Working Paper

Trade and welfare: does industrial organization matter?

Author(s):
Balistreri, Edward J.; Hillberry, Russell H.; Rutherford, Thomas F.

Publication Date:
2009

Permanent Link:
https://doi.org/10.3929/ethz-a-005888527

Rights / License:
In Copyright - Non-Commercial Use Permitted
Trade and Welfare: Does Industrial Organization Matter?

Edward J. Balistreri, Russell H. Hillberry and Thomas F. Rutherford

Working Paper 09/119
September 2009

Economics Working Paper Series
Trade and Welfare:
Does industrial organization matter?

Edward J. Balistreri*  Russell H. Hillberry
Colorado School of Mines  University of Melbourne

Thomas F. Rutherford
ETH Zürich
September 2009

Abstract

Many contemporary theoretic studies of trade over geography reduce to an examination of constant-elasticity reactions to changes in iceberg trade costs. These impacts are readily analyzed in simple constant-returns models based on the Armington (1969) assumption of regionally differentiated goods. Following the line of reasoning suggested by Arkolakis et al. (2008) one can reach the surprising conclusion that industrial organization does not matter. In the present paper, we show that this finding is fragile, and with a minor elaboration of their model, the rich industrial-organization features of the popular Melitz (2003) model do, in fact, generate important differences for trade and welfare.

Keywords: Variety effects; Heterogeneous firms; Gains from trade
JEL classification: F1

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

*Corresponding author: Engineering Hall 311, Division of Economics and Business, Colorado School of Mines, Golden, CO 80401-1887, USA; email: ebalistr@mines.edu; voice: (303) 384-2156; fax: (303) 273-3416.
model based on the Melitz (2003) theory of heterogeneous firms and a simple constant-
We show, however, that this result is fragile. Addition of a second sector which competes 
for factor services breaks the equivalence. That is, if the elasticity of factor supply to 
the traded sector is larger than zero the models will produce divergent assessments of the 
impact of commercial policy on trade and welfare.

2 Models

Our analysis begins with two models calibrated to a common benchmark dataset, one 
model based on Melitz (2003) and another based on Armington (1969) as elaborated 
by Devarajan et al. (1993). In our simulations we include three regions (indexed by $r$ 
or $s$). Each region is endowed with a primary factor (labor) which can be used in a 
traded sector or directly consumed as leisure. Trade theories concerning these models are 
well developed in the literature, so we simply present our notation and the equilibrium 
conditions for each model. The theoretical setup employed 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.\footnote{Our setup is equivalent to having a second constant-returns sector which uses only labor. The labor 
supply elasticity to the traded sector is zero either when the value share of the non-traded sector is zero 
or when preferences are Cobb-Douglas.}

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 calibrated pa-
rameters of the Melitz model are found by inverting the equilibrium conditions. The 
Armington distribution parameters (the $\xi_{rs}$) 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; $w^0_r = e^0_r = 1$. This is a convenient choice because it
Table 1: Variables

<table>
<thead>
<tr>
<th></th>
<th>Melitz</th>
<th>Armington</th>
</tr>
</thead>
<tbody>
<tr>
<td>Welfare:</td>
<td>$W_r$</td>
<td>✓</td>
</tr>
<tr>
<td>Unit expenditure index:</td>
<td>$e_r$</td>
<td>✓</td>
</tr>
<tr>
<td>Price index on traded composite:</td>
<td>$P_r$</td>
<td>✓</td>
</tr>
<tr>
<td>Nominal demand for traded composite:</td>
<td>$V_r$</td>
<td>✓</td>
</tr>
<tr>
<td>Number of entered firms:</td>
<td>$M_r$</td>
<td>✓</td>
</tr>
<tr>
<td>Number of operating firms:</td>
<td>$N_{rs}$</td>
<td>✓</td>
</tr>
<tr>
<td>Average-firm revenues:</td>
<td>$\bar{r}_{rs}$</td>
<td>✓</td>
</tr>
<tr>
<td>Average-firm price:</td>
<td>$\bar{p}_{rs}$</td>
<td>✓</td>
</tr>
<tr>
<td>Average-firm productivity:</td>
<td>$\bar{\varphi}_{rs}$</td>
<td>✓</td>
</tr>
<tr>
<td>Wage:</td>
<td>$w_r$</td>
<td>✓</td>
</tr>
<tr>
<td>Nominal income:</td>
<td>$Y_r$</td>
<td>✓</td>
</tr>
</tbody>
</table>

Table 2: Parameters

**Fixed parameters:**
- Pareto shape parameter: $a = 3.4$
- Pareto lower support: $b = 0.2$
- Substitution elasticity Melitz varieties: $\sigma_M = 3.8$
- Substitution elasticity Armington varieties: $\sigma_A = 4.4 \ (= a + 1)$
- Probability of firm death: $\delta = 0.05$
- Value share of traded sector: $\gamma = 0.5$
- Labor endowment $\bar{L} = 2/3$

**Instruments:**
- Iceberg trade-cost factor: $\tau_{rs}$
- Top-level substitution elasticity between traded and non-traded goods: $\alpha$

**Assumed initial conditions:**
- Benchmark home-market trade cost factor: $\tau_{rr}^0 = 1.0$
- Benchmark external-market trade cost factor: $\tau_{rs}^0 = 2.0 \ (\forall r \neq s)$
- 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: $\psi_T$
- Preference weight on non-traded sector: $\psi_L$
- Armington bilateral CES weights: $\xi_{rs}$
Table 3: Algebraic Conditions

<table>
<thead>
<tr>
<th>Formula</th>
<th>Melitz</th>
<th>Armington</th>
<th>(eq.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top-level unit expenditure function:</td>
<td>✓</td>
<td>✓</td>
<td>(1)</td>
</tr>
<tr>
<td>[ e_r = (\psi_T P_r^{1-\alpha} + \psi_L w_r^{1-\alpha})^{1/(1-\alpha)} ]</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Price index on traded aggregate:</td>
<td>✓</td>
<td>✓</td>
<td>(2a)</td>
</tr>
<tr>
<td>[ P_r = (\sum_s N_{sr} P_{sr}^{-M_r})^{1/(1-\sigma_M)} ]</td>
<td>✓</td>
<td>✓</td>
<td>(2b)</td>
</tr>
<tr>
<td>Nominal demand for traded aggregate:</td>
<td>✓</td>
<td>✓</td>
<td>(3)</td>
</tr>
<tr>
<td>[ V_r = \psi_T Y_r \left( \frac{e_r}{P_r} \right)^{\alpha-1} ]</td>
<td>✓</td>
<td>✓</td>
<td>(4)</td>
</tr>
<tr>
<td>Firm-level nominal demand:</td>
<td>✓</td>
<td>✓</td>
<td>(5)</td>
</tr>
<tr>
<td>[ \tilde{r}<em>{rs} = V_s \left( \frac{P_s}{\tilde{p}</em>{rs}} \right)^{\sigma_{M_r}-1} ]</td>
<td>✓</td>
<td>✓</td>
<td>(6)</td>
</tr>
<tr>
<td>Optimal pricing:</td>
<td>✓</td>
<td>✓</td>
<td>(7)</td>
</tr>
<tr>
<td>[ \tilde{p}<em>{rs} = \frac{w_r \tau</em>{rs}}{\tilde{p}<em>{rs}(1-1/\sigma</em>{M_r})} ]</td>
<td>✓</td>
<td>✓</td>
<td>(8)</td>
</tr>
<tr>
<td>Free entry:</td>
<td>✓</td>
<td>✓</td>
<td>(9a)</td>
</tr>
<tr>
<td>[ w_r \delta f_r^c = \sum_s N_{rs} M_r \tilde{p}<em>{rs}(\sigma</em>{M_r}-1) ]</td>
<td>✓</td>
<td>✓</td>
<td>(9b)</td>
</tr>
<tr>
<td>Zero cutoff profits:</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>[ w_r f_{rs} = \tilde{p}<em>{rs}(\sigma</em>{M_r}-1) ]</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Average productivity:</td>
<td>✓</td>
<td>✓</td>
<td>(10)</td>
</tr>
<tr>
<td>[ \tilde{\varphi}<em>{rs} = b \left( \frac{a}{a+1-\sigma</em>{M_r}} \right)^{1/(\sigma_{M_r}-1)} \left( \frac{N_{rs}}{M_r} \right)^{-1/a} ]</td>
<td>✓</td>
<td>✓</td>
<td>(11)</td>
</tr>
<tr>
<td>Labor market clearance:</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>[ \bar{L}<em>r = \psi_L Y_r \left( \frac{w_r}{a} \right)^{\alpha} + \delta f_r^c M_r + \sum_s N</em>{rs} \left( f_{rs} + \frac{\tau_{rs} \tilde{p}<em>{rs}}{\psi_r \tilde{p}</em>{rs} \tilde{p}_{rs}} \right) ]</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Nominal Income:</td>
<td>✓</td>
<td>✓</td>
<td>(12)</td>
</tr>
<tr>
<td>[ Y_r = w_r L ]</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Welfare:</td>
<td>✓</td>
<td>✓</td>
<td>(13)</td>
</tr>
<tr>
<td>[ W_r = Y_r / e_r ]</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>

a If \( \alpha = 1 \) this reverts to the familiar Cobb-Douglas form.
simplifies our calculation of the elasticity of labor supply available to the traded sector of the economy. The relevant residual labor supply function is given by

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

(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

\[ \eta = (1 - \gamma)(\alpha - 1) = \frac{\alpha - 1}{2}. \]  

(13)

So, we use the instrument, \( \alpha \), 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 eliminate iceberg trade costs between regions one and two. Using the instrument \( \alpha \), we control the implied labor-supply elasticity (\( \eta \)) faced by the trade sectors. Setting the Armington elasticity as suggested by Arkolakis et al. (2008) \( (\sigma_A = a + 1) \), 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 reductions in trade-costs 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 of experiments. Although the curves in Figure 2 intersect twice, it is only

²We also ran experiments where we fixed \( \alpha = 3 \) and calibrated \( \gamma \) to the assumed labor-supply elasticity. Again, at values of \( \eta \) above zero the models did not generate the same results. It is only in the special case that \( \gamma = 1 \) is equivalence between the Armington and Melitz models is obtained.
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 the number of entered firms is unaffected by changes in iceberg costs. 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 $M_r$. At $\eta \neq 0$, however, 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) where the new import varieties generated by trade 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
Figure 2: Region-3 welfare comparison ($\sigma_A = a + 1$)

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

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

<table>
<thead>
<tr>
<th></th>
<th>Benchmark</th>
<th>Scenario $\eta = 0$</th>
<th>Scenario $\eta = 1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entered Firms:</td>
<td>$M_1$</td>
<td>10.00</td>
<td>10.00</td>
</tr>
<tr>
<td>Varieties Consumed:</td>
<td>$N_{1,1}$</td>
<td>9.50</td>
<td>5.47</td>
</tr>
<tr>
<td></td>
<td>$N_{2,1}$</td>
<td>0.59</td>
<td>3.61</td>
</tr>
<tr>
<td></td>
<td>$N_{3,1}$</td>
<td>0.59</td>
<td>0.48</td>
</tr>
<tr>
<td>Total Varieties:</td>
<td>$\sum_r N_{r,1}$</td>
<td>10.69</td>
<td>9.55</td>
</tr>
<tr>
<td>Feenstra Ratio:</td>
<td>$(\lambda_1^f/\lambda_1^u)^{-1/(\sigma_M-1)}$</td>
<td>1.00</td>
<td>1.08</td>
</tr>
</tbody>
</table>
supplies. Feenstra (forthcoming) 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
$\mathbf{t}$ versus $\mathbf{t} - 1$, are given by deviations in the ratio $(\lambda^t_r/\lambda^{t-1}_r)^{1/(\sigma M -1)}$ from unity, where
$\lambda^z_r$ 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 (forthcoming)
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 fundamental differences 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. One might think that $\sigma_A$ parameter can be set to match the
trade reactions in the Melitz model when $\eta \neq 0$, but this is not the case. If we adjust $\sigma_A$
to match some of the Melitz-model trade flows the errors on other flows in the bilateral
matrix become larger. (Norman (1990) reached a similar conclusion nearly 20 years ago.)

4 Conclusion

Arkolakis et al. (2008) analyze a single sector model with heterogeneous-firms and con-
cluded that new theories “do not really offer new gains from trade, given observed trade
levels.” We replicate this finding in comparing Armington and Melitz formulations with
iceberg trade costs. Provided that the labor supply elasticity is zero and the Armington
elasticity of substitution equal to one plus the Melitz Pareto-shape parameter, these mod-
els are identical. This result is, however, 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.
References


Feenstra, Robert C. (forthcoming) ‘Measuring the gains from trade under monopolistic competition.’ Canadian Journal of Economics


Working Papers of the Center of Economic Research at ETH Zurich

(PDF-files of the Working Papers can be downloaded at www.cer.ethz.ch/research).

09/119 E. J. Balistreri, R. H. Hillberry and T. F. Rutherford
Trade and Welfare: Does Industrial Organization Matter?

09/118 H. Gersbach, G. Sorger and C. Amon
Hierarchical Growth: Basic and Applied Research

09/117 C. N. Brunnschweiler

09/116 S. Valente
Optimal Policy and Non-Scale Growth with R&D Externalities

09/115 T. Fahrenberger
Short-term Deviations from Simple Majority Voting

09/114 M. Müller
Vote-Share Contracts and Learning-by-Doing

09/113 C. Palmer, M. Ohndorf and I. A. MacKenzie
Life’s a Breach! Ensuring ‘Permanence’ in Forest Carbon Sinks under Incomplete Contract Enforcement

09/112 N. Hanley and I. A. MacKenzie
The Effects of Rent Seeking over Tradable Pollution Permits

09/111 I. A. MacKenzie
Controlling Externalities in the Presence of Rent Seeking

09/110 H. Gersbach and H. Haller
Club Theory and Household Formation

09/109 H. Gersbach, V. Hahn and S. Imhof
Constitutional Design: Separation of Financing and Project Decision

09/108 C. N. Brunnschweiler
Oil and Growth in Transition Countries

09/107 H. Gersbach and V. Hahn
Banking-on-the-Average Rules

09/106 K. Pittel and D.T.G. Rübbelke
Decision Processes of a Suicide Bomber – Integrating Economics and Psychology

08/105 A. Ziegler, T. Busch and V.H. Hoffmann
Corporate Responses to Climate Change and Financial Performance: The Impact of Climate Policy
Endogenous Growth, Backstop Technology Adoption and Optimal Jumps

Characteristics of Terrorism

Taxation of Oil Products and GDP Dynamics of Oil-rich Countries

Accumulation Regimes in Dynastic Economies with Resource Dependence and Habit Formation

Disentangling Specific Subsets of Innovations: A Micro-Econometric Analysis of their Determinants

Increasing Returns to Scale and Welfare: Ranking the Multiple Deterministic Equilibria

Unifying time-to-build theory

International Emission Permit Markets with Refunding

Sectoral Heterogeneity, Resource Depletion, and Directed Technical Change: Theory and Policy

The Efficiency and Evolution of R&D Networks

Vote-Buying and Growth

Banking with Contingent Contracts, Macroeconomic Risks, and Banking Crises

Optimal taxation of a monopolistic extractor: Are subsidies necessary?

Optimal control of pollutants with delayed stock accumulation

Computation of Equilibria in OLG Models with Many Heterogeneous Households

Structural Estimation and Solution of International Trade Models with Heterogeneous Firms
08/88 E. Mayer and O. Grimm
Countercyclical Taxation and Price Dispersion

08/87 L. Bretschger
Population growth and natural resource scarcity: long-run development under seemingly unfavourable conditions

08/86 M. J. Baker, C. N. Brunnschweiler, and E. H. Bulte
Did History Breed Inequality? Colonial Factor Endowments and Modern Income Distribution

08/85 U. von Arx and A. Ziegler
The Effect of CSR on Stock Performance: New Evidence for the USA and Europe

08/84 H. Gersbach and V. Hahn
Forward Guidance for Monetary Policy: Is It Desirable?

08/83 I. A. MacKenzie
On the Sequential Choice of Tradable Permit Allocations

08/82 I. A. MacKenzie, N. Hanley and T. Kornienko
A Permit Allocation Contest for a Tradable Pollution Permit Market

08/81 D. Schiess and R. Wehrli
The Calm Before the Storm? - Anticipating the Arrival of General Purpose Technologies

08/80 D. S. Damianov and J. G. Becker
Auctions with Variable Supply: Uniform Price versus Discriminatory

08/79 H. Gersbach, M. T. Schneider and O. Schneller
On the Design of Basic-Research Policy

08/78 C. N. Brunnschweiler and E. H. Bulte
Natural Resources and Violent Conflict: Resource Abundance, Dependence and the Onset of Civil Wars

07/77 A. Schäfer, S. Valente
Habit Formation, Dynastic Altruism, and Population Dynamics

07/76 R. Winkler
Why do ICDPs fail? The relationship between subsistence farming, poaching and ecotourism in wildlife and habitat conservation

07/75 S. Valente
International Status Seeking, Trade, and Growth Leadership

07/74 J. Durieu, H. Haller, N. Querou and P. Solal
Ordinal Games

07/73 V. Hahn
Information Acquisition by Price-Setters and Monetary Policy