Quantitative International Trade: Making Use of New Findings

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- Our models should reflect our view of the economy as an equilibrium system.
- Working out an equilibrium system often requires keeping things very simple.
- But, with innovations in modeling we can have it both ways.
- Briefly discuss two examples where progress has been made.

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- But a gravity model is too mechanical.
- Need to build deviations from the law of one price into traditional models.
- Much recent progress on this front.

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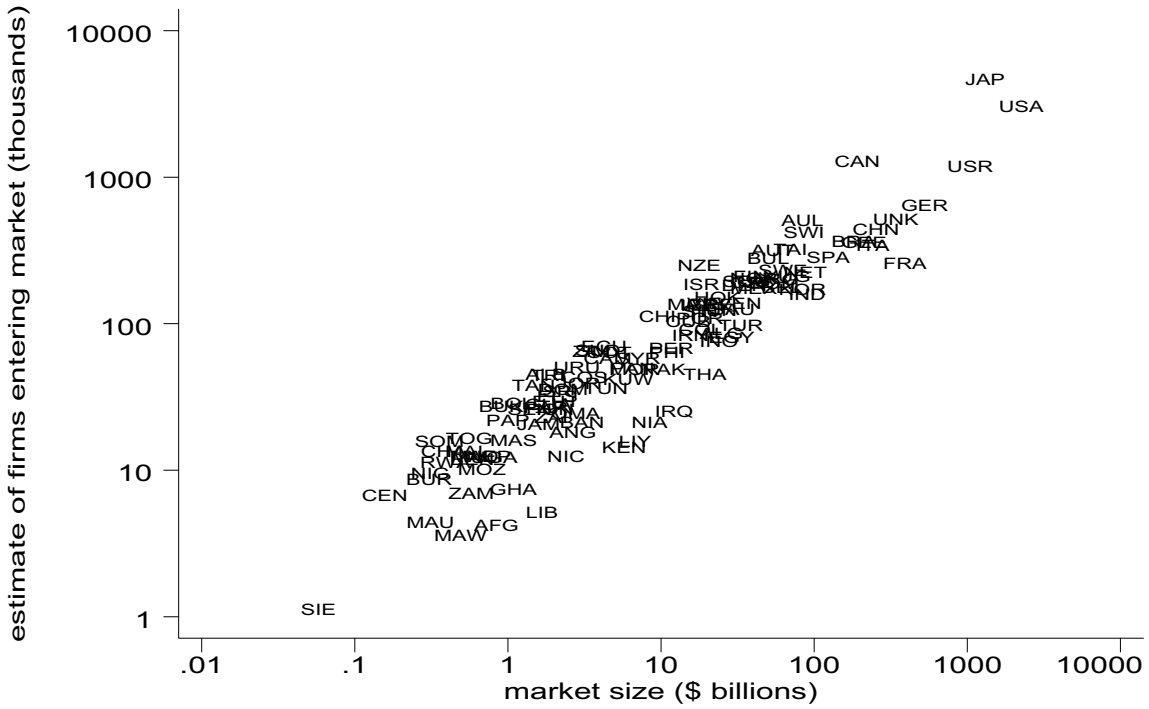
- But, its hard to abandon the simplicity of a representative firm.
- And, focussing too much on individual producers, its easy to lose track of aggregate adjustments at the heart of trade theory.
- But, heterogeneity is also at the heart of trade theory, i.e. comparative advantage.
- Even better, the same models that handle geography also handle firm heterogeneity.


estimate of firms entering market (thousands)
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market size ($ billions)
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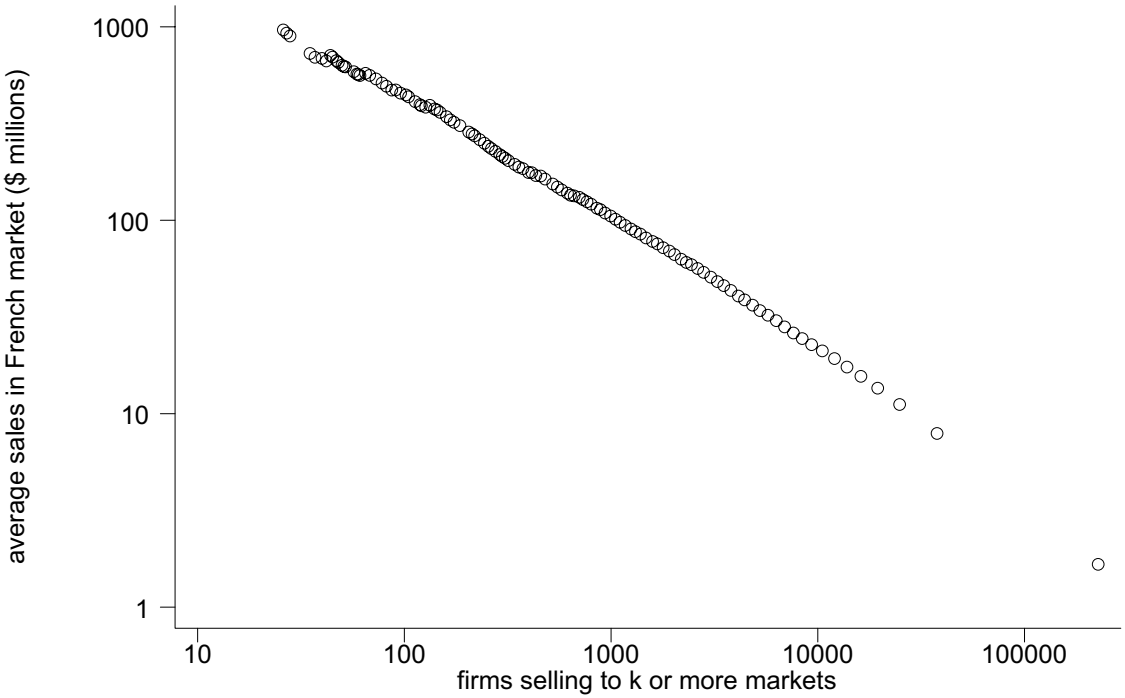
1000
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average sales in French market ($ millions)
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firms selling to k or more markets

Today's Goal

- Demonstrate a practical application of one such model.
- Calculate consequences of eliminating the US trade deficit for terms of trade and real wages.
- Discuss quantitative methods along the way.

Related Literature

- The "Transfer Problem" debated by Keynes, Ohlin and others.
- Dornbusch, Fischer, and Samuelson (1977) analysis in a 2-country Ricardian model (DFS).
- Series of papers by Obstfeld and Rogoff (2000, ..., 2005).
- Popular writings voicing concern that an adjustment of U.S. current account could be devastating.

Dornbusch, Fischer, and Samuelson

- Continuum of tradeable goods $z \in [0, 1]$.
- Cobb Douglas preferences: share $\alpha < 1$ allocated evenly over tradables.
- US and ROW(*), labor endowments L, L^*, wages w, w^*.
- Relative labor productivity in US $A(z)$, goods ordered so $A'(z) < 0$.
- Perfect competition.

Equilibrium

- Production condition: produce z in US iff $z \leq \bar{z}$.
- Yields a downward sloping curve:

$$\omega = \frac{w}{w^*} = A(\bar{z}).$$

- Market clearing condition:

$$\alpha(1-\bar{z})(wL+D) = \alpha\bar{z}(w^*L^* - D) + D.$$

- Yields an upward sloping curve:

$$\omega = \frac{\bar{z}}{1-\bar{z}}\frac{L^*}{L} + \frac{(1-\alpha)D}{\alpha(1-\bar{z})w^*L}.$$

- An equilibrium is a pair $(\omega, \bar{z})$ at the intersection of these two curves.

Effect of the Deficit

- Larger deficit D shifts up ω given $\bar{z}$.
- Results in higher equilibrium US relative wage ω and smaller range $\bar{z}$ of tradables produced in US.
- Production of tradables as a share of US GDP falls with higher deficit:

$$\lambda = \frac{\alpha \bar{z}(wL + w^* L^*)}{wL} = \alpha \bar{z} \left(1 + \frac{L^*}{\omega L}\right).$$

How Big Are These Effects?

- GDP's $Y = 13.2$, $Y^* = 34.0$, US exports $X = 1.4$, US imports $I = 2.2$, and deficit $D = 0.8$ (\$ trillions) in 2006.

- Share of US exports in ROW spending on tradables:

$$\alpha\bar{z} = \frac{X}{Y^* - D} = 0.04$$

- Share of ROW exports (US imports) in US spending on tradables:

$$\alpha(1 - \bar{z}) = \frac{I}{Y + D} = 0.16.$$

- Logic of the model implies $\alpha = 0.2$.

Parameterizing Productivity

- Parameterize $A(z)$ as in Eaton and Kortum (2002):

$$A(z) = \left(\frac{T}{T^*}\right)^{1/\theta} \left(\frac{1-z}{z}\right)^{1/\theta}.$$

- Thus,

$$\bar{z} = \frac{T\omega^{-\theta}}{T\omega^{-\theta} + T^*}.$$

- Labor requirements: $[A(z) = \frac{a^*(z)}{a(z)}]$, as:

$$a^*(z) = T^{*-1/\theta}(1-z)^{1/\theta},$$

and

$$a(z) = T^{-1/\theta} z^{1/\theta}.$$

- Yields exact price index for tradables in the US:

$$p = e^{-1/\theta} \left[T w^{-\theta} + T^* w^{*-\theta}\right]^{-1/\theta}.$$

Counterfactual

- Exogenous change of $D = 0.8$ to $D' = 0$. Given w^*, what happens to w? i.e to

$$\hat{w} = w'/w = \omega'/\omega = \hat{\omega}.$$

- Counterfactual GDP is $Y' = w'L = Y\hat{\omega}$ while $Y^{*'} = Y^*$.
- Trick to calculate counterfactual threshold good:

$$\bar{z}' = \frac{T\omega'^{-\theta}}{T\omega'^{-\theta} + T^*} = \frac{\bar{z}\hat{\omega}^{-\theta}}{\hat{\omega}^{-\theta} + (1 - \bar{z})}.$$

- Note that we didn't need to know T, T^*, or w (hence, don't need to know the skill of a nation's labor force).
- Just solve for $\hat{\omega}$ in

$$(1 - \bar{z}')Y\hat{\omega} = \bar{z}'Y^*.$$

Counterfactual (continued)

- Solves out as:

$$\hat{\omega} = \left(\frac{\bar{z} Y^*}{(1-\bar{z}) Y} \right)^{1/(1+\theta)} = \left(\frac{\frac{E}{Y^*-D} Y^*}{\frac{I}{Y+D} Y} \right)^{1/(1+\theta)}.$$

- The change in the US tradables price index can be written as

$$\frac{p'}{p} = \hat{p} = \left[\bar{z} \hat{\omega}^{-\theta} + (1-\bar{z}) \right]^{-1/\theta}.$$

- The change in the US overall price index is

$$\hat{P} = (\hat{p})^{\alpha} (\hat{w})^{1-\alpha}.$$

Results

- Set $\theta = 8.28$ (from EK (2002)).
- Solve for $\hat{\omega} = 0.96$, i.e. a 4% decline in the US relative wage.
- Change in the US price index for tradables is $\hat{p} = 0.99$ so that the change in the US real wage is $(\hat{\omega}/\hat{p})^{\alpha} = 0.99$.
- The counterfactual share of tradables in US GDP is $\lambda' = 0.18$, a 3 percentage point increase.

Beyond the 2-Country World

- Apply what we've learned from the analysis of bilateral trade among the countries of the world.
  - Unlike gravity tradition, ignore the usual suspects (distance, common language).
  - Instead, extract bilateral resistance parameters directly from bilateral trade shares.
  - Advantages: (i) clean and non-parametric and (ii) doesn't impose bilateral balance as would symmetric proxies.
- Demonstrate the critical distinction between adjustments in relative wages (potentially large) and adjustment to real wages (tiny).

Important Caveats

- Our exercise is pure comparative statics: we don't model how, why, or when adjustment of current accounts occurs.
- No attempt to model dynamics, with lower elasticities in the short run, as in Ruhl (2005).
- No attempt to introduce nominal rigidities, which play a major role in much of the current literature.
- Manufacturing does all the work: we hold fixed any non-manufacturing trade imbalances.

Basic Equations

- A world of N countries with n indexing an importer and i and exporter.
- Now have bilateral iceberg costs $d_{ni} \geq 1$ in shipping from i to n.
- Gravity equation (for example from Frechet distribution of efficiencies)

$$\pi_{ni} = \frac{T_i(c_i d_{ni})^{-\theta}}{\sum_{k=1}^{N} T_k(c_k d_{nk})^{-\theta}}$$

- Goods Market Clearing condition

$$Y_i^M = \sum_{n=1}^{N} \pi_{ni} X_n^M,$$

- Acknowledge deficits in manufacturing: $X_i^M = Y_i^M + D_i^M$,

Trade in Intermediates

- Let $\beta < 1$ be the value added share in producing manufactures.
- Assume a CES aggregator (with parameter σ) for manufactured goods used either as intermediates or as final consumption.
- Price index (in country n) for manufactures:

$$p_n = \gamma \left[\sum_{i=1}^{N} T_i (w_i^{\beta} p_i^{1-\beta} d_{ni})^{-\theta} \right]^{-1/\theta},$$

- New trade share equation:

$$\pi_{ni} = \frac{T_i (w_i^{\beta} p_i^{1-\beta} d_{ni})^{-\theta}}{\sum_{k=1}^{N} T_k (w_k^{\beta} p_k^{1-\beta} d_{nk})^{-\theta}},$$

Manufactures Within the Overall Economy

- Manufactures Share $\alpha < 1$ in the final consumption good.
- Aggregate expenditure:

$$X_i = Y_i + D_i = w_i L_i + D_i.$$

- Acknowledge trade in non-manufactured goods (oil, services) so that D_i need not equal D_i^M.
- Spending on manufactures:

$$X_n^M = \alpha X_n + (1 - \beta) Y_n^M.$$

Equilibrium

- Factor market clearing

$$w_i L_i + D1_i = \sum_{n=1}^{N} \pi_{ni} \left[w_n L_n + D2_n \right]$$

$$D1_i = D_i - \frac{1}{\alpha} D_i^M$$

$$D2_n = D_n - \frac{1-\beta}{\alpha} D_n^M$$

- price levels

$$p_n = \gamma \left[\sum_{k=1}^{N} T_k (w_k^{\beta} p_k^{1-\beta} d_{ni})^{-\theta} \right]^{-1/\theta}.$$

Equations for Counterfactual

- Factor market clearing

$$\widehat{w}_i Y_i + D1'_i = \sum_{n=1}^{N} \frac{\pi_{ni} \widehat{w}_i^{-\theta\beta} \widehat{p}_i^{-\theta(1-\beta)}}{\sum_{k=1}^{N} \pi_{nk} \widehat{w}_k^{-\theta\beta} \widehat{p}_k^{-\theta(1-\beta)}} \left(\widehat{w}_n Y_n + D2'_n\right)$$

$$D1'_i = D'_i - \frac{1}{\alpha} D_i^{M\prime}$$

$$D2'_n = D'_n - \frac{1-\beta}{\alpha} D_n^{M\prime}$$

- price levels

$$\widehat{p}_n = \left(\sum_{k=1}^{N} \pi_{nk} \widehat{w}_k^{-\theta\beta} \widehat{p}_k^{-\theta(1-\beta)} \right)^{-1/\theta}.$$

Implementation

- Set $\alpha = 0.188$, $\beta = 0.312$, and $\theta = 8.28$.
- Alvarez and Lucas (2006) prove there is a unique solution, and motivate a numerical algorithm to find it.
- Wage changes are normalized so that world GDP remains constant.

Table 1: Trade Imbalances

	current account		manufacturing trade balance	
	$ billions	% of GDP	actual	counterfactual
ChinaHK	85.6	4.1	121.8	36.2
France	-5.6	-0.3	-5.3	-0.3
Germany	103.0	3.8	209.5	106.5
Japan	173.3	3.7	277.0	103.7
United States	-664.0	-5.7	-484.6	179.4

Table 3: Changes that Eliminate Current Account Imbalances

	initial CA	implied changes		
	(% of GDP)	wage	real wage	welfare
ChinaHK	4.1	1.02	1.00	1.04
France	-0.3	1.00	1.00	1.00
Germany	3.8	1.03	1.00	1.04
Japan	3.7	1.04	1.00	1.04
United States	-5.7	0.93	0.99	0.94

Table 4: Actual and Counterfactual Bilateral Imbalance

	balance with U.S.		balance with China	
	actual	counterfactual	actual	counterfactual
ChinaHK	166.6	64.9		
France	1.2	-22.5	-11.3	-9.3
Germany	27.2	-30.8	-7.0	-8.6
Japan	84.4	-3.5	40.8	18.3
United States			-166.6	-64.9

Lessons

- Moderate changes in wages.
- Tiny changes in real wages.
- Substantial changes in trade flows and manufacturing shares.
- Some bilateral deficits persist.