), information costs, contract enforcement costs, currency costs, legal costs, and distribution costs.

Reductions in trade costs due to policy changes or technological improvements have occurred and will continue to occur and thereby increase trade and welfare. However, since trade costs are based on widely divergent barriers that differ in nature – some generate revenues, some waste, some increase in the value of shipments others are fixed costs –, the effects of trade cost reductions (say liberalization) on trade, industry structure, the economy and welfare must ultimately depend on the actual type of costs that are reduced.[1]

Against this background it is surprising that most theory to date has not acknowledged this issue. The present paper attempts to address this problem by examining and comparing the welfare effects of different types of trade costs (including partially redistributed tariffs) in an intra-industry trade model with heterogenous firms. The inclusion of heterogenous firms endogenizes average productivity through selection mechanisms. These selection mechanisms and resulting intra-industry reallocations are differently affected by different types of trade costs, and therefore the heterogenous firms framework is able to identify and compare welfare effects from various trade costs – and liberalizations hereof – running through average productivity that are not found in the traditional settings with homogenous firms (e.g. Krugman, 1980). As a result, the present paper provides a broader and relevant foundation for future empirical research into the consequences of economic integration.

Our distinction into real trade barriers and tariff trade barriers turns out to be particularly fruitful.[2] By real trade barriers, we mean costs that are real in terms of actually absorbing resources, this can be administration costs, border formalities,

[1]For example, Francoise and Martin (2010) provide – inter alia – an instructive account of different trade barriers in the context of CGE models and show how standard representations of trade barriers can lead to sizable underestimations of the gains from trade, in particular in the context of heterogeneous firms. Needless to say that the issue of trade liberalization and welfare effects is highly relevant for policy making and ongoing discussions ranging from export facilitation to preferential trade agreements. See for example the recent empirical studies that detail out various trade costs channels by Balistreri et al. (2011), Dennis and Shepherd (2011) and Jacks et al. (2011).

[2]Schröder (2004) introduces a similar distinction into a Krugman (1980) model without firm heterogeneity. Accordingly, no intra-industry reallocation and productivity effects are observed, and the presented welfare rankings are solely driven by changes in the number of varieties.

transport costs and foreign regulation and safety standards, i.e., such trade costs burn up resources because e.g. firms have to employ staff to tackle these barriers. Real trade costs are what the existing models following Melitz (2003) capture when including iceberg costs and fixed export costs. On the other hand, tariff trade barriers, although very real for the individual firm, are unreal for the economy as a whole in the sense that they imply a reallocation of resources, that is, a tax that is imposed upon trade-active firms but eventually redistributed to consumers. Moreover, we vary the degree of redistribution efficiency, say due to wasteful rent-seeking or administrative waste only a part of the tariff revenues is actually redistributed; thus we can capture a wide range of real and tariff trade barriers in the present formulation.

Table 1 lists existing theoretical literature. The papers are selected on the criteria that they provide welfare analyses, are placed in heterogeneous firms settings, deal with open economies, and feature trade barriers and policies that go beyond the customary iceberg and fixed export costs.[3] Furthermore, Table 1 lists the present paper to facilitate comparison and to illustrate the differences and contribution of our research in relation to existing work. We compare the existing literature along several central dimensions.

Table 1 discloses that the literature has examined a range of barriers to trade and trade policies such as tariff and even subsidies that operate like strategic trade policy tools (e.g. Demidova and Rodrigues-Clare, 2009; Jung, 2011; Pflüger and Südekum, 2009). Most studies include iceberg costs and fixed export costs, both of which are real trade costs and represent items such as transport costs or the costs associated with fulfilling foreign standards. Although iceberg costs are a useful and a preferred modeling device in theoretical work, empirical studies have repeatedly pointed at the importance of including additional empirically relevant formulations of trade costs, see Baier and Bergstrand (2001), Hummels and Skiba (2004), or Anderson and Wincoop (2004). Fixed costs of exporting are a central element of the heterogeneous firms trade theory and are well established in the literature, e.g., Roberts and Tybout (1997), Das et al. (2007), Jørgensen and Schröder (2008). Apart from the customary iceberg costs and fixed export costs the present paper includes ad valorem tariffs and unit tariffs, whereby the latter for purpose of comparison and tractability are modeled fully symmetrically to the iceberg costs.[4]

[3] In fact Baldwin and Forslid (2010) do not fulfill the last criteria but are included as a benchmark representing the Melitz (2003) model. Moreover, the reader should note that the above criteria exclude a wide range of previous and ongoing research that in some but not all respects relates to the current paper. For example, Schröder and Sørensen (2010) introduced ad valorem and unit taxes in a closed economy heterogeneous firms setting, Bohnstedt et al. (2011) examine the effects of government investment into basic research (improving the underlying distribution) in a Melitz (2003) type model, or Demidova and Krishna (2007) show how the inclusion of fixed export costs can reverse conclusions of a Chamberlinian- Ricardian model on the impact of trade partner technological progress on home country welfare. Similarly, in Krugman (1980)-type intra-industry trade models with homogeneous firms redistributed tariffs have been implemented and analyzed by Gros (1987) and later by Jørgensen and Schröder (2005). Still, in order to focus on the problem of trade barriers and trade costs in heterogeneity settings, the selection presented in Table 1 turns out to provide a sufficient comparison.

[4] Thus the realized unit tariff is – like the realized iceberg cost – heterogeneous across firms, i.e. lower for more productive firms. Schröder and Sørensen (2010) introduce a homogenous unit

Table 1: Overview of Literature on Trade Barriers, Welfare and Heterogeneous Firms

Author (year)	**Barriers**	**Redistribution**	**Policy regime**	**Comparison measure**	**Model**	**Findings**
Baldwin and Forslid (2010)	Iceberg, fixed export costs	No redistribution	Bilateral / symmetric	Welfare qualitative	Melitz (2003)	Identify anti-variety effect
Cole (2011a)	Iceberg, ad valorem tariff, fixed export costs	No redistribution	Bilateral / symmetric	Exporter profits, mass of variety, welfare comparison for equal size barrier	Heterogeneous fixed costs ala Jørgensen and Schröder (2008)	Equivalence of Iceberg and ad valorem collapses when firms are heterogenous, welfare gain from tariff reductions outperforms iceberg reductions
Cole (2011b)	Iceberg, ad valorem tariff, fixed export costs	To government sector	Symmetric and asymmetric	Elasticity of trade flows wrt iceberg and tariff	Chaney (2008)	Elasticity of trade flows wrt ad valorem is non-constant and larger than wrt iceberg
Cole and Davies (2011)	Ad valorem tariff, fixed export costs, fixed FDI costs	Full (tariff)	Non-cooperativt Nash-tariff setting	Optimal tariffs, tariff war, tariff jumping	Heterogeneous fixed costs ala Jørgensen and Schröder (2008), with endogenous FDI	World welfare maximized with negative tariff, Nash-tariffs reduce welfare via survival of inefficient firms, FDI and tariff jumping mitigates the effect
Demidova and Rodriguez-Clare (2009)	Consumption subsidy, ad valorem import tariff, ad valorem export tax / subsidy	Full (all four tools)	Unilateral	First best (optimal policy), welfare decomposition, qualitative	Small country Melitz (2003)	Decomposition into 4 parts, find opposing effects on welfare and productivity from export subsidies and import tariffs
Felbermayr et al. (2011)	Ad valorem tariff, iceberg, fixed export costs	Full (tariff)	Non-cooperativt Nash-tariff setting	Optimal tariffs, tariff war	Melitz (2003) with two asymmetric countries	Terms-of trade effect present, reductions in iceberg and fixed costs lead to higher Nash-tariffs, heterogeneity leads to lower optimal tariffs
Irarrazabal et al. (2010)	Ad valorem trade costs and unit trade costs	No redistribution	Welfare neutral substitution of barriers	Welfare qualitative, motivational model for empirical analysis	Chaney (2008)	Ad valorem trade costs benefit high productivity firms, iceberg cost reductions command additional welfare gain
Jung (2011)	Entry subsidy, fixed cost subsidy, fixed export costs	Full (subsidies)	Unilateral	First best (optimal policy), welfare qualitative	Small country Melitz (2003)	Entry subsidy does not improve welfare, but fixed cost subsidy does
Jørgensen and Schröder (2008)	Ad valorem tariffs, fixed export costs	Full or no (tariff)	Bilateral / symmetric	Welfare qualitative	Heterogeneous fixed costs	Small tariff increases national and global welfare
Pflüger and Südekum (2009)	Iceberg, fixed export costs, subsidy of entry costs	Full (subsidy)	Non-cooperative Nash strategic entry subsidy	Welfare qualitative	Melitz (2003) with homogenous goods sector	Entry subsidy enhances welfare, works like strategic trade policy tool
This paper	Iceberg, ad valorem tariff, unit tariff, fixed export costs	Partial (tariffs)	Multilateral / symmetric	Welfare comparison for equal effect on openness	Melitz (2003)	Analytical welfare rankings of all four barriers, ranking depends on degree of redistribution

NOTE: The table lists existing theoretical contributions. 'Barriers' refers to the trade barriers and policies included; 'Redistribution' records if no, partial or full redistribution of revenues or costs is modeled; 'Policy regime' states what type of policy experiment is conducted; the category 'Comparison measure' records on what criterion trade barriers and liberalization are compared or if only qualitative welfare results are presented (e.g. the sign of welfare effects of a barrier are provided but no comparison across barriers is conducted); 'Model' refers to the underlying model framework; 'Findings' lists a selection of key-findings.

Next, we note that tariff redistribution (or taxation respectively) features in some but not all previous studies, probably because the redistribution of revenues (taxing) in a general equilibrium framework increases complexity. However, this channel is of crucial importance for policy analyses, as becomes obvious in the context of subsidies studied in for example Demidova and Rodrigues-Clare (2009) or Pflüger and

tax in a closed economy heterogeneous firms framework and illustrate how the resulting distorted relative prices limit the tractability of such a model severely, rendering it unfit for the analytical welfare comparison provided in the current paper.

Südekum (2009). Instead of either ignoring redistribution or modeling full redistribution, the present paper implements partial redistribution. This parametrization of the redistribution efficiency of tariff revenues allows us to model the full range of policies and is not previously found in the literature on trade barriers and heterogeneous firms. Most importantly, it turns out that the degree of redistribution efficiency matters crucially for the welfare rankings and thus commands important policy implications. In particular, a varying degree of redistribution efficiency can reflect different degrees of rent-seeking activity or administrative waste.

In terms of the policy regime and policy experiments, Table 1 shows that optimal tariff policies, unilateral and bilateral (multilateral) trade policy and liberalization experiments are included in the existing literature. However, while work conducting first best or tariff-war like analyses (e.g.Cole and Davies, 2011; Felbermayr et al., 2011) can identify rich welfare implications, and while traditional welfare analyses (e.g. Jørgensen and Schröder, 2008; Irarrazabal et al., 2010) provide the direction of welfare effects qualitatively, an actual welfare comparison of different trade barriers is rarely provided. The only exceptions are Cole (2011a) who compares equal size barriers and Cole (2011b) who examines the elasticity of trade flows.

A central problem is that it is not at all clear what an appropriate measure of comparison of trade barriers and trade liberalization should be for theoretical work in international economics. Accordingly, an actual tools comparison – like the one conducted in the present paper – is rarely provided. In contrast, the public economics tax literature has a long tradition for tax tool comparisons based on an equal yield criterion. The present paper provides a novel take on this issue by imposing a common measure of comparison. Multilateral reductions of the four included barriers are compared for identical effects on economic integration, i.e. an equal increase in trade openness. This allows us not only to state the direction of welfare effects for different liberalization channels, as has been done in previous literature, but also to compare their relative performance in terms of welfare and changes in industry structure for a given increase in trade openness. Moreover, openness is a suitable variable for empirical observation, bringing the results and predictions of the theory closer to empirical work.

Table 1 shows that the existing literature on trade barriers and heterogeneous firms has predominantly been based on models featuring marginal cost heterogeneity, such as Melitz (2003) or Chaney (2008), but features a few contributions based on fixed cost heterogeneity (e.g. Jørgensen and Schröder, 2008; Cole, 2011a). The advantage of the later modeling approach is that the inclusion of additional trade barriers, such as tariffs, is considerably easier to implement in general equilibrium, when firms only differ in their fixed costs. Alternatively, the literature has evoked small country assumptions or homogeneous goods sectors to maintain tractability. The present paper succeeds in deriving welfare comparisons for four different types of trade barriers – and hence four channels of economic integration – in a $n+1$ symmetric countries Melitz (2003) model with Pareto distributed marginal productivities.

Finally, we can turn to the findings of the current paper in contrast to existing literature. For the empirically relevant situation where all four types of barriers are present simultaneously and firms self-select into exporters and non-exporters, we find that the welfare ranking depends on the degree of tariff redistribution, i.e. the degree of costly rent-seeking in allocation of the tariff revenue.[5] Since the various modes of trade liberalization have different impacts on both industry structure and tariff revenue, the resulting effects on welfare are also widely divergent. In particular cuts in the ad valorem tariff move from the least to the most preferred mode of trade liberalization as the fraction of tariff revenue wasted on rent-seeking activities moves from zero to one. The driver behind this movement is that a reduction in an ad valorem tariff – in contrast to reductions in the other three trade barriers – has the most advantageous effect on industry structure (largest productivity gains), but is most costly in terms of lost tariff revenue. On the other hand, in a situation where rent-seeking activities absorb all the tariff revenue (zero redistribution), we find equal welfare effects from trade liberalization based on reductions in iceberg costs, unit tariffs or fixed export costs. In all situations with partial redistribution, reductions in the iceberg (real variable trade costs) are preferred to reductions in real fixed trade costs which again is preferred to reductions in the unit tariff in terms of the welfare gains associated with trade opening. These findings complement the findings presented in Table 1. Most centrally, they qualify the existing findings in the literature based on either full or no redistribution, as it is exactly the degree of redistribution that turns out to drive changes in the associated welfare rankings.

The rest of the paper is structured as follows. Section 2 introduces the standard model augmented to include tariffs and partial redistribution (i.e. rent-seeking activities). Section 3 presents the central welfare ranking and results on industry structure. Section 4 concludes. Finally, an appendix contains all the proofs.

2 The Model

We consider the workhorse model of the new trade theory with heterogenous firms, Melitz (2003), with the conventional assumption of Pareto distributed firm-specific productivities, see e.g. Helpman et al. (2004), Chaney (2008) and Eaton et al. (2008). In the Melitz (2003) model the economy consists of $n+1$ countries that are symmetric at aggregate levels including trade policies. Hence, we consider multilateral changes in trade policies/costs and thereby we do not consider countries' unilateral incentives to use policies to increase welfare at the expense of other countries, e.g. through terms of trade improvements.

Households

Consider the representative household inelastically supplying L units of labor. The preferences of the household over a set of goods/varieties (Ω) are given by the CES aggregate

$$U = \left[\int_{\omega\in\Omega} q\left(\omega\right)^{\frac{\sigma-1}{\sigma}} d\omega\right]^{\frac{\sigma}{\sigma-1}} ,$$

[5] We assume in the model that an exogenous given fraction $1-\chi\in[0,1]$ of the tariff revenue is wasted on costly (in terms of labor) rent-seeking activities, red-tape, etc.

where $q(\omega)$ is consumption of variety ω and $\sigma > 1$ is the elasticity of substitution between any goods. Optimal demand for each variety takes the form

$$q(\omega) = \left(\frac{p(\omega)}{P}\right)^{-\sigma} \frac{E}{P}, \tag{1}$$

where E denotes aggregate expenditures, $p(\omega)$ the price of variety ω and P the price index of one unit of the composite good defined by

$$P = \left[\int_{\omega\in\Omega} p(\omega)^{1-\sigma} d\omega\right]^{\frac{1}{1-\sigma}}. \tag{2}$$

Firms

Monopolistic firms face constant but heterogenous marginal costs. Firms face standard Dixit-Stiglitz innovation costs of developing a new variety (F_E).[6] Innovation costs are sunk before each new variety is randomly associated with a variety-specific marginal productivity ($\varphi(\omega)$) and thus marginal costs. Production exhibits increasing returns as firms face fixed costs of production (F). Finally, firms face fixed market costs in each export market (F_X). In addition, exporting firms also face variable real and tariff trade costs. Real variable trade costs are in line with the literature modeled by iceberg costs, $\tau \geq 1$, i.e. firms ship τ units for one unit to arrive at the export market. Accordingly, firm heterogeneity implies firm-specific unit costs of export. To emphasize the importance of real versus tariff costs, we introduce a comparable unit tariff of $t\frac{1}{\varphi}$ per unit of export.[7] Total marginal costs of supplying one unit to the foreign market, including production costs, real trade costs and unit tariffs, thus become $\frac{\tau+t}{\varphi}$. Moreover, firms face a standard ad valorem tariff, $T > 0$.

Inserting demand (1) and utilizing that demand is identical across the symmetric countries, profit conditional on export status reads

$$\pi(\varphi) = \begin{cases} \left(\frac{p}{P}\right)^{-\sigma}\frac{E}{P}\left(p-\frac{1}{\varphi}\right) - F & \textit{if pure domestic} \\ \left(\frac{p}{P}\right)^{-\sigma}\frac{E}{P}\left(p-\frac{1}{\varphi}\right) + n\left(\frac{p_x}{P}\right)^{-\sigma}\frac{E}{P}\left(\frac{p_x}{1+T}-\frac{1}{\varphi}(\tau+t)\right) - F - nF_X & \textit{if exporting} \end{cases},$$

where p (p_x) is the price charged in the domestic (export) market(s). Optimal pricing implies

$$\begin{aligned} p &= \frac{\sigma}{\sigma-1}\frac{1}{\varphi} \\ p_x &= \frac{\sigma}{\sigma-1}\frac{\tau+t}{\varphi}(1+T). \end{aligned} \tag{3}$$

In order to obtain closed form solutions and thus to ensure tractability, we follow the literature and assume that marginal productivities are drawn from a Pareto

[6] The costs consist of employing F_E units of labor. However, as we set the wage w to be the numeraire ($w \equiv 1$), the costs equal F_E.

[7] This formulation of the tariff enhances tractability substantially. We must stress that it is simply the tariff equivalent of the real iceberg trade cost; other specifications are conceivable.

distribution (see e.g. Helpman et al., 2004; Chaney, 2008; Eaton et al., 2008). The cumulative distribution function of marginal productivity is given by

$$G(\varphi) = \begin{cases} 1 - \left(\frac{\varphi_0}{\varphi}\right)^k & if \quad \varphi \geq \varphi_0 > 0 \\ 0 & if \quad \varphi < \varphi_0 \, , \end{cases}$$

where φ_0 and k are scale and shape parameters.[8]

The fixed costs of production and market access and the heterogeneous marginal productivities imply that firms self-select into groups of non-producing, pure domestic and exporting firms according to marginal productivities.

As is standard in the literature, we focus on steady state equilibria and assume zero discounting. With no discounting the present values of firms are kept finite by assuming that firms die with constant probability $\delta > 0$. Free entry ensures that firms enter until expected lifetime profits equal the costs of developing a new variety.

Productivity thresholds

Flow profits in the domestic ($\pi_D(\varphi)$) and in the export ($\pi_X(\varphi)$) markets are given by

$$\begin{aligned} \pi_D(\varphi) &= B\varphi^{\sigma-1} - F \\ \pi_X(\varphi) &= B\varphi^{\sigma-1}(1+T)^{-\sigma}(\tau+t)^{1-\sigma} - F_X, \end{aligned}$$

where $B \equiv \frac{1}{\sigma-1}\left(\frac{\sigma}{\sigma-1}\right)^{-\sigma} P^{\sigma-1}E$.

Following the literature, we focus on the empirically relevant equilibria in which there is partitioning of firms into exiters, non-exporters and exporters and that all exporting firms also supply the domestic market. Only the most productive firms find it worth while paying the fixed export market costs. Let φ^* and φ_X^* be the thresholds such that firms with $\varphi \geq \varphi_X^*$ are exporters, firms with $\varphi \in [\varphi^*, \varphi_X^*)$ are domestic firms, and firms with $\varphi < \varphi^*$ do not produce. The partitioning constraint with all four trade barriers present becomes $(1-T)^{-\sigma}(\tau+t)^{\sigma-1}F_X > F$. Then we have that $\pi_D(\varphi^*) = F$ and $\pi_X(\varphi_X^*) = 0$ which can be rewritten as

$$\begin{aligned} B(\varphi^*)^{\sigma-1} &= F \\ B(\varphi_X^*)^{\sigma-1} &= (1+T)^{\sigma}(\tau+t)^{\sigma-1}F_X \, . \end{aligned}$$

implying that $\varphi_X^* = \varphi^*\left(\frac{(1+T)^{\sigma}(\tau+t)^{\sigma-1}F_X}{F}\right)^{\frac{1}{\sigma-1}}$. As there is free entry, firms enter the industry until the expected value of the stream of profits equals the investment costs (entry costs). This free entry condition

$$\int_{\varphi^*}^{\infty} \pi_D(\varphi)\, dG(\varphi) + n\int_{\varphi_X^*}^{\infty} \pi_X(\varphi)\, dG(\varphi) = \delta F_E$$

[8]The density of marginal productivities is given by

$$g(\varphi) = G'(\varphi) = \begin{cases} k(\varphi_0)^k \varphi^{-k-1} & if \quad \varphi \geq \varphi_0 > 0 \\ 0 & if \quad \varphi < \varphi_0 \, . \end{cases}$$

We assume that $k > \sigma - 1$ to bound expected profits prior to entry from above.

pins down the two thresholds to

$$\varphi^* = \varphi_0 \left(\frac{(\sigma-1)}{k-(\sigma-1)} \frac{F}{\delta F_E} \right)^{\frac{1}{k}} \left(1 + n(\tau+t)^{-k} (1+T)^{-k\frac{\sigma}{\sigma-1}} \left(\frac{F_X}{F} \right)^{1-k\frac{1}{\sigma-1}} \right)^{\frac{1}{k}} \quad (4)$$

$$\varphi_X^* = \varphi^*(\tau+t)(1+T)^{\frac{\sigma}{\sigma-1}} \left(\frac{F_X}{F} \right)^{\frac{1}{\sigma-1}}$$

Both thresholds are invariant to the level of aggregate demand. However, aggregate demand determines the mass of active firms (M).

Aggregation with redistributed tariffs

A key difference between real and tariff trade costs in general equilibrium is that we explicitly model and include the revenues generated by the tariffs barrier via a lump-sum redistribution scheme to households. Accordingly, closing the model we depart from the standard labor market clearing condition and instead we evoke the expenditure-sales clearing condition.[9] Aggregate expenditure on goods, E, of households is the sum of wage earnings and the tariff revenue less waste and spending on rent-seeking activities.[10] The fraction $1-\chi \in [0,1]$ of tariff revenue is assumed to be wasted on costly (in terms of labor) rent-seeking activities and accordingly only the fraction $\chi \in [0,1]$ of the tariff revenue re-enters households' demand for goods.[11] Aggregate tariff revenue reads

$$\begin{aligned} TR &= M \int_{\varphi_X^*}^{\infty} n \frac{E}{P} \left(\frac{p_x(\varphi)}{P} \right)^{-\sigma} \left(\frac{t}{\varphi} + \frac{T}{1+T} p_x(\varphi) \right) \mu(\varphi)\, d\varphi \\ &= Mn(\sigma-1) F \left(\frac{t}{\tau+t} + T \frac{\sigma}{\sigma-1} \right) \frac{k}{k-(\sigma-1)} (\tau+t)^{-k} (1+T)^{-k\frac{\sigma}{\sigma-1}} \left(\frac{F_X}{F} \right)^{1-k\frac{1}{\sigma-1}} \end{aligned}$$

where $\mu(\varphi) = \frac{g(\varphi)}{1-G(\varphi^*)}$ is the distribution function for active firms. Aggregate sales read

$$\begin{aligned} R &= M \int_{\varphi^*}^{\infty} p(\varphi) \left(\frac{p(\varphi)}{P} \right)^{-\sigma} \frac{E}{P} \mu(\varphi)\, d\varphi + nM \int_{\varphi_X^*}^{\infty} p_x(\varphi) \left(\frac{p_x(\varphi)}{P} \right)^{-\sigma} \frac{E}{P} \mu(\varphi)\, d\varphi \\ &= M\sigma F \frac{k}{k-(\sigma-1)} \left(1 + n(\tau+t)^{-k} (1+T)^{1-k\frac{\sigma}{\sigma-1}} \left(\frac{F_X}{F} \right)^{1-\frac{k}{\sigma-1}} \right). \end{aligned}$$

[9]Obviously, the equilibrium number of firms can also be determined from the full employment condition.

[10]Following the literature, we assume zero discounting. This assumption implies zero return to savings and thereby no capital income.

[11]This formulation captures in a simple way that rent-seeking activities increase with the rents to be seeked (the tariff revenue), and it covers various other forms of administrative waste and red-tape.

The equilibrium condition $E = L + \chi TR = R$ determines the mass of firms/varieties

$$\begin{aligned} M &= \frac{L}{F}\frac{k-(\sigma-1)}{k\sigma} \\ &\times \left[1+\left[1-\chi\left(\frac{t}{\tau+t}\frac{1}{1+T}\frac{\sigma-1}{\sigma}+\frac{T}{1+T}\right)\right]n(\tau+t)^{-k}\left(1+T\right)^{1-k\frac{\sigma}{\sigma-1}}\left(\frac{F_X}{F}\right)^{1-k\frac{1}{\sigma-1}}\right]^{-1}. \end{aligned} \tag{5}$$

Finally, using the price index (2)[12], the optimal prices (3), the thresholds (4), and the mass of firms (5), welfare becomes

$$\begin{aligned} W &= \frac{R}{P} = (\sigma-1)\,F\left(\frac{L}{\sigma F}\right)^{\frac{\sigma}{\sigma-1}} \\ &\times \left(\frac{1+n(\tau+t)^{-k}\left(1+T\right)^{1-k\frac{\sigma}{\sigma-1}}\left(\frac{F_X}{F}\right)^{1-\frac{k}{\sigma-1}}}{1+\left[1-\chi\left(\frac{t}{\tau+t}\frac{1}{1+T}\frac{\sigma-1}{\sigma}+\frac{T}{1+T}\right)\right]n(\tau+t)^{-k}\left(1+T\right)^{1-k\frac{\sigma}{\sigma-1}}\left(\frac{F_X}{F}\right)^{1-k\frac{1}{\sigma-1}}}\right)^{\frac{\sigma}{\sigma-1}}\varphi^* \\ &= \tilde{W}\left(1+n(\tau+t)^{-k}\left(1+T\right)^{-k\frac{\sigma}{\sigma-1}}\left(\frac{F_X}{F}\right)^{1-k\frac{1}{\sigma-1}}\right)^{\frac{1}{k}} \\ &\times \left(\frac{1+n(\tau+t)^{-k}\left(1+T\right)^{1-k\frac{\sigma}{\sigma-1}}\left(\frac{F_X}{F}\right)^{1-\frac{k}{\sigma-1}}}{1+\left[1-\chi\left(\frac{t}{\tau+t}\frac{1}{1+T}\frac{\sigma-1}{\sigma}+\frac{T}{1+T}\right)\right]n(\tau+t)^{-k}\left(1+T\right)^{1-k\frac{\sigma}{\sigma-1}}\left(\frac{F_X}{F}\right)^{1-k\frac{1}{\sigma-1}}}\right)^{\frac{\sigma}{\sigma-1}}, \end{aligned} \tag{6}$$

where $\tilde{W} = (\sigma-1)\,\varphi_0\left(\frac{L}{F}\frac{1}{\sigma}\right)^{\frac{\sigma}{\sigma-1}} F\left(\frac{(\sigma-1)}{k-(\sigma-1)}\frac{F}{\delta F_E}\right)^{\frac{1}{k}} > 0$. The degree of rent-seeking activities, $1-\chi$, has no effect on the industry structure, but decreases welfare as disposable income and thereby consumption decreases.[13] However, more rent-seeking also decreases welfare indirectly, as the smaller demand cf. (5) decreases the mass of varieties which in turn decreases welfare due to love of variety. We state:

Lemma 1. *A larger degree of tariff redistribution χ has no effect on the thresholds but increases welfare through increased disposable income and an increased number of varieties.*

3 Trade liberalization, welfare and industry structure

The above specification presents a version of the Melitz (2003) framework extended to include tariffs that are redistributed to households and thus matter in general

[12]The price index becomes

$$P = M^{\frac{1}{1-\sigma}}\frac{\sigma}{\sigma-1}\left(\frac{k}{k-(\sigma-1)}\right)^{\frac{1}{1-\sigma}}(\varphi^*)^{-1}\left[1+n(\tau+t)^{-k}\left(1+T\right)^{1-k\frac{\sigma}{\sigma-1}}\left(\frac{F_X}{F}\right)^{1-k\frac{1}{\sigma-1}}\right]^{\frac{1}{1-\sigma}}$$

[13]Rent-seeking activities affect market size, but due to constant elasticities of demand the market size has no impact on the industry structure.

equilibrium. Inspection of (6) leads to a first result on trade liberalization channels and welfare:

Lemma 2. *Trade liberalization through reductions in either real variable trade costs (τ), real fixed trade costs (F_X), unit tariffs (t) or ad valorem tariffs (T) increases welfare.*

Next, we will address the question of how different types of trade liberalization rank in terms of their effect on welfare. To fix the scale of changes in the different trade costs, we compare changes in trade costs yielding the same effect on a standard measure of economic integration, namely openness (Θ) defined by imports plus exports relative to GDP.[14] In the present setting this measure becomes

$$\Theta = 2\frac{n(\tau+t)^{-k}\left(1+T\right)^{1-k\frac{\sigma}{\sigma-1}}\left(\frac{F_X}{F}\right)^{1-\frac{k}{\sigma-1}}}{1+n(\tau+t)^{-k}\left(1+T\right)^{1-k\frac{\sigma}{\sigma-1}}\left(\frac{F_X}{F}\right)^{1-\frac{k}{\sigma-1}}} \in (0,2)\ . \tag{7}$$

As expected, trade liberalization in any dimension increases openness:

Lemma 3. *Openness (Θ) increases in trade liberalization irrespective of the source, i.e. it increases through reductions in real variable trade costs (τ),unit tariffs (t), ad valorem tariffs (T) or fixed trade costs (F_X).*

From the openness measure (7) it follows that trade liberalizations of equal impact on openness must satisfy

$$dt = d\tau \tag{8}$$

$$dT = \frac{1+T}{\tau+t}\frac{k}{k\frac{\sigma}{\sigma-1}-1}d\tau \tag{9}$$

$$dF_X = \frac{F_X}{\tau+t}\frac{k}{k\frac{1}{\sigma-1}-1}d\tau \tag{10}$$

For later reference it is useful to rewrite the exit threshold as

$$\varphi^*_\Theta = \varphi_0\left(\frac{(\sigma-1)}{k-(\sigma-1)}\frac{F}{\delta F_E}\right)^{\frac{1}{k}}\left(1+\frac{1}{1+T}\frac{\Theta}{2-\Theta}\right)^{\frac{1}{k}} \tag{11}$$

and to note that

Lemma 4. *Trade liberalization in any dimension increases the exit threshold. The impact on the exit threshold of trade liberalizations with equal impact on openness is stronger for a reduction in the ad valorem tariff than reductions in the other trade costs.*

[14] Another conceivable measure would be the share of imports in GDP. All results stated are robust also for such a specification.

It is convenient for tractability to express welfare in terms of the openness measure:

$$W = W_\Theta = \tilde{W}\left(1+\frac{1}{1+T}\frac{\Theta}{2-\Theta}\right)^{\frac{1}{k}}\left(\frac{1+\frac{\Theta}{2-\Theta}}{1+\left[1-\chi\left(\frac{t}{\tau+t}\frac{1}{1+T}\frac{\sigma-1}{\sigma}+\frac{T}{1+T}\right)\right]\frac{\Theta}{2-\Theta}}\right)^{\frac{\sigma}{\sigma-1}} \tag{12}$$

The change in welfare from changing x for $x = t, T, \tau, F_X$ follows from (12) and reads

$$dW = \frac{\partial W_\Theta}{\partial \Theta}d\Theta + \frac{\partial W_\Theta}{\partial x}dx$$

and as we rank modes of trade liberalization for given changes in the openness measure, we only need to rank $\frac{\partial W_\Theta}{\partial x}dx$ for $x = t, T, \tau, F_X$. We are now in a position to rank the welfare gains from increasing openness arising from reductions in the four types of trade costs.

Proposition 1. *For trade liberalizations with a given effect on openness, Θ, it follows:*
1) When all tariff revenue is wasted on rent-seeking activities, reductions in iceberg trade costs, fixed trade costs and unit tariffs all have the same impact on welfare.
2) When only part of the tariff revenue is wasted on rent-seeking activities, reductions in iceberg trade costs (τ) are preferred to reductions in fixed trade costs (F_X) which again is preferred to reductions in unit tariffs (t).
3) Reductions in ad valorem tariffs move from the least to the most preferred mode of trade liberalization as the degree of rent-seeking moves from zero to one.

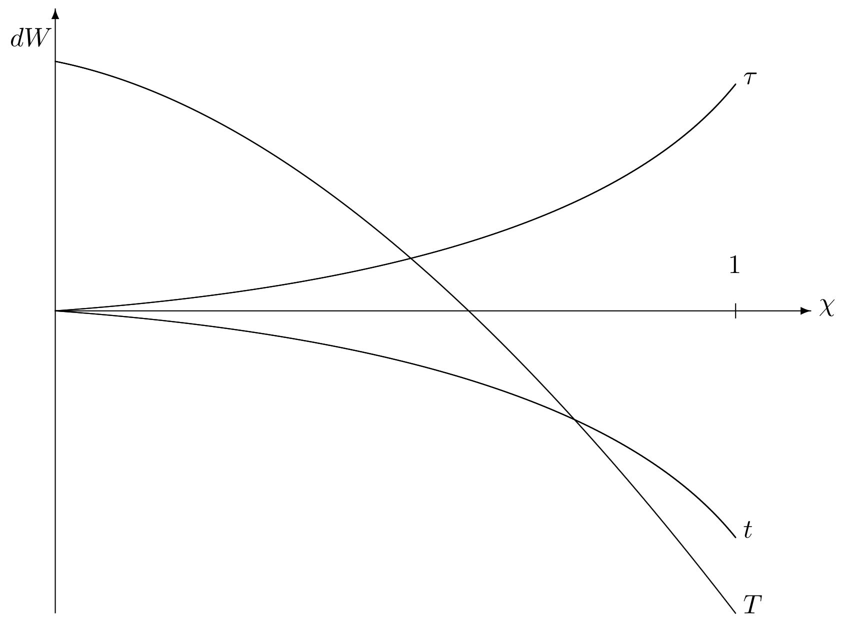

Figure 1: Welfare gains from liberalization for equal openness effect (relative to reduction in F_X).

Figure 1 illustrates the welfare ranking. When all tariff revenue is wasted on rent-seeking activities, i.e. $\chi = 0$, the tariff revenue plays no role and from the welfare expression (6) it follows that trade liberalization only affects welfare through the exit threshold and thus the industry structure. From the exit threshold (11) and Lemma 3 it follows that reductions in fixed trade costs, iceberg trade cost and unit tariffs must have the same effect on openness and also have the same impact on the exit threshold. This in turn ensures identical welfare gains and explains result 1 in Proposition 1. As expected, iceberg costs and unit tariffs have the same effect on welfare since the entire tariff revenue is wasted by rent-seeking activities and the unit tariff is modelled as the tariff equivalent of the iceberg costs. The equivalent welfare effect from reductions in fixed and iceberg trade costs is noteworthy, however, this result is likely to be sensitive to the assumption of Pareto distributed marginal productivities. The ad valorem tariff reduction-driven trade liberalization generates higher welfare gains, stemming from the impact on exit thresholds and hence increased intra-industry reallocations.

Turning to the case with limited rent-seeking activities, i.e. $\chi > 0$, tariff revenue matters. Tariff revenue can be written as

$$TR_\Theta = L \frac{\left(\frac{t}{\tau+t}\frac{1}{1+T}\frac{\sigma-1}{\sigma} + \frac{T}{1+T}\right)\frac{\Theta}{2-\Theta}}{1 + \left(1 - \chi\left(\frac{t}{\tau+t}\frac{1}{1+T}\frac{\sigma-1}{\sigma} + \frac{T}{1+T}\right)\right)\frac{\Theta}{2-\Theta}} \tag{13}$$

and comparing the effect on tariff revenue of the various modes of trade liberalization, we find

Lemma 5. *For trade liberalizations yielding an equal increase in openness (Θ), reductions in real trade costs imply a higher tariff revenue than reductions in tariffs. Among tariffs the unit tariff generates more tariff revenue compared to the ad valorem tariff. Among real trade costs the iceberg trade cost is preferred on a tariff revenue scale to the fixed cost of exporting.*

That reductions in real trade costs are preferred to reductions in tariffs in terms of tariff revenue is hardly surprising, since real-cost reductions generate additional trade volume that boosts the tariff earnings even for constant tariff rates. However, the rankings among real trade costs and among tariffs are less obvious.

Reductions in fixed trade costs, iceberg trade costs and unit tariffs yield identical welfare gains through changes in the industry structure, cf. Lemma 3. However, according to Lemma 4 they have a heterogenous effects on tariff revenue which therefore determines the welfare ranking, i.e. result 2 of Proposition 1.

The final result of Proposition 1 states that the ad valorem tariff moves from the least to the most preferred mode of trade liberalization as the degree of rent-seeking moves from zero to one. To understand this, recall from Lemma 3 that a lower ad valorem tariff yields the largest impact on the exit threshold and thus generates the most favorable intra-industry reallocations. This clearly makes ad valorem tariffs the most preferred mode when all tariff revenue is wasted. Turning to tariff revenue, we have that the ad valorem tariff is most costly in terms of tariff revenue. A smaller degree of rent-seeking (less waste) makes tariff revenue increasingly important and the ranking of the ad valorem tariff therefore gradually deteriorates and eventually becomes the least preferred mode.

Turning to the industry structure, we have above derived and ranked the effects on the exit threshold from various modes of trade liberalization, cf. Lemma 3. For the degree of international engagement of firms we find, as expected, that trade liberalization increases the fraction of firms exporting. However, in the present framework we are able to compare various modes of trade liberalization for a given impact on openness and find that

Proposition 2. *Trade liberalization increases the fraction of firms exporting. The fraction of firms exporting increases most as trade liberalization occurs through reductions in fixed costs of exporting followed by reductions in the ad valorem tariff. The iceberg costs and the iceberg type tariff have equal impacts on the fraction of firms exporting.*

And finally to complete the characterization of the industry structure, we turn to the mass of (domestic) firms:

Proposition 3. *Trade liberalization reduces the mass of active (domestic) firms. When all tariff revenue is wasted on rent-seeking activities, all modes of trade liberalization have the same effect on the mass of active (domestic) firms. With partial redistribution, more (domestic) firms are active when liberalization occurs through reductions in real trade costs. For real costs reductions most (domestic) firms are active when liberalization occurs through lower iceberg trade costs. For tariff cost reductions most (domestic) firms are active when the unit tariff is reduced.*

4 Conclusion

This paper takes the recent advances of intra-industry trade models with heterogeneous firms into the arena of policy questions in international economics. We examine and compare the welfare effects of four distinct channels of multilateral trade liberalization (economic integration). In particular, we have compared reductions in real variable trade costs (iceberg costs), real fixed export costs and partially redistributed unit and ad valorem tariffs in a Melitz (2003) type model, along a criterion of equal effect on trade openness. Our key findings are i) the welfare ranking is sensitive to the degree of efficiency in tariff redistribution as ad valorem tariffs move from the least to the most preferred mode of liberalization as the fraction of tariffs wasted on rent-seeking activities moves from zero to unity and ii) when only part of tariff revenue is wasted, reductions in real variable trade costs are preferred to reductions in real fixed trade costs which again is preferred to an iceberg type unit tariff. These findings are driven by the fact that various modes of trade liberalization have different effects on the industry structure (including aggregate productivity) and on the number of varieties available to the consumers. Moreover the paper stresses that the preferred mode of trade liberalization may depend on the degree of redistribution (e.g. the extent of rent-seeking activities) and thus indirectly on the strength of institutions.

The paper demonstrates that the model family following Melitz (2003) can be brought much closer to empirically relevant trade cost formulations, it can straightforwardly be extended to include, for example, redistributed tariffs, while remaining highly tractable. These extensions are of relevance to applications in policy modeling and to taking the model back to data and episodes of real world economic integration. Taking our findings beyond the narrow formal framework in which they are derived, they have implications for the understanding and analysis of real world integration episodes. First, studies assessing the welfare gains from tariff liberalizations as managed within WTO, NAFTA or the European customs union will tend to overstate the gains from liberalization if tariff cuts are modeled as iceberg cost reductions. Second, the findings of the present paper have implications for the sequencing of trade liberalization. While the largest welfare gains for sufficiently efficient tariff redistribution are to be harvested by reductions in real trade costs, these parameters rarely feature on the political agenda; in contrast the central weight in post World War II trade policy has been on tariff cuts. The reason for this is, of course, that many of the parameters determining real trade costs are outside the realm of traditional political negotiations. Transport technologies, costs of information flows, and costs of conducting business across borders are much less subject to politics as they are subject to technological advance and possibility. Still, issues such as time wasted in transit and border controls, common standards, and demands of foreign regulation and red-tape may clearly be influenced by international agreements. The present paper has shown that some of the largest gains from trade are to be harvested when tackling these types of real trade barriers.

Appendix: Proofs

Proof of Lemma 1: Follows by inspection of (4) and the derivatives of the welfare expression (6) with respect to χ.

Proof of Lemma 2: Follows directly from the derivatives of the welfare expression (6) with respect to the various trade costs.

Proof of Lemma 3: Follows directly from the derivatives of openness (7) with respect to the various trade costs.

Proof of Lemma 4: That trade liberalization in any dimension increases the exit threshold follows directly from the partial derivatives of (4). The ranking among trade liberalizations with an equal impact on openness (Θ) follows from the derivatives of (11) yielding $\frac{\partial \varphi^*_\Theta}{\partial \tau} = \frac{\partial \varphi^*_\Theta}{\partial F_X}\frac{dF_X}{d\tau} = \frac{\partial \varphi^*_\Theta}{\partial t}\frac{dt}{d\tau} = 0$ and $\frac{\partial \varphi^*_\Theta}{\partial T}\frac{dT}{d\tau} < 0$, where $\frac{dF_X}{d\tau}$, $\frac{dt}{d\tau}$ and $\frac{dT}{d\tau}$ follows from (8)-(10).

Proof of Proposition 1: Apply (8)-(10) and the partial derivatives of the welfare expression (12) to obtain $\frac{\partial W_\Theta}{\partial F_X}\frac{dF_X}{d\tau} = 0$, $\frac{\partial W_\Theta}{\partial \tau} = -\frac{\frac{\Theta}{2-\Theta}\chi W_\Theta \frac{1}{1+T}\frac{t}{t+\tau}\frac{1}{t+\tau}}{1+\left[1-\chi\left(\frac{t}{t+\tau}\frac{1}{1+T}\frac{\sigma-1}{\sigma}+\frac{T}{1+T}\right)\frac{\Theta}{2-\Theta}\right]} \leq 0$, $\frac{\partial W_\Theta}{\partial t}\frac{dt}{d\tau} = \frac{\frac{\Theta}{2-\Theta}\chi W_\Theta \frac{1}{1+T}\frac{\tau}{t+\tau}\frac{1}{t+\tau}}{1+\left[1-\chi\left(\frac{t}{t+\tau}\frac{1}{1+T}\frac{\sigma-1}{\sigma}+\frac{T}{1+T}\right)\frac{\Theta}{2-\Theta}\right]} \geq 0$ and $\frac{\partial W_\Theta}{\partial T}\frac{dT}{d\tau} = W_\Theta \frac{1+T}{t+\tau}\frac{k}{k\frac{\sigma}{\sigma-1}-1}\left[\frac{-\frac{\Theta}{2-\Theta}\frac{1}{1+T}\frac{1}{1+T}}{1+\frac{1}{1+T}\frac{\Theta}{2-\Theta}}\frac{1}{k} + \frac{\frac{\Theta}{2-\Theta}\chi\frac{1}{1+T}\frac{1}{1+T}\left(\frac{\sigma-1}{\sigma}-\frac{t}{t+\tau}\right)}{1+\left[1-\chi\left(\frac{t}{t+\tau}\frac{1}{1+T}\frac{\sigma-1}{\sigma}+\frac{T}{1+T}\right)\frac{\Theta}{2-\Theta}\right]}\right]$. The first result comes from noting that $\frac{\partial W_\Theta}{\partial x}\frac{dx}{d\tau}\Big|_{\chi=0} = 0$ for $x = t, \tau, F_X$. For $\chi > 0$ it holds that $\frac{\partial W_\Theta}{\partial \tau} < 0 = \frac{\partial W_\Theta}{\partial F_X}\frac{dF_X}{d\tau} < \frac{\partial W_\Theta}{\partial t}\frac{dt}{d\tau}$ which proves the second result. All terms are continuos in χ and $\frac{\partial W_\Theta}{\partial T}\frac{dT}{d\tau}\Big|_{\chi=0} = -W_\Theta \frac{1}{k\frac{\sigma}{\sigma-1}-1}\frac{\frac{\Theta}{2-\Theta}\frac{1}{1+T}\frac{1}{t+\tau}}{1+\frac{1}{1+T}\frac{\Theta}{2-\Theta}} < 0 = \frac{\partial W_\Theta}{\partial x}\frac{dx}{d\tau}\Big|_{\chi=0} = 0$ for $x = t, \tau, F_X$ and $\frac{\partial W_\Theta}{\partial T}\frac{dT}{d\tau}\Big|_{\chi=1} > \frac{\partial W_\Theta}{\partial t}\frac{dt}{d\tau}\Big|_{\chi=1} > \frac{\partial W_\Theta}{\partial F_X}\frac{dF_X}{d\tau}\Big|_{\chi=1} > \frac{\partial W_\Theta}{\partial \tau}\Big|_{\chi=1}$ which proves the third result.

Proof of Lemma 5: It follows from (13) that $\frac{\partial TR_\Theta}{\partial \tau} < \frac{\partial TR_\Theta}{\partial F_X}\frac{dF_X}{d\tau} = 0 < \frac{\partial TR_\Theta}{\partial t}\frac{dt}{d\tau} < \frac{\partial TR_\Theta}{\partial T}\frac{dT}{d\tau}$, where $\frac{dF_X}{d\tau}$, $\frac{dt}{d\tau}$ and $\frac{dT}{d\tau}$ follows from (8)-(10).

Proof of Proposition 2: The first follows directly from noting that $p_{x,\Theta} = \left(\frac{\varphi^*_X}{\varphi^*}\right)^{-k} = \frac{\Theta}{2-\Theta}\frac{1}{n}\frac{F}{F_X}\frac{1}{1+T}$ and by using Lemma 2. The rest follows from applying that $\frac{\partial p_{x,\Theta}}{\partial F_X}\frac{dF_X}{d\tau} = -\frac{p_{x,\Theta}}{t+\tau}\frac{k}{k\frac{1}{\sigma-1}-1} < -\frac{p_{x,\Theta}}{t+\tau}\frac{k}{k\frac{\sigma}{\sigma-1}-1} = \frac{\partial p_{x,\Theta}}{\partial t}\frac{dt}{d\tau} < 0 = \frac{\partial p_{x,\Theta}}{\partial \tau}$.

Proof of Proposition 3: That trade liberalization reduces the mass of active firms follows from the partial derivatives of (5). We can write the mass of firms as $M_\Theta = \frac{L}{F}\frac{k-(\sigma-1)}{k\sigma}\left[1+\left[1-\chi\left(\frac{t}{t+\tau}\frac{1}{1+T}\frac{\sigma-1}{\sigma}+\frac{T}{1+T}\right)\right]\frac{\Theta}{2-\Theta}\right]^{-1}$ and the ranking comes from noting that $\frac{\partial M_\Theta}{\partial F_X}\frac{dF_X}{d\tau} = 0$, $\frac{\partial M_\Theta}{\partial \tau} = -M_\Theta \frac{\frac{\Theta}{2-\Theta}\chi\frac{\sigma-1}{\sigma}\frac{t}{t+\tau}\frac{1}{t+\tau}}{1+\left[1-\chi\left(\frac{t}{t+\tau}\frac{1}{1+T}\frac{\sigma-1}{\sigma}+\frac{T}{1+T}\right)\right]\frac{\Theta}{2-\Theta}} \leq 0$, $\frac{\partial M_\Theta}{\partial T}\frac{dT}{d\tau} = M_\Theta \frac{\frac{\Theta}{2-\Theta}\chi\left(1-\frac{t}{t+\tau}\frac{\sigma-1}{\sigma}\right)\frac{1}{1+T}\frac{1}{t+\tau}\frac{k}{k\frac{\sigma}{\sigma-1}-1}}{1+\left[1-\chi\left(\frac{t}{t+\tau}\frac{1}{1+T}\frac{\sigma-1}{\sigma}+\frac{T}{1+T}\right)\right]\frac{\Theta}{2-\Theta}} \geq 0$, $\frac{\partial M_\Theta}{\partial t}\frac{dt}{d\tau} = M_\Theta \frac{\frac{\Theta}{2-\Theta}\chi\frac{1}{1+T}\frac{\sigma-1}{\sigma}\frac{1}{t+\tau}\frac{\tau}{t+\tau}}{1+\left[1-\chi\left(\frac{t}{t+\tau}\frac{1}{1+T}\frac{\sigma-1}{\sigma}+\frac{T}{1+T}\right)\right]\frac{\Theta}{2-\Theta}} \geq 0$ and $\frac{\partial M_\Theta}{\partial T}\frac{dT}{d\tau}\Big|_{\chi>0} > \frac{\partial M_\Theta}{\partial t}\frac{dt}{d\tau}\Big|_{\chi>0} \Leftrightarrow tk + (\sigma-1)\tau > 0$.

References

Anderson, J.E. and E. van Wincoop (2004), Trade Costs. *Journal of Economic Literature* 42: 691–751.

Baier, S.L. and J.H. Bergstrand (2001), The Growth of World Trade: Tariffs, Transport Costs, and Income Similarity. *Journal of International Economics* 53: 1–27.

Baldwin, R.E. and R. Forslid (2010), Trade Liberalization with Heterogenous Firms. *Review of Development Economics*, Vol 14 (2), 161–176.

Balistreri, E.J.; R.H. Hillberry and T.F. Rutherford (2011), Structural Estimation and Solution of International Trade Models with Heterogeneous Firms. Journal of International Economics, Vol 83 (2), 95–108.

Bohnstedt, A.; C. Schwarz and J. Südekum (2011), Globalization and strategic research investments. *Research Policy*, forthcoming.

Chaney, T. (2008), Distorted Gravity: Heterogeneous Firms, Market Structure, and the Geography of International Trade. *American Economic Review*, Vol. 98 , pp. 1707-1721.

Cole, M.T. (2011a), Not All Trade Restrictions are Created Equally. *Review of World Economics*, Vol. 147 (3), 411–427.

Cole, M.T. (2011b), Distorted Trade Barriers. University College Dublin, Centre for Economic Research, WP 11/05.

Cole, M.T. and R.B. Davies (2011), Strategic Tariffs, Tariff Jumping, and Heterogeneous Firms. *European Economic Review*, Vol. 55 (4), 480–496.

Das, S.; M.J. Roberts and J.R. Tybout (2007), Market entry costs, producer heterogeneity, and export dynamics. *Econometrica*, Vol. 75 (3), 837–873.

Demidova, S. and K. Krishna (2007), Trade and Trade Policy with Differentiated Products: A Chamberlinian-Ricardian Model. A Comment.*Journal of International Trade & Economic Development*, Vol. 16 (3), pp. 435-441.

Demidova, S. and A. Rodriguez-Clare (2009), Trade Policy Under Firm-Level Heterogeneity in a Small Economy. *Journal of International Economics*, Vol. 78, pp. 100-112.

Dennis, A. and B. Shepherd (2011), Trade Facilitation and Export Diversification. *The World Economy*, Vol. 34 (1), 101-122.

Eaton, J.; S. Kortum and F. Kramarz (2008), An Anatomy of International Trade: Evidence from French Firms. *NBER Working Paper* No. 14610

Felbermayr, G.; B. Jung and M. Larch (2011),Optimal Tariffs, Retaliation and the Welfare Loss from Tariff Wars in the Melitz Model. CESifo Working Paper No. 3474.

Francois J.F. and W. Martin (2010), Ex Ante Assessment of the Welfare Impacts of Trade Reform with Numerical Models. in: *Frontiers of Economics and Globalization, Volume 7 – New Developments in Computable General Equilibrium Analysis for Trade Policy*, J. Gilbert (ed).Emerald Publishing.

Greenaway, D. and R. Kneller (2007), Firm Heterogeneity, Exporting and Foreign

Direct Investment. *The Economic Journal*, Vol 117, pp. 134-161.

Gros, D. (1987), A Note on the Optimal Tariff, Retaliation and the Welfare Loss from Tariff Wars in a Framework with Intra-industry Trade. *Journal of International Economics* 23: 357–367.

Helpman, E.; M.J. Melitz and S.R. Yeaple (2004), Export Versus FDI with Heterogeneous Firms. *American Economic Review*, Vol. 94(1), pp. 300–316.

Hummels, D. and A. Skiba (2004), Shipping the Good Apples Out? An Empirical Confirmation of the Alchian-Allen Conjecture. *Journal of Political Economy* 112: 1384-402.

Irarrazabal, A.; A. Moxnes and L.D. Opromolla (2010), The Tip of the Iceberg: Modeling Trade Costs and Implications for Intra-Industry Reallocation, CEPR Discussion Papers 7685.

Jacks, D.S.; C.M. Meissner and D. Novy (2011), Trade Booms, Trade Busts, and Trade Costs. *Journal of International Economics*, Vol 83 (2), 185–201.

Jung, B. (2011), Optimal fixed cost subsidies in Melitz-type models, *Empirica*, forthcoming.

Jørgensen, J.G. and P.J.H. Schröder (2005), Welfare Ranking Ad Valorem and Specific Tariffs under Monopolistic Competition. *Canadian Journal of Economics*, Vol. 38 (1), pp. 228–241.

Jørgensen, J.G. and P.J.H. Schröder (2008), Fixed Export Cost Heterogeneity, Trade and Welfare. *European Economic Review*, Vol. 52 (7), pp. 1256–1274 .

Krugman, P. (1980), Scale Economies, Product Differentiation, and the Pattern of Trade. *American Economic Review*, Vol. 70 (5), pp. 950–959.

Melitz, M.J. (2003), The Impact of Trade on Intra-industry Reallocations and Aggregate Industry Productivity. *Econometrica*, Vol. 71 (6), pp. 1695-1725.

Pflüger M. and J. Südekum (2009), Subsidizing Firm Entry in Open Economies. IZA Working Paper 4384.

Roberts, M.J. and J.R. Tybout (1997), The Decision to Export in Colombia: An Empirical Model of Entry with Sunk Costs. *American Economic Review*, Vol. 87 (4), pp. 545-564.

Schröder, P.J.H. (2004), Real versus Tariff Liberalization: A Welfare Comparison under Monopolistic Competition. *Open Economies Review*, Vol. 15 (4), pp. 403–418.

Schröder, P.J.H. and A. Sørensen (2010), Ad valorem versus unit taxes: Monopolistic competition, heterogeneous firms, and intra-industry reallocations, *Journal of Economics*, Vol. 101(3), pp. 247–265.

Wagner, J. (2007), Exports and Productivity: A Survey of the Evidence from Firm-level Data. *The World Economy*, Vol. 30 (1), pp. 60-82.

Economics Working Paper

2011-05: John Kennes, Daniel Monte and Norovsambuu Tumennasan: The Daycare Assignment Problem

2011-06: Rene Saran and Norovsambuu Tumennasan: Whose Opinion Counts?

2011-07: Mark Strøm Kristoffersen: Liquidity Constraints and Fiscal Stabilization Policy

2011-08: Martin Paldam: The cycle of development in Africa. A story about the power of economic ideas

2011-09: Thorvardur Tjörvi Ólafsson, Ásgerdur Pétursdóttir and Karen Á. Vignisdóttir: Price setting in turbulent times. Survey evidence from Icelandic firms

2011-10: Torben M. Andersen: Social policies and activation in the Scandinavian welfare model: the case of Denmark

2011-11: Norovsambuu Tumennasan: To Err is Human: Implementation in Quantal Response Equilibria

2011-12: Norovsambuu Tumennasan: Do Contracts Help? A Team Formation Perspective

2011-13: Norovsambuu Tumennasan: Quantity Precommitment and Price Matching

2011-14: Anette Primdal Kvist, Helena Skyt Nielsen and Marianne Simonsen: The effects of Children's ADHD on Parents' Relationship Dissolution and Labor Supply

2011-15: Hristos Doucouliagos and Martin Paldam: The robust result in meta-analysis of aid effectiveness: A response to Mekasha and Tarp

2011-16: Helena Skyt Nielsen and Beatrice Schindler Rangvid: The Impact of Parents' Years since Migration on Children's Academic Achievement

2011-17: Philipp J.H. Schröder and Allan Sørensen: Firm Exit, Technological Progress and Trade

2011-18: Philipp J.H. Schröder and Allan Sørensen: A welfare ranking of multilateral reductions in real and tariff trade barriers when firms are heterogenous