Trade and Welfare: Does industrial organization matter?

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Abstract

Many contemporary theoretic studies of trade over geography reduce to an examination of constant-elasticity reactions to changes in *iceberg* trade costs. Given that we can get constant elasticity reactions out of a simple constant-returns model based on the Armington (1969) assumption of regionally differentiated goods, is all of the attention on industrial organization and trade worthwhile? We follow the work of Arkolakis et al. (2008) to show the surprising result that industrial organization does not matter. We show, however, that this result is fragile, and with a slight generalization to the standard theoretic setup the rich industrial-organization features of the popular Melitz (2003) model do, in fact, generate important differences for trade and welfare.

1 Introduction

Arkolakis et al. (2008) show that, given appropriate parameterization to match trade responses, many contemporary theoretic models of trade over geography generate equivalent gains from trade. We can push this result further to show equivalence between a model based on the Melitz (2003) theory of heterogeneous firms and a simple constant-returns model based on the Armington (1969) assumption of trade in regional aggregates. We show, however, that this result is quite fragile. Simply adding one additional sector that competes

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for factor services breaks the equivalence. That is, if the elasticity of factor supply to the traded sector is other than zero the models will *not* yield equivalent impacts on trade and welfare.

2 Models

We compare the results of trade cost removal across a Melitz (2003) based model and an Armington (1969) based model with equivalent treatments of factor supply. In our simulations we include three regions (indexed by r or s) each with an endowment of labor that can be used in a traded sector or directly consumed in utility (which is the same as having a second constant-returns sector that just uses labor). The trade theories are well developed in the literature, so we simply present our notation and the equilibrium conditions for each model. The theory presented by Arkolakis et al. (2008) is a special case of the Melitz model when we parameterize it such that the implied factor-supply elasticity to the traded sector is zero.[1] Tables 1 and 2 define our notation, and the algebraic formulation of the alternative models is presented in Table 3.

Given the initial conditions and values of the fixed parameters, the calibration parameters for the Melitz model are determined by inverting the equilibrium conditions. The Armington distribution parameters (the ξ_{rs}) are calculated such that the Armington and Melitz models have identical benchmark trade flows.

In the calibration we choose labor and welfare units such that the initial wages and true-cost-of-living indexes are one; $w_r^0 = e_r^0 = 1$ (where the superscript indicates the benchmark equilibrium). This is a convenient choice because it simplifies our calculation of the elasticity of labor supply available to the traded sector of the economy. The relevant residual labor

[1] Either the share of the non-traded sector can be set to zero, or the top-level elasticity of substitution between the traded and non-traded goods can be set to one, in order to generate perfectly inelastic labor supply to the traded sector.

Table 1: Variables

		Melitz	**Armington**
Welfare:	W_r	✓	✓
Unit expenditure index:	e_r	✓	✓
Price index on traded composite:	P_r	✓	✓
Nominal demand for traded composite:	V_r	✓	✓
Number of entered firms:	M_r	✓	
Number of operating firms:	N_{rs}	✓	
Average-firm revenues:	$\tilde{r}_{rs}$	✓	
Average-firm price:	$\tilde{p}_{rs}$	✓	
Average-firm productivity:	$\tilde{\varphi}_{rs}$	✓	
Wage:	w_r	✓	✓
Nominal income:	Y_r	✓	✓

Table 2: Parameters

Fixed parameters:			
Pareto shape parameter:	a	$=$	3.4
Pareto lower support:	b	$=$	0.2
Substitution elasticity Melitz varieties:	σ_M	$=$	3.8
Substitution elasticity Armington varieties:	σ_A	$=$	4.4 $(= a + 1)$
Probability of firm death:	δ	$=$	0.05
Value share of traded sector:	γ	$=$	0.5
Labor endowment	$\bar{L}$	$=$	2/3
Instruments:			
Iceberg trade-cost factor:	τ_{rs}		
Top-level substitution elasticity between traded and non-traded goods:	α		
Assumed initial conditions:			
Benchmark home-market trade cost factor:	τ_{rr}^0	$=$	1.0
Benchmark external-market trade cost factor:	τ_{rs}^0	$=$	2.0 $(\forall r \neq s)$
Benchmark number of entered firms:	m_r^0	$=$	10
Benchmark number of operating home firms:	n_{rr}^0	$=$	9.5
Benchmark number of operating export firms:	n_{rs}^0	$=$	0.6 $(\forall r \neq s)$
Calibrated parameters:			
Fixed operating-cost on r to s link:	f_{rs}		
Fixed cost of productivity draw:	f_r^e		
Preference weight on traded sector:	ψ_T		
Preference weight on non-traded sector:	ψ_L		
Armington bilateral CES weights:	ξ_{rs}		

Table 3: Algebraic Conditions

	Melitz	**Armington**	(eq.)
Top-level unit expenditure function:[a]			
$e_r = \left(\psi_T P_r^{1-\alpha} + \psi_L w_r^{1-\alpha}\right)^{1/(1-\alpha)}$	✓	✓	(1)
Price index on traded aggregate:			
$P_r = \left(\sum_s N_{sr} \tilde{p}_{sr}^{1-\sigma_M}\right)^{1/(1-\sigma_M)}$	✓		(2a)
$P_r = \left(\sum_s \xi_{sr} (\tau_{sr} w_s)^{1-\sigma_A}\right)^{1/(1-\sigma_A)}$		✓	(2b)
Nominal demand for traded aggregate:			
$V_r = \psi_T Y_r \left(\frac{e_r}{P_r}\right)^{\alpha-1}$	✓	✓	(3)
Firm-level nominal demand:			
$\tilde{r}_{rs} = V_s \left(\frac{P_s}{\tilde{p}_{rs}}\right)^{\sigma_M-1}$	✓		(4)
Optimal pricing:			
$\tilde{p}_{rs} = \frac{w_r \tau_{rs}}{\tilde{\varphi}_{rs}(1-1/\sigma_M)}$	✓		(5)
Free entry:			
$w_r \delta f_r^e = \sum_s \frac{N_{rs}}{M_r} \frac{\tilde{r}_{rs}(\sigma_M-1)}{a\sigma_M}$	✓		(6)
Zero cutoff profits:			
$w_r f_{rs} = \frac{\tilde{r}_{rs}(a+1-\sigma_M)}{a\sigma_M}$	✓		(7)
Average productivity:			
$\tilde{\varphi}_{rs} = b\left(\frac{a}{a+1-\sigma_M}\right)^{1/(\sigma_M-1)} \left(\frac{N_{rs}}{M_r}\right)^{-1/a}$	✓		(8)
Labor market clearance:			
$\bar{L}_r = \psi_L \frac{Y_r}{e_r} \left(\frac{e_r}{w_r}\right)^{\alpha} + \delta f_r^e M_r + \sum_s N_{rs} \left(f_{rs} + \frac{\tau_{rs}\tilde{r}_{rs}}{\tilde{\varphi}_{rs}\tilde{p}_{rs}}\right)$	✓		(9a)
$\bar{L}_r = \psi_L \frac{Y_r}{e_r} \left(\frac{e_r}{w_r}\right)^{\alpha} + \sum_s \frac{\xi_{rs}\tau_{rs}V_s}{P_s} \left(\frac{P_s}{\tau_{rs} w_r}\right)^{\sigma_A}$		✓	(9b)
Nominal Income:			
$Y_r = w_r \bar{L}$	✓	✓	(10)
Welfare:			
$W_r = Y_r / e_r$	✓	✓	(11)

[a] If $\alpha = 1$ this reverts to the familiar Cobb-Douglas form.

supply function is given by

$$g(w_r) = \bar{L}_r - \psi_L \frac{Y_r}{e_r(w_r)} \left(\frac{e_r(w_r)}{w_r} \right)^{\alpha}, \tag{12}$$

which is derived from equation (9a). Substituting in the unit expenditure function and $Y_r = w_r \bar{L}_r$, and then calculating the elasticity evaluated at the benchmark ($w = e(w) = 1$), yields

$$\eta = (1 - \gamma)(\alpha - 1) = \frac{\alpha - 1}{2}. \tag{13}$$

So, we use the instrument, α, to control the implied labor supply elasticity. If we set $\alpha = 1$ then the elasticity is zero and we have a model that is consistent with Arkolakis et al. (2008).[2]

3 Experiment and Results

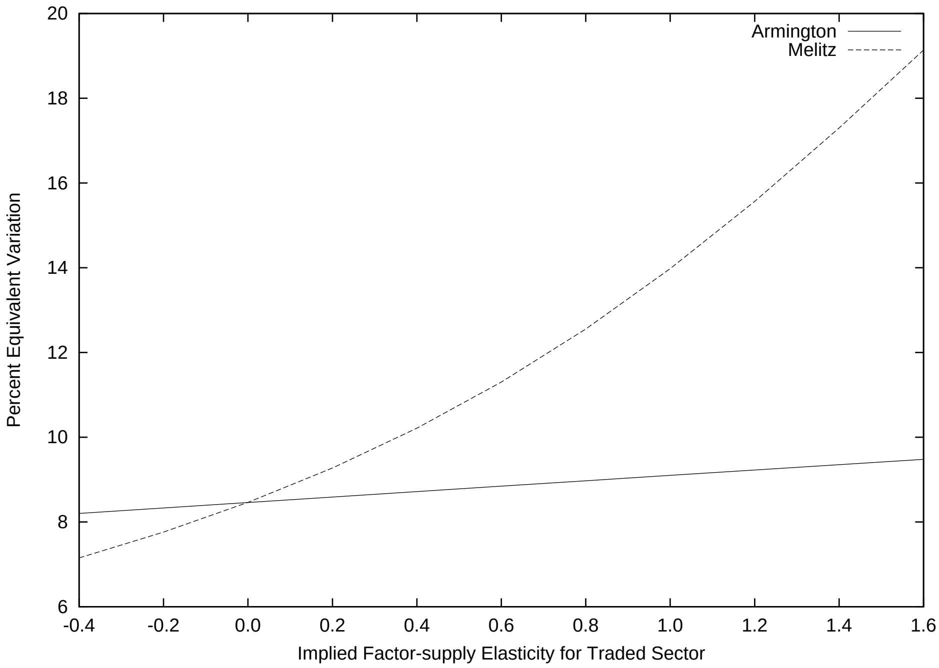
In order to compare the Armington versus Melitz models we compute a simple experiment where we remove iceberg trade costs between regions one and two.[3] Using the instrument α, we control the implied labor-supply elasticity (η) faced by the trade sectors. Setting the Armington elasticity as suggested ($\sigma_A = a + 1$), we find that the welfare impacts of removing the iceberg costs are different across the models, except in the special case that the implied labor-supply elasticity is exactly zero.

Figure 1 plots the region-1 welfare impact of the trade-cost removal as a function of the implied labor-supply elasticity. Notice that the welfare impacts are only equivalent at $\eta = 0$. The results for region 2 are identical to region 1, because of the symmetry built into our illustrative model. Figure 2 shows the welfare impacts on the third region for the same set

[2] We also ran experiments where we fixed $\alpha = 3$ and calibrated γ to the assumed labor-supply elasticity. Again, at values of η above zero the models did not generate the same results. It is only in the special case that $\gamma = 1$, as in the Arkolakis et al. (2008) environment, that equivalence between the Armington and Melitz models is obtained.

[3] The simulations are computed using GAMS software. All programs are available from the authors.

Figure 1: Region-1 welfare comparison ($\sigma_A = a + 1$)



of experiments. Although the curves in Figure 2 intersect twice, it is only at $\eta = 0$ that we have equivalence in the models across the multiregion equilibrium.

One key feature of the environment set up by Arkolakis et al. (2008) is that there is never any entry. Labor supply is perfectly inelastic so all of the adjustments in firm revenues and number of operating firms shows up in the wage. Changes in nominal entry costs are mirrored by changes in expected profits, so equation (6) is satisfied with no changes in M_r. The number of entered firms is unaffected by changes in iceberg costs, as long as $\eta = 0$. At $\eta \neq 0$ the wage only partially absorbs the adjustments in the industrial organization and M_r changes. In Table 4 we present the basic industrial organization in the Melitz model in the benchmark and in scenarios with different labor supply responses. At $\eta = 1$ we have entry as labor is drawn into the Melitz sector.

At $\eta = 0$ Table 4 shows the "anti-variety effect" emphasized by Baldwin and Forslid (forthcoming) and Arkolakis et al. (2008), where the new import varieties generated by trade

Figure 2: Region-3 welfare comparison ($\sigma_A = a + 1$)

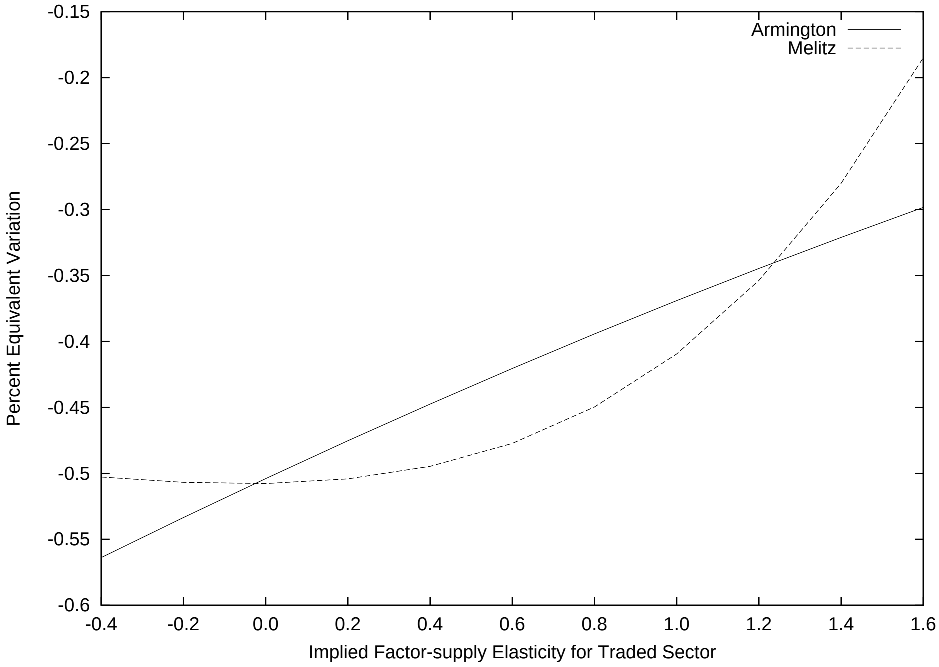


Table 4: Heterogeneous-firms model region-1 entry and consumption of varieties

		Benchmark	Scenario $\eta = 0$	Scenario $\eta = 1$
Entered Firms:	M_1	10.00	10.00	12.30
Varieties Consumed:	$N_{1,1}$	9.50	5.47	6.77
	$N_{2,1}$	0.59	3.61	4.47
	$N_{3,1}$	0.59	0.48	0.53
Total Varieties:	$\sum_r N_{r,1}$	10.69	9.55	11.77
Feenstra Ratio:	$(\lambda_1^1/\lambda_1^0)^{-1/(\sigma_M-1)}$		1.00	1.08

liberalization are more than offset by lost domestic varieties. Notice, however, that the total number of varieties consumed in region 1 goes from 10.69 in the benchmark to 11.77 in the scenario, when $\eta = 1$. The anti-variety effect is dominated when there is enough response in factor supplies. Feenstra (2009) emphasizes, however, that because these varieties enter the expenditure system at different prices we cannot simply count up varieties and infer variety gains or losses. Feenstra shows that variety gains, when comparing equilibriums t versus $t-1$, are given by deviations in the ratio $(\lambda_r^t/\lambda_r^{t-1})^{-1/(\sigma_M-1)}$ from unity, where λ_r^z represents region-r's share of expenditures at equilibrium z on goods available in both equilibria to the total expenditures at z. We confirm the Feenstra (2009) analytical result that there are no *import*-variety gains or losses in the Melitz structure (for the case that $\eta = 0$), but we find that the variety gains reemerge when we allow resources to be drawn into the Melitz sector.

To emphasize the fragility of the equivalence between the Armington and Melitz models we look at trade flows. In the case that $\eta = 0$ the trade patterns before and after the removal of trade costs are identical, but we can only match the multiregion trade flows in this special case. One might ask if the σ_A parameter can be set to match the trade reactions in the Melitz model when $\eta \neq 0$? The answer is no. As we adjust σ_A to match some of the Melitz-model trade flows the errors on other flows in the bilateral matrix become larger.

4 Conclusion

We agree with Arkolakis et al. (2008) that for the purposes of comparison, models should be parameterized so as to produce similar (and where possible equivalent) responses to trade cost reductions. In an important theoretic contribution Arkolakis et al. (2008) show, in a one sector model with heterogeneous-firms, that the new theories "do not really offer new gains from trade, given observed trade levels." In our simple comparison of Armington and Melitz formulations with iceberg trade costs, we set the Armington elasticity of substitution equal to one plus the Melitz Pareto-shape parameter. If the labor-supply elasticity faced by the traded sector is zero, the trade flow reactions and welfare impacts of trade-cost removal are identical across the Armington and Melitz models. We show, however, that this result is fragile. If the labor-supply elasticity is different than zero the industrial organization begins to matter. Firm entry and import variety effects become important if the labor-supply elasticity is not zero.

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