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Unilateral Trade Liberalization in the Melitz Model: A Note

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Abstract

In the two-country Melitz (2003) model, unilateral trade liberalization is often cast as a reduction of iceberg transportation costs and wages are determined by a linear outside sector. We show that welfare results reverse when wages adjust and trade frictions are revenue-generating tariffs.

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1. Introduction

Melitz & Ottaviano (2008) use a variant of Melitz' (2003) heterogeneous firms trade model to show that unilateral trade liberalization–cast as lower iceberg transportation costs–can be *immiserizing*. The key mechanism in that paper is that firms find it optimal to relocate to the relatively more protected market and serve the liberalized economy through exports. The mass of available varieties falls in the liberalizing country. The model features a linear outside sector that pins down wages. The paper by Demidova (2008) differs in that it has constant markups but cross-country productivity heterogeneity. However, it also predicts immiserization due to unilateral liberalization, due to a similar relocation mechanism and technologically fixed wages.[1] Generalizing Demidova & Rodriguez-Clare (2009, 2011), we use a two-country framework with fully endogenous wages. Moreover, we contrast iceberg transportation costs (non-tariff import barriers) to revenue-generating tariffs.

In stark contrast to the case of a linear outside good, the model with fully endogenous wages predicts that a unilateral reduction of non-tariff import barriers *benefits both* countries. When trade liberalization comes as a unilateral reduction in an *ad valorem* import tariff, the liberalizing country typically loses, while the other country always gains. Our analysis suggests that the assumption of a linear outside sector–often made for the sake of convenience–distorts the welfare predictions of the model. Equating trade liberalization with lower iceberg transportation costs–as also often done–is equally problematic.

Our paper is closely related to a recent paper by Felbermayr, Jung & Larch (2012), who derive the optimal tariff formula in a standard Melitz (2003) model with Pareto-distributed firm-level productivities. Their work studies how optimal tariffs depend on model parameters such as the degree of firm-level or cross-country productivity heterogeneity. But it is silent about the welfare effects of lower iceberg trade costs in the face of country-level asymmetries.

2. Model

2.1 Setup

Our setup is a two-country version of Arkolakis, Demidova, Klenow & Rodriguez-Clare (2008), henceforth ADKR, to which we refer for a more detailed explanation of the model setup.[2] The major difference to ADKR is that we allow for revenue-generating *ad valorem* tariffs. Home and Foreign, indexed $i \in \{H, F\}$, are populated by representative consumers who inelastically supply the only factor of production, labor, L_i at price w_i. The consumers have identical standard Dixit-Stiglitz preferences with a constant elasticity of substitution given by $\sigma > 1$.

Firms compete monopolistically. After paying innovation costs $w_i f^e$, each draws its productivity level φ from a Pareto distributed c.d.f. $G[\varphi] = 1 - \varphi^{-\beta}$, where $\beta > \sigma - 1$ to guarantee the existence of a well-defined size distribution. Output is linear in φ. Fixed costs of accessing market j are given by $w_i f_{ij}$, where we set $f_{ii} = f_{jj} = f^d$ and

[1] See the clarification in Demidova & Rodriguez-Clare (2011). An immiserization result stemming from unilateral *tariff* reduction is obtained by Jorgenson & Schroeder (2008) in a model with heterogeneous fixed costs but homogeneous marginal costs.

[2] In contrast to us, for their purposes, ADKR do not derive the complete comparative statics of their model.

$f_{ij} = f_{ji} = f^x$. Country i may levy an *ad valorem tariff* $t_{ij} > 1$ on its imports or may impose a non-tariff import barrier $\tau_{ij} > 1$, where $t_{ii} = t_{jj} = \tau_{ii} = \tau_{jj} = 1$. In line with the above cited papers, we model non-tariff import barriers as iceberg transportation costs.

2.2 Equilibrium conditions

The first set of equilibrium conditions is made up of four *zero cutoff-profit conditions* (ZCPs). They determine the productivity φ_{ij}^* of those firms in country i which just break even by selling to market j:

$$r\left[\varphi_{ij}^*\right] = \sigma w_i f_{ij}, \ \ i \in \{H, F\}, \ \ j \in \{H, F\}, \tag{1}$$

where $r\left[\varphi_{ij}\right] = E_j P_j^{\sigma-1} t_{ji}^{-\sigma}\left(\frac{\rho\varphi_{ij}}{\tau_{ji} w_i}\right)^{\sigma-1}$ is revenue of firm φ located in i earned from sales in j with $\rho = (\sigma-1)/\sigma$. E_j is aggregate expenditure. The price index P_i is given by

$$P_i^{1-\sigma} = \theta \sum_{j\in\{H,F\}} m_{ji} M_j \left(\frac{\rho\varphi_{ji}^*}{w_j \tau_{ij} t_{ij}}\right)^{\sigma-1}, \tag{2}$$

with $\theta \equiv \beta/(\beta-(\sigma-1)) > 0$. M_j denotes the mass of domestic firms operating in j and $m_{ji} = \left(1 - G\left[\varphi_{ji}^*\right]\right)/\left(1 - G\left[\varphi_{jj}^*\right]\right) = \left(\varphi_{jj}^*/\varphi_{ji}^*\right)^{\beta}$ is the probability of exporting.

The second set of conditions is made up of two *free entry conditions*, which make sure that expected profits equalize the costs of innovation

$$(\theta-1)\left(\varphi_{ii}^*\right)^{-\beta} \sum_{j\in\{H,F\}} m_{ij} f_{ij} = f^e. \tag{3}$$

Finally, there are two *labor market clearing conditions*

$$M_i = \frac{(\theta-1) L_i}{\sigma\theta f^e}\left(\varphi_{ii}^*\right)^{-\beta}. \tag{4}$$

These conditions make up a system of eight equations in eight unknown endogenous variables $\{\varphi_{HH}^*, \varphi_{FF}^*, \varphi_{HF}^*, \varphi_{FH}^*; M_H, M_F; w_H, w_F\}$.

2.3 Welfare and auxiliary relationships

The variable of interest in this note is the representative agent's level of welfare. Under the Pareto assumption, we have

$$W_i = \theta(\sigma-1)^{\rho} \sum_j m_{ji} M_j \left(\frac{f_{ji}}{\tau_{ij}}\varphi_{ji}^*\right)^{\rho}. \tag{5}$$

In contrast to tariffs, non-tariff barriers appear directly in this expression. To sign changes of W_i, we need to pin down changes in cutoffs φ_{ji}^*.

In the presence of tariffs, aggregate expenditure E_i relevant for welfare is

$$E_i = \sum_{j\in\{H,F\}} t_{ij} M_j \bar{r}_{ji} = \sigma\theta M_i w_i \sum_{j\in\{H,F\}} t_{ij} m_{ij} f_{ij}, \tag{6}$$

where $\bar{r}_{ij} = \sigma\theta w_i m_{ij} f_{ij}$ denotes average revenues that a firm in i makes on market j. The second equality in (6) follows balanced trade, $M_i \bar{r}_{ij} = M_j \bar{r}_{ji}$, which is implied by agents being on their budget constraints.

Finally, different to the case of non-tariff barriers, equilibrium welfare will turn out to depend on both, the share of revenues earned domestically, α_i, and the share of expenditure spent on domestic varieties, $\tilde{\alpha}_i$:

$$\alpha_i \equiv \frac{M_i \bar{r}_{ii}}{M_i \bar{r}_{ii} + M_i \bar{r}_{ij}} = \frac{1}{1 + m_{ij}(f^x/f^d)}; \tilde{\alpha}_i \equiv \frac{M_i \bar{r}_{ii}}{M_i \bar{r}_{ii} + t_i M_j \bar{r}_{ji}} = \frac{1}{1 + t_i m_{ij}(f^x/f^d)}. \quad (7)$$

Importantly, $\tilde{\alpha}_i < \alpha_i$. Without tariffs, $\tilde{\alpha}_i = \alpha_i$.

3. Unilateral trade liberalization

We study the effect of a reduction in a given import tariff t_H and of a lower non-tariff import barrier τ_H on welfare in Home and Foreign.[3] In contrast to models with a linear outside sector, Home's relative wage $\omega \equiv w_H/w_F$ is free to adjust. After characterizing endogenous wage adjustment in the presence of tariff income, we derive the general equilibrium effects of unilateral trade liberalization on both countries' welfare.

3.1 Endogenous wage adjustment

To prepare the comparative statics, we totally differentiate the above equations, using the traditional 'hat' notation $\hat{x} \equiv dx/x$. Using Home's import cutoff condition (1) relative to its domestic cutoff condition, and totally differentiating, one obtains

$$\rho \left(\hat{\varphi}^*_{FH} - \hat{\varphi}^*_{HH} \right) + \hat{\omega} = \hat{t}_H + \rho \hat{\tau}_H. \quad (8)$$

Changes in tariffs or transportation costs can be absorbed by adjustment in cutoffs or the wage rate.

Home's export cutoff condition relates the change in the wage rate to changes in its export cutoff and foreign aggregate variables

$$\hat{\omega} = \rho \hat{\varphi}^*_{HF} + \rho \hat{P}_F + (1 - \rho) \hat{E}_F. \quad (9)$$

Foreign's price index can be written in exactly the same variables as (9)

$$\hat{P}_F = \frac{1 - \tilde{\alpha}_F}{\theta - 1 + \tilde{\alpha}_F} \hat{\varphi}^*_{HF} - \frac{\tilde{\alpha}_F}{\theta - 1 + \tilde{\alpha}_F} \frac{\hat{E}_F}{\sigma - 1} + \frac{(1 - \tilde{\alpha}_F)(\theta - 1)}{\theta - 1 + \tilde{\alpha}_F} \hat{\omega}, \quad (10)$$

where Foreign's domestic entry cutoff condition $\hat{\varphi}^*_{FF} = -\hat{P}_F - \hat{E}_F / (\sigma - 1)$ has been used. If tariff revenue melts away as in Ossa (2011), a tariff reform has no direct effect on aggregate income. Then, equation (9) simplifies to $\hat{\omega} = \beta / \left(1 - \tilde{\alpha}_F + \beta \tilde{\alpha}_F / \rho\right) \hat{\varphi}^*_{HF}$. With tariff revenue, this is no longer true. Differentiating (6) and using balanced trade,

$$\hat{E}_F = -\beta \hat{\varphi}^*_{FF} + (1 - \tilde{\alpha_F}) \hat{m}_{FH} = -\beta \frac{\alpha_F - \tilde{\alpha}_F}{\alpha_F} \hat{\varphi}^*_{FH} = -\beta \frac{\alpha_F - \tilde{\alpha}_F}{\alpha_F} \left(\hat{\varphi}^*_{HF} - \frac{\hat{\omega}}{\beta} \right), \quad (11)$$

where the second equality follows from balanced trade, $\hat{\omega} - \beta \hat{\varphi}^*_{HF} = -\beta \hat{\varphi}^*_{FH}$.

Equations (10) and (11) allow to rewrite (9) as a function of Home's export cutoff only

$$\hat{\omega} = \xi \hat{\varphi}^*_{HF}, \text{ where } \beta > \xi \equiv \frac{\beta \rho}{\rho + \alpha_F (\beta - \rho)} > \rho. \quad (12)$$

Hence, if an exogenous change in t_H or τ_H increases φ^*_{HF}, Home's wage relative to Foreign's must go up.

[3] Whenever convenient, we write t_H and τ_H for t_{HF} and τ_{HF}.

3.2 Welfare effects

Using (12), balanced trade, and the totally differentiated free entry condition $\hat{\varphi}^*_{ii} = -(1-\alpha_i)\hat{\varphi}^*_{ij}/\alpha_i$, Home's relative import cutoff condition (8) implies

$$\hat{\varphi}^*_{FH} = \kappa\left(\hat{t}_H + \rho\hat{\tau}_H\right), \text{ where } \kappa \equiv \left(\rho + \frac{\beta\rho}{\beta-\xi}\left(\frac{\xi}{\rho} + \frac{1-\alpha_H}{\alpha_H}\right)\right)^{-1} > 0. \tag{13}$$

Since balanced trade together with (12) implies a positive link between both export (import) cutoffs, $\hat{\varphi}^*_{HF} = \beta\hat{\varphi}^*_{FH}/(\beta-\xi)$, Foreign's import cutoff goes up, too. By free entry, domestic cutoffs move in the opposite directions.

Totally differentiating (5), using the labor market clearing conditions to replace M_j and the free entry conditions to substitute out φ^*_{ii}, the change in welfare is

$$\hat{W}_i = \frac{\beta-\rho}{\beta}\left[-\beta\frac{\alpha_i-\tilde{\alpha}_i}{\alpha_i} + \xi A_i\right]\hat{\varphi}^*_{HF} - (1-\tilde{\alpha}_i)\rho\hat{\tau}_{ij}, \tag{14}$$

where $A_H = 1-\tilde{\alpha}_H > 0$ and $A_F = -(1-a_F)\tilde{\alpha}_F/a_F < 0$. In contrast to tariffs, τ_H directly appears in Home's utility function (5) due to its resource saving effect.

Let $\hat{\tau}_H = 0$ and consider a tariff reform. If initially $t_H = 1$, $\alpha_H - \tilde{\alpha}_H = 0$. Hence, $\hat{W}_H/\hat{t}_H > 0$ for a 'small' tariff (either revenue-generating or 'wasteful').[4] In contrast, we always have $\hat{W}_F/\hat{t}_H < 0$.

Now, fix $t_H = 1$ and consider a unilateral liberalization of Home's non-tariff import barriers. τ_H has no direct effect on W_F. Noting $\hat{\varphi}^*_{FH}/\hat{\tau}_H > 0$ and the positive link between both export cutoffs implied by balanced trade, we have $\hat{W}_F/\hat{\tau}_H < 0$. Using the same relationships and $A_H = 1-\tilde{\alpha}_H$ in $\hat{W}_H$, one obtains $\hat{W}_H/\hat{\tau}_H < 0$. The result follows from $(\beta-\rho)\kappa\xi/(\beta-\xi) = [1+\beta\rho/\alpha_H(\beta-\rho)]^{-1} < 1$.

We may summarize:

Proposition 1 *In a two-country Melitz (2003) model with Pareto-distributed productivities, unilateral liberalization of a 'small' ad valorem import tariff lowers welfare of the liberalizing country and raises welfare of its trading partner, while a unilateral reduction of non-tariff import barriers always benefits both countries.*

So, lower non-tariff import barriers do not immiserize the liberalizing country or its trade partner.[5] This is in contrast to Demidova (2008) or Melitz & Ottaviano (2008) where wages are technologically fixed. A unilateral reduction of the tariff can hurt the liberalizing country.[6] In Ossa's (2011) model, due to the linear outside sector, without modeling tariff income, unilateral reduction of tariffs always lowers Home's welfare.

Note that tariffs are unimportant for the welfare effects of lower iceberg trade costs. As equation (14) shows, lower unilateral iceberg costs increase welfare in both countries even in the total absence of tariff income. So, mutual welfare gains do not depend

[4] Our analysis shows that there exists a finite positive optimal tariff in a one-sector Melitz (2003) model. This generalizes Demidova & Rodriguez-Clare (2009) who study the small economy case. It also summarizes Ossa (2011) who studies a wasteful tariff in a model with a linear outside sector.

[5] Demidova & Rodriguez-Clare (2011) have already shown the welfare effects for Home, albeit in a setup without tariffs; the proof for Foreign is new.

[6] Demidova & Rodriguez-Clare (2009) show the existence of an optimal tariff in the *small* economy Melitz model. Our results pertain to a world of two large countries. Felbermayr, Jung & Larch (2012) study tariff wars in the Melitz model.

on increased imports generating higher tariff revenue. Rather, they materialize because import thresholds are, in general equilibrium, linked through the balanced trade requirement. The firm relocation effect, the key mechanism of the Melitz & Ottaviano (2008) model, is also at work in the present model. However, it is completely neutralized by wage adjustment and therefore has no bearing on equilibrium allocations and outcomes. In the Melitz & Ottaviano (2008) economy, it is the absence of wage adjustment that makes immiserizing a possible outcome: given relative wages, firms relocate into the relatively more protected market from where they serve the liberalized economy. However, in the Melitz-Pareto model, the wage adjustment is exactly such that the relocation channel is compensated.

Finally, note that our results qualitatively carry over to the Krugman (1980) model which is nested by our setup for $\beta \to \sigma - 1$.[7] This implies that the trade policy effects in the Melitz (2003) model with Pareto-distributed productivities are very similar to those of the model without firm-level heterogeneity. Of course, this does not imply that given changes in tariffs or trade costs yield quantitatively identical welfare effects. Rather, as shown by Arkolakis, Costinot & Rodriguez-Clare (2012) in the absence of tariff revenue, if some variation in trade costs induces the same change in openness, welfare effects are similar conditional on the trade cost elasticity obtained from a gravity model. Felbermayr, Jung & Larch (2012) show that, if variation in openness is due to revenue-generating tariffs, the optimal tariff formula in the Melitz (2003) model cannot simply be written as a function of measured openness and the trade cost elasticity. The reason lies in the fact that tariffs redistribute income across countries and this gives additional leverage to the selection effect original to models with firm-level heterogeneity.

[7] See Burstein & Vogel (2011).

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