Measured Aggregate Gains from International Trade

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Introduction

- New micro-level data in international trade
- New trade models to explain facts and answer new questions
- Did this agenda shape answers to key "aggregate" questions?
  - Implications of structural models for welfare gains from trade
  - This talk: measured aggregate gains from trade

Measured gains from trade in practice

- Empirical relationship between trade & real GDP
  - e.g. Frankel-Romer 1999, Rodriguez-Rodrik 2001, Feyrer 2009
- Aggregate productivity: role of reallocation between producers
  - e.g. Bernard and Jensen 1999, Pavnik 2002, Trefler 2004
- CPI bias due to increasing varieties and quality
  - e.g. Feenstra 94, Broda-Weinstein 06, Feenstra-Romalis 2012

Questions

- Impact of reduction in trade costs on aggregate productivity?
  - Sufficient statistics across models?
- Does CPI & real consumption capture welfare gains?
- Provide some answers within a class of baseline trade models
- Follow measurement procedures of BEA
- Kehoe-Ruhl (2010), Feenstra-Reinsdorf-Slaughter (2009), Burstein and Cravino (2013)

Roadmap

- Perfect competition and general production functions
  - Reductions in trade costs and aggregate productivity
  - Welfare, real consumption, real GDP
- "New" trade model: MC, endogenous varieties and quality
  - Sufficient statistics for aggregate productivity
  - Biases in consumption deflators vs. welfare price indices
- Quantitative applications, relate to empirical literature

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- Equilibrium allocations maximize profits given prices

$$\Pi_{it} = \max_{\{y_{in}(z),\, x_i(z)\}} \int_{\Omega_i} \sum_n p_{int}(z)\, y_{in}(z)/\tau_{int} - W_{it} x_i(z)\,\mathrm{d}z$$

$$\text{subject to} \left\{\sum y_{in}(z),\, x_i(z)\right\} \in Y_i(z) \text{ for all } z$$

Real GDP and Aggregate Productivity

- $GDP_{it} = \int_{\Omega_i} \sum_n p_{int}(z) y_{int}(z) / \tau_{int} \mathrm{d}z = W_{it} X_{it} + \Pi_{it}$

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  - $\lambda_{int_0}(z)$: revenue share at t_0

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- Plus tariff revenues evaluated at constant prices

Trade Costs and Aggregate Productivity

- $dlogA_{it} = \sum_n \int_{\Omega_i} \lambda_{int_0}(z)\, d\log\left(\frac{p_{int}(z)}{\tau_{int}\bar{p}_{int}(z)}\right) \mathrm{d}z$
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- Intuition: Δ productivity $\approx$ Δ profits at constant prices
  - Evaluated at initial prices, profits fall
  - Evaluated at final prices, profits rise
- Trade costs incurred domestically
  - $\bar{p}_{int}(z) = p_{int}(z) \Rightarrow d\log A_{it} = -\sum_n \lambda_{int_0} d\log \tau_{int}$
- **Aggregate productivity only captures, to a first order, changes in the domestic production set**

Baseline: Real Consumption and Welfare

- Real consumption: expenditures deflated by CPI
- Benchmark assumptions
  - Homothetic preferences
  - Set of available goods and product quality fixed over time
- Theoretical price index $\approx$ CPI
- Higher order terms from using fixed weights in CPI (substitution bias).

Real Consumption and Real GDP

- Abstract from other sources of final demand (e.g. investment)
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  - terms of trade

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- Real consumption $\neq$ real GDP
  - trade imbalances
  - terms of trade
- World as a whole is a closed economy
- Change in variable trade costs, up to first order:

$$\sum_i E_{it_0}\, dlogRC_{it} = \sum_i GDP^E_{it_0}\, dlogRGDP^E_{it}$$

$$\frac{1}{E_{wt_0}} \sum_i GDP^E_{it_0}\, dlogRGDP^E_{it} = -\frac{1}{E_{wt_0}} \times \sum_i \sum_n \text{Exports}_{int_0} \times d\log \tau_{in}$$

  - Independent of where trade costs incurred
  - World real GDP captures 1^{st} order effects of $\Delta\tau$ on welfare

"New" trade model

- Linear production functions: $y = zl$
- Variable trade costs incurred by exporter, same % of price for all i, n producers
- CES aggregator, monopolistic competition, constant markups

$$C_{nt} = \left[\sum_i \int_{\Omega_{int}} a_{int}(z)^{\frac{1}{\rho}} q_{int}(z)^{\frac{\rho-1}{\rho}} \, \mathrm{d}z \right]^{\frac{\rho}{\rho-1}}$$

- Endogenous Ω_{int}, labor fixed costs to sell per destination
- Endogenous $a_{int}(z)$, labor cost $h(z, a)$
- Constant aggregate profits / value added (e.g. free entry)

Measured Aggregate Productivity

- PPI non-quality adjusted prices: $\frac{p_{int}(z)}{p_{int-1}(z)} = \frac{\tau_{int}}{\tau_{int-1}} \frac{W_{it}}{W_{it-1}}$
- $\frac{PPI_{it}}{PPI_{it-1}} = \sum_n \bar{\lambda}_{int} \frac{\tau_{int}}{\tau_{int-1}} \frac{W_{it}}{W_{it-1}}$
  - $\bar{\lambda}_{int}$ revenue share of continuing goods
- $\frac{A_{it}}{A_{it-1}} = \frac{VA_{it}}{VA_{it-1}} \frac{1}{PPI_{it}/PPI_{it-1}}$, $VA_{it} = \bar{\kappa}_i W_{it} L_{it}$

$$\frac{A_{it}}{A_{it-1}} = \frac{1}{\sum_n \frac{\tau_{int}}{\tau_{int-1}} \bar{\lambda}_{int}}$$

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$$\frac{A_{it}}{A_{it-1}} = \frac{1}{\sum_n \frac{\tau_{int}}{\tau_{int-1}} \bar{\lambda}_{int}}$$

- PPI quality-adjusted prices:
  - Same expression, up to 1^{st} order, if $G \sim$ Pareto, $h = z^{\eta} a^{\gamma}$

Aggregate productivity and reallocation

- Standard productivity accounting:

$$\Delta A_i = \underbrace{\sum_{z \in Z_{cont}} \Delta \frac{rva_i(z)}{l_i(z)} \times \overline{\frac{l_i(z)}{L_i}}}_{\text{Own}} + \underbrace{\sum_{z \in Z_{cont}} \overline{\frac{rva_i(z)}{l_i(z)}} \times \Delta \frac{l_i(z)}{L_i}}_{\text{Reallocation}}$$
$$+ \underbrace{\sum_{z \in Z_{entry}} \frac{rva_{it}(z)}{l_{it}(z)} \frac{l_{it}(z)}{L_{it}}}_{\text{Entry}} - \underbrace{\sum_{z \in Z_{exit}} \frac{rva_{it-1}(z)}{l_{it-1}(z)} \frac{l_{it-1}(z)}{L_{it-1}}}_{\text{Exit}}$$

- Different variations of this decomposition, e.g. BJ 99 U.S., Pavnik 02 Chile, Trefler 04 Canada
  - Periods of large trade growth, "Reallocation" term large

Aggregate productivity decomposition

- Three specifications

1. Melitz with endogenous quality and cutoffs (all terms active)
2. Melitz with fixed quality and cutoffs (exit = 0)
3. Krugman (all firms the same, reallocation = 0)

- Two countries, trade shares 7% and 15%, trade elasticity = 3.5 (in i and iii), firm-size slope coefficient = 1.2, elasticity of exporters' quality to trade costs = 1.3 (in i)
- $\tau_t/\tau_{t-1} = 0.8$, trade volumes roughly double

Aggregate productivity decomposition

	Krugman	Melitz fixed	Melitz endog.
Aggr Prod. Fisher	0.26	0.20	0.26
Aggreg. product. $t_0 = 0$	0.15	0.16	0.16
% contribution:			
own	100%	94%	78%
reallocation	0	6%	99%
entry	0	0	0
exit	0	0	−77%

- Different composition, same total
  - Cannot conclude $\Uparrow$ A smaller in absence of reallocation

Measured productivity and variable markups

$$\frac{A_{it}}{A_{it-1}} = \frac{1 - \frac{Prof_{t-1}}{VA_{t-1}}}{1 - \frac{Prof_t}{VA_t}} \frac{1}{\sum_n \frac{\tau_{int}}{\tau_{int-1}} \frac{\overline{mkup_{int}}}{mkup_{int-1}} \bar{\lambda}_{int}}$$

- Reduction in Prof/VA reduces growth in measured productivity
  - Models in ACDR: Prof/VA unchanged
- Reduction in markups $\Uparrow$ measured productivity
  - $\Downarrow$ in trade costs: markups $\Uparrow$ for exporters, $\Downarrow$ for domestic

CPI versus Welfare-based price index

- So far, standard substitution bias
- New trade models:
  - Discontinued, newly produced, newly imported goods
  - Quality changes mismeasured in prices
- Next: CPI biases cancel-out, to a first order, at the world level
  - Country-by-country under stronger assumptions
  - With or without quality adjustment under stronger assumptions

Real consumption and welfare

- Assumptions
  - CES, CRS, $\frac{\text{Profits}}{\text{VA}}$ constant, $\frac{\text{trade cost}}{\text{price}}$ = all i,n producers
- Change in variable trade cost, up-to first order:

$$\sum_i E_{it_0}\, dlogRC_{it} = \sum_i E_{it_0}\, dlogC_{it}$$

$$= -\frac{1}{E_{wt_0}} \times \sum_i \sum_n \text{Exports}_{int_0} \times d\log \tau_{in}$$

- Envelope condition on firms' exit, export, and quality (Atkeson-Burstein 2010)

Real consumption and welfare: stronger assumptions

- Change in variable trade cost
- $G \sim$Pareto and $h = z^{\eta} a^{\gamma}$
  - World RC $\cong$ theoretical consumption whether prices in CPI quality adjusted or not
- Fixed costs, quality costs incurred in destination markets, $G \sim$ Pareto, $h = z^{\eta} a^{\gamma}$, TB/GDP constant (ACR Prop 2)
  - $\Delta RC_i \cong \Delta$theoretical C_i

Small ⇓ trade costs

- Fixed and quality-related costs use domestic labor

	Real consumption		
	$t_0 = 0$ wghts	$t_0 = 1$ wghts	Fischer
Small country	0.15	0.15	0.15
Large country	0.07	0.07	0.07
World	0.10	0.10	0.10
	Welfare		
Small country	0.16		
Large country	0.07		
World	0.10		

Large uniform ⇓ trade costs (doubling trade volumes)

	Real consumption		
	$t_0 = 0$ wghts	$t_0 = 1$ wghts	Fischer
Small country	0.17	0.35	0.27
Large country	0.07	0.15	0.12
World	0.10	0.21	0.16
	Welfare		
Small country	0.26		
Large country	0.11		
World	0.15		

- Substitution bias more important than varieties, quality biases

Adjusting price indices for quality and variety

	Marginal $\Downarrow \tau$	Large $\Downarrow \tau$
Real consumption		
No adjustments	0.15	0.27
All quality adjustment	0.16	0.29
Imports variety adjusted	0.20	0.35
Imports variety & quality adjustment	0.30	0.53
Welfare	0.16	0.26

- Measured real consumption closer to welfare if neither import nor domestic price indices adjusted for Δ in quality, variety

Taking stock

- Aggregate productivity
  - Captures shifts in domestic production possibility set, not changes in prices or trade costs incurred abroad
  - Sufficient statistics, different margins, same total
- Consumption deflators versus welfare-based price index
  - Δ variable trade cost: substitution bias more important than bias due to Δ varieties or mismeasured quality
  - Aggregate productivity captures 1st order effects of $\Delta\tau$ on welfare at world level, not country-by-country
  - Empirical link between trade and real GDP not likely to change much if consumption deflators used instead of output deflators, since these are highly correlated

Caution

- In using results on equivalence between RC and welfare to interpret in a welfare sense the observed relation between real consumption and trade in data
- Many restrictions underlying our results may not be met in practice (e.g. changes in trade shares are not only driven by changes in variable trade costs)
- Our results establishing theoretical benchmark under which real consumption is a good measure of welfare in response to trade liberalization
- Measurement procedures in individual countries may differ from US and recommended by UN