Trade Adjustment Dynamics and the Welfare Gains from Trade

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Fundamental questions

1. How big are the welfare gains from trade?

2. How big are trade barriers?

Advances in trade theory

- Producer-level heterogeneity
  - Eaton and Kortum (2002), Melitz(2003)
- Discrete-choice export decisions
  - Baldwin and Krugman (1989), Roberts and Tybout (1997)
  - Entry cost and continuation cost formulation
  - Exporting is a dynamic choice
- What have we learned?

Fundamental questions: The literature

1. How big are the welfare gains from trade?

- Not very big
- In “static” models: Firm heterogeneity not important (Arkolakis, Costinot, Rodriguez-Clare, 2012)

2. How big are trade barriers?

- Producer export entry costs are very large
- Significant fraction of entry cost is sunk

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2. How big are trade barriers?

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- Significant fraction of entry cost is sunk

- Missing: Connection between firm dynamics and the aggregate
  - Most GE models lack micro-founded aggregate dynamics
  - Most exporter dynamic models are PE

Our model

- GE model with producer-level export dynamics
- Keep standard sunk/fixed cost setup
- Introduce stochastic variable trade costs
  - Need time, resources, and luck to become an efficient exporter
  - Model: 3 years to turn profit, 5 years to break even
- Key tradeoff: accumulating varieties vs. exporters
- Plant-level data discipline aggregate dynamics

Fundamental questions: Our answers

1. How big are the welfare gains from trade?
   - Larger than steady-state changes
   - Gain 2.8X larger than no-micro-dynamics model
   - Gain 1.5X larger than sunk-cost model
   - Unilateral liberalization: Welfare gain, but s-s consumption falls
2. How big are trade barriers?
   - Entry costs are smaller than previous estimates
   - Sunk component substantially smaller
   - Total resources devoted to exporting are large

Overview

- Exporter dynamics facts
- Model
- Results
    - Estimates of export technology
    - Welfare in bilateral trade reform
    - Welfare in unilateral trade reform

Micro exporter facts

1. Not all plants export (22% in US)
2. Exporters are relatively large (5x larger)
3. Exporting is persistent (83% survival)

Micro exporter facts

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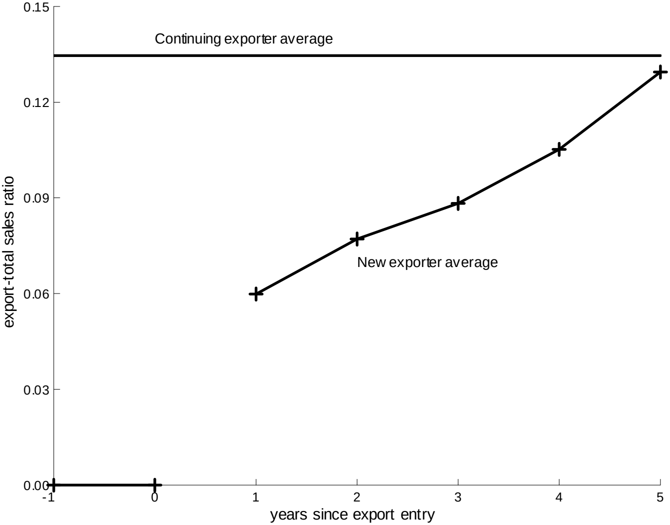
3. Exporting is persistent (83% survival)
4. New exporters start with low *export intensity*

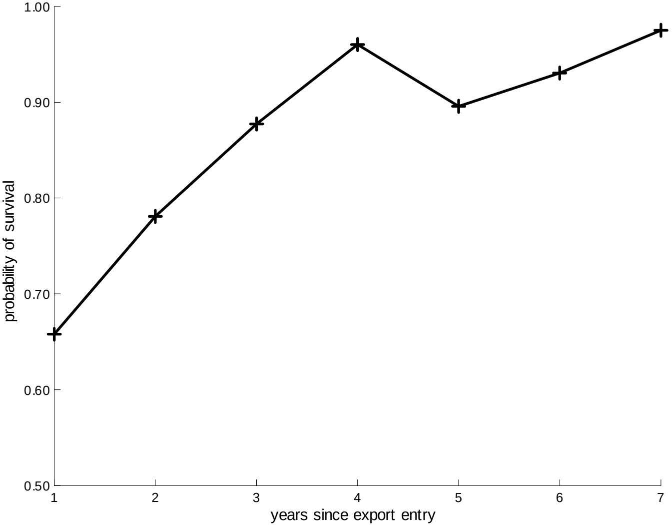
$$\text{exs}_{it} = \text{exports}_{it}/\text{total sales}_{it}$$

5. New exporters take time (5yrs) to get to average exporter levels
6. New exporters have high exit rates

Export intensity of Colombian exporters (Ruhl & Willis, 17)



Survival probability of Colombian new exporters (Ruhl & Willis, 17)



New exporter importance, growth, and survival

	End of sample		Starter size discount		Export survival	
	Part.	Exports	Sales	Intensity	All exporters	Starters
Chile (98–06)	56.7	39.2	0.53	0.45	0.81	0.65
Colombia (81–89)	57.2	38.4	0.41	0.46	0.90	0.66
Balanced panels						
Chile (98–06)	27.4	9.2	0.49	0.59	0.83	0.66
Colombia (81–89)	24.7	14.5	0.43	0.48	0.90	0.68
Compustat (84–92)	28.2	11.0	0.54	0.51	0.93	0.83
U.S.* (84–92)	42.0		0.4–0.6	0.55	0.66	

*Bernard and Jensen (1995, 1999, 2004)

Model

- General equilibrium, infinite horizon, 2 country $\{H, F\}$ model
- Idiosyncratic uncertainty, no aggregate uncertainty
- Heterogeneous plants producing differentiated tradable goods
  - Monopolistic competitors
  - Fixed export costs: startup and continuation
  - Plants are created: endogenous mass of firms
- Exporter life cycle: time to build demand/lower marginal export costs
- Final C/I good combines available differentiated tradables

Model

- Mass N_t, N_t^* differentiated H & F intermediates
- Each variety produced by 1 domestic-owned establishment
  - Idiosyncratic technology shocks: z, $\phi(z'|z)$
  - Fixed export cost: $f = \{f_H, f_L\}$ (paid in labor)
  - Iceberg costs: $\xi = \{\xi_L, \xi_H, \infty\}$
  - Establishment's state: $s = (z, \xi, f)$
  - Measure of establishments: $\varphi_{i,t}(z, \xi, f)$

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  - Establishment's state: $s = (z, \xi, f)$
  - Measure of establishments: $\varphi_{i,t}(z, \xi, f)$
- Free entry: hire f_E workers, draw $\phi_E(z)$ in $t+1$
- Exogenous survival: $n_s(z)$
- Timing: fixed costs paid 1 period in advance

Exporting technology

- A nonexporter
  - In current period: $\xi = \infty$
  - Can pay $f = f_H$ to begin exporting next period
  - If so, in next period: $\xi' = \xi_L$

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- An exporter
  - In current period: $\xi < \infty$
  - Can pay $f = f_L$ to continue exporting
  - If so, in next period: draw ξ' w prob. $\rho_\xi(\xi'|\xi)$
  - If not: exit raises cost to ∞

Exporting technology

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  - If so, in next period: draw ξ' w prob. $\rho_\xi(\xi'|\xi)$
  - If not: exit raises cost to ∞
- Our model: $\xi_H > \xi_L$, $f_H > f_L$
  - Das, Roberts, Tybout (2007): $\xi_H = \xi_L$, $f_H > f_L$
  - Ghironi and Melitz (2005): $\xi_H = \xi_L$, $f_H = f_L$
  - Krugman (1980) w/heterogeneity: $\xi_H = \xi_L$, $f_H = f_L = 0$

Consumer's problem

$$V_{C,0} = \max_{\{C_t, B_t, K_{t+1}\}} \sum_{t=0}^{\infty} \beta^t U(C_t)$$

$$C_t + K_{t+1} + Q_t \frac{B_t}{P_t} \leq W_t L_t + R_t K_t + (1-\delta) K_t + \Pi_t + T_t + \frac{B_{t-1}}{P_t},$$

- P_t, W_t denote price level & real wage
- Π_t sum of home country profits, T_t lump sum gov't transfers
- Foreign problem is analogous; foreign variables denoted by *

$$\begin{aligned} Q_t &= \beta \frac{U_{C,t+1}}{U_{C,t}} = \beta \frac{U^*_{C,t+1}}{U^*_{C,t+1}}, \\ 1 &= \beta \frac{U_{C,t+1}}{U_{C,t}} (R_{t+1} + 1 - \delta) = \beta \frac{U^*_{C,t+1}}{U^*_{C,t}} \left(R^*_{t+1} + 1 - \delta\right) \end{aligned}$$

Competitive final good producers

- Combine domestic and imported intermediates, produce goods for
  - Consumption, investment, and intermediate use

$$D_t = \left[\int_s y^d_{H,t}(s)^{\frac{\theta-1}{\theta}} \varphi_{H,t}(s)\, ds + \int_s y^d_{F,t}(s)^{\frac{\theta-1}{\theta}} \varphi_{F,t}(s)\, ds \right]^{\frac{\theta}{\theta-1}}$$

$$D_t = C_t + I_t + \int_s x(s) \varphi_{H,t}(s)\, ds$$

- Representative firm maximizes

$$\Pi_t = D_t - \int_s P_{H,t}(s)\, y^d_{H,t}(s)\, \varphi_{H,t}(s)\, ds - (1+\tau) \int_s P_{F,t}(s)\, y^d_{F,t}(s)\, \varphi_{F,t}(s)\, ds$$

- Generates standard input demand functions
- τ is a policy

Tradable producers

- Individual state is $s = (z, \xi, f)$
- Production Technology: $y_t(s) = e^z \left[k_t(s)^\alpha l_t(s)^{1-\alpha}\right]^{1-\alpha_x} x(s)^{\alpha_x}$
- Profit, $\Pi_t(s)$, is

$$\max_{P_H, P_H^*, l, k, x} P_{H,t}(s)\, y_{H,t}(s) + P_{H,t}^*(s)\, y_{H,t}^*(s) - W_t l_t(s) - R_t k_t(s) - P_t x_t(s)$$

$$\text{s.t. } y_t(s) = y_{H,t}^d(s) + (1+\xi)\, y_{H,t}^{d*}(s),$$

Export decision

$$V_t\left(z,\xi,f\right)=\max\left\{V_t^1\left(z,\xi,f\right),V_t^0\left(z,\xi,f\right)\right\}$$

$$\begin{aligned}V_t^1\left(z,\xi,f\right)=&\max\Pi_t\left(z,\xi,f\right)-W_tf\\&+n_s\left(z\right)Q_t\sum_{\xi'\in\{\xi_L,\xi_H\}}\int_{z'}V_{t+1}\left(z',\xi',f_L\right)\phi\left(z'|z\right)dz'\rho_\xi\left(\xi'|\xi\right)\end{aligned}$$

$$\begin{aligned}V_t^0\left(z,\xi,f\right)=&\max\Pi_t\left(z,\xi,f\right)\\&+n_s\left(z\right)Q_t\int_{z'}V_{t+1}\left(z',\infty,f_H\right)\phi\left(z'|z\right)dz'\end{aligned}$$

- With 3 iceberg costs there are three marginal firm types

Free entry

- Hire f_E workers to enter

- Draw technology $\phi_E(z)$, produce in $t+1$

$$V_t^E = -W_t f_E + Q_t E V_t(z, \infty, f_H)\,\phi_E(z) \leq 0$$

$\Rightarrow N_{TE,t}$ new establishments

Trade

- No simple relationship between parameters and trade elasticity
- Trade depends on tariff and distribution of plant types $\phi_{it}(z, \xi, f)$
- Lower tariff: increases export participation
- Lower tariff: increases duration in exporting, lowering ξ

Calibration: Aggregates

- Utility: $U(c) = \frac{c^{1-\sigma}}{1-\sigma}$

σ	IES	2
δ	Capital depreciation	0.10
β	Disounting	0.96
θ	Elasticity of substitution	5
τ	Tariff (Anderson and van Wincoop)	0.1
α_x	MFR gross output/MFR VA $= 2.8$	0.81
α	Capital share of income $= 34\%$	0.13

Calibration: Establishment heterogeneity

- Productivity

$$z' = \rho z + \epsilon \qquad \epsilon \sim N(0, \sigma_\epsilon^2)$$

- Initial productivity

$$z' = -\mu_E + \epsilon_E \qquad \epsilon_E \sim N\left(0, \frac{\sigma_\epsilon^2}{1-\rho^2}\right)$$

- Probability of exit

$$1 - n_s(z) = \max\{0, \min\{e^{-\lambda z} + n_{d0}, 1\}\}$$

- Export costs: two state Markov $\rho_{LL} = \rho_{HH}$
- Parameters $\left(f_L, f_H, \xi_L, \xi_H, \rho_{HH}, \lambda, n_{d0}, \mu_E, \rho, \sigma_\epsilon^2\right)$

Calibration: Establishment data

A. Exporter dynamics and characteristics:

1. Overall participation rate = 22.3 % (92 Census of Mfrs.)

2. Stopper rate = 17 % (ASM)

3. Initial export intensity 1/2 of avg. intensity (Ruhl&Willis 17)

4. 5 years to reach avg export intensity (Ruhl&Willis 17)

Calibration: Establishment data

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B. Establishment heterogeneity:

5. Entrant 5-yr survival 37 % (Dunne et al. 89)

6. Birth labor share =1.5 % (Davis, et al. 96)

7. Exit labor share = 2.3 % (Davis, et al. 96)

8. Establishment and employment distribution (92 Census)

9. Establishment exporter distribution (92 Census)

Overview

- Exporter dynamics facts
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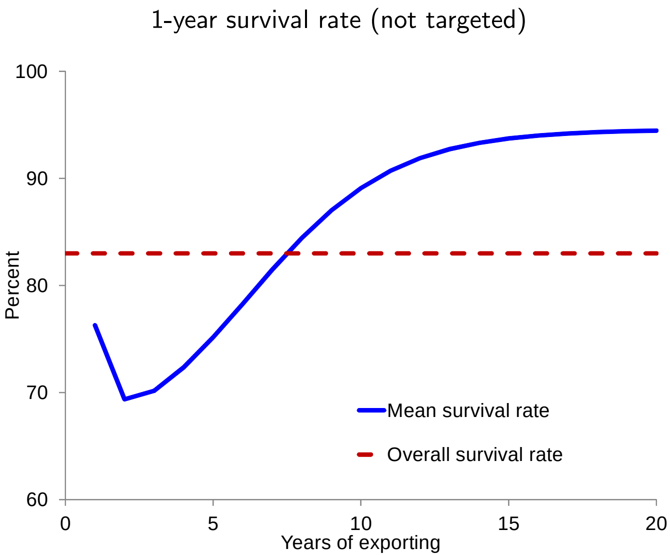
  - **Estimates of export technology**
  - Welfare in bilateral trade reform
  - Welfare in unilateral trade reform

Estimate of benchmark export technology

- Entry cost 40% larger than continuation cost: $f_H/f_L = 1.4$
- High iceberg cost 62% larger than low iceberg cost (1.72 vs. 1.07)
- Iceberg cost very persistent: $\rho\left(\xi_H|\xi_H\right) = 0.92$

Common parameters

	Benchmark	Sunk-cost
f_H/f_E	0.038	
f_L/f_E	0.027	
ξ_H	1.718	
ξ_L	1.070	
ρ_ξ	0.916	


1-year survival rate (not targeted)
100
90
80
70
60
Percent
0
5
10
15
20
Years of exporting
Mean survival rate
Overall survival rate

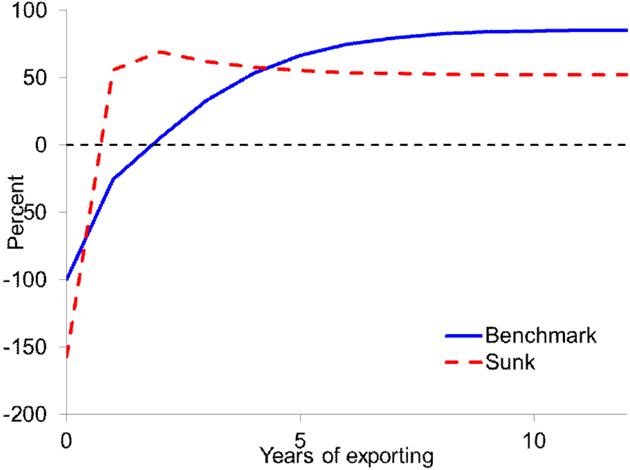
Alternative model: Sunk cost export technology

- Restriction: $\xi_H = \xi_L$

	Benchmark	Sunk-cost
f_H/f_E	0.038	0.058
f_L/f_E	0.027	0.015
ξ_H	1.718	1.430
ξ_L	1.070	1.430
ρ_ξ	0.916	1.000

- $f_H/f_L = 3.9$ vs. $f_H/f_L = 1.4$ in benchmark
- In benchmark model, high survival rate arises because producers don't want to go through growth process again — not sunk costs.

Profits of marginal starters: $\left(E\pi_{x,t} - f\right)/f_H^{bench}$



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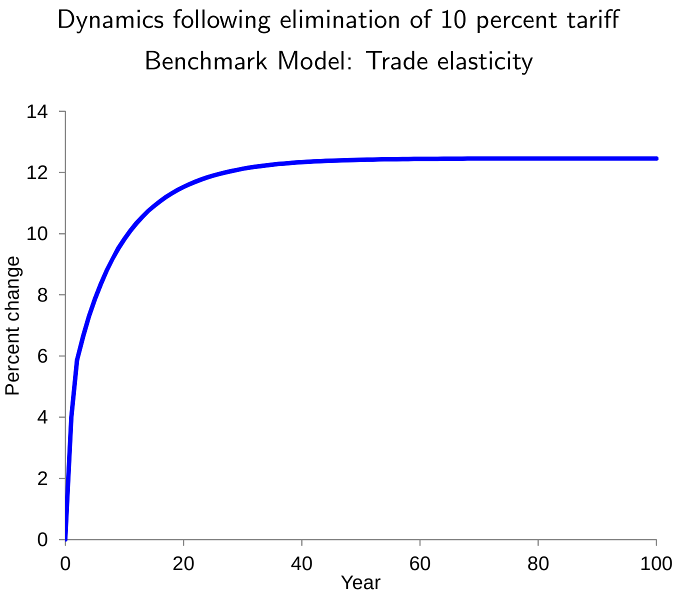
3 experiments

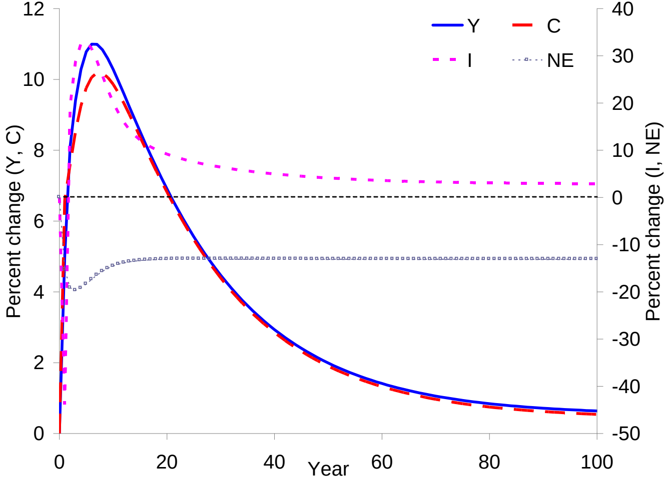
1. Benchmark: $\xi_H > \xi_L$, $f_H > f_L$
2. Sunk cost: $\xi_H = \xi_L$, $f_H > f_L$
3. No cost: $\xi_H = \xi_L$, $f_H = f_L = 0$

- Consider unanticipated global tariff reduction, $\tau = 0.1 \rightarrow \tau = 0$


Dynamics following elimination of 10 percent tariff
Benchmark Model: Trade elasticity
Percent change
Year
0
2
4
6
8
10
12
14
0
20
40
60
80
100

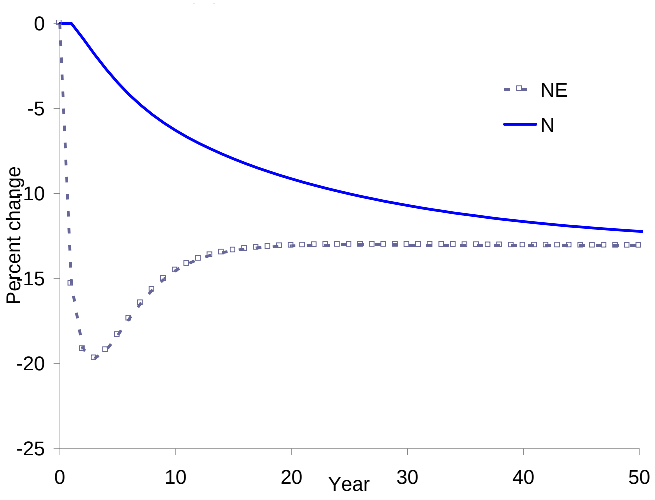
Dynamics following elimination of 10 percent tariff

Benchmark Model: Aggregate dynamics



Dynamics following elimination of 10 percent tariff

Benchmark Model: Aggregate dynamics



The benchmark model

Change	**Benchmark**	**Sunk-cost**	**No-cost**
Welfare gain	6.30		
Avg. trade elasticity ($\bar{\varepsilon}_t$)	10.2		
Δ SS. Consumption	0.42		
SS. Trade elasticity	11.5		

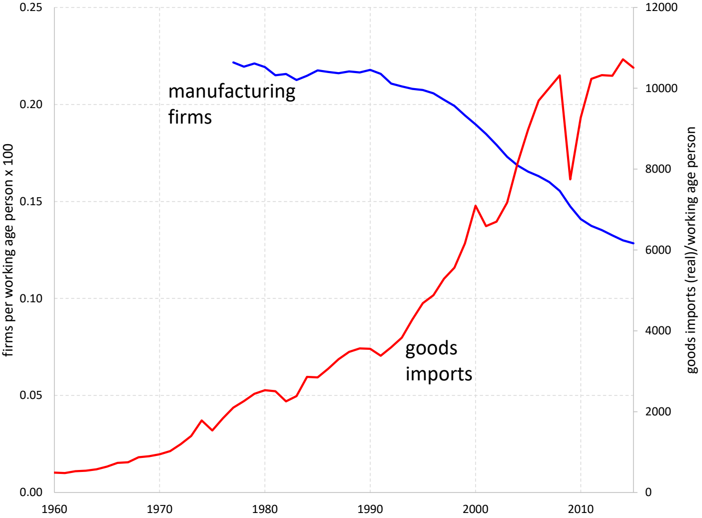
Welfare gain is x: $\sum_{t=0}^{\infty} \beta^t U\left(C_{-1} e^x\right) = \sum_{t=0}^{\infty} \beta^t U\left(C_t\right)$

$$\bar{\varepsilon}_t = (1-\beta) \sum_{t=0}^{\infty} \beta^t \varepsilon_t$$

Source of overshooting

- Tariffs lead to an overaccumulation of establishments relative to free trade steady state
- These establishments can be converted at a low cost to exporters
- Labor that would have gone to firm creation goes to production

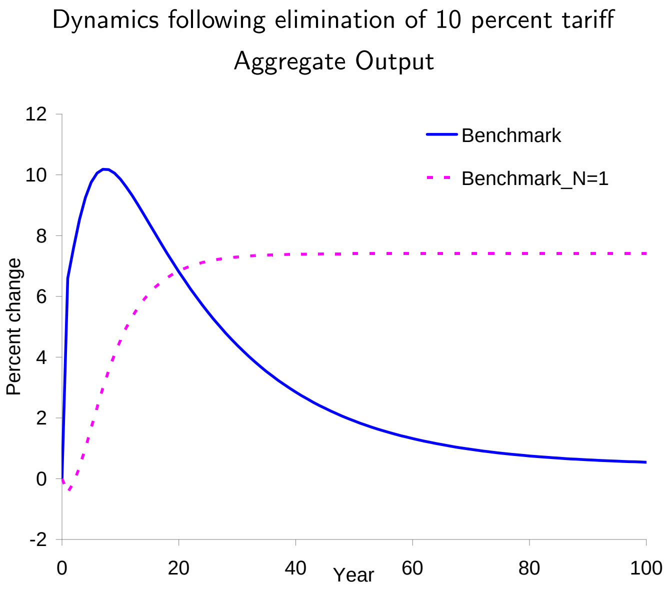
Firms in the United States



Source of overshooting

- Tariffs lead to an overaccumulation of establishments relative to free trade steady state
- These establishments can be converted at a low cost to exporters
- Labor that would have gone to firm creation goes to production

- Plant creation dynamics key to overshooting
- Experiment: subsidize entry so that $N_t = 1$



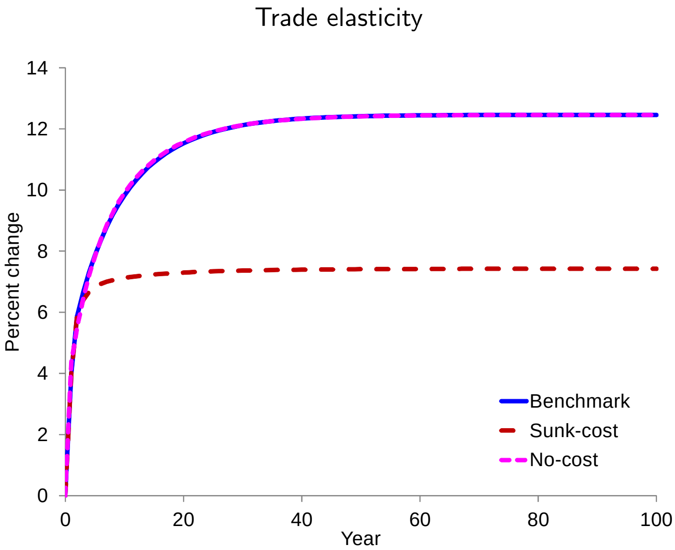
Dynamics following elimination of 10 percent tariff
Aggregate Output
Percent change
Year
Benchmark
Benchmark_N=1
12
10
8
6
4
2
0
-2
0
20
40
60
80
100

The sunk-cost model

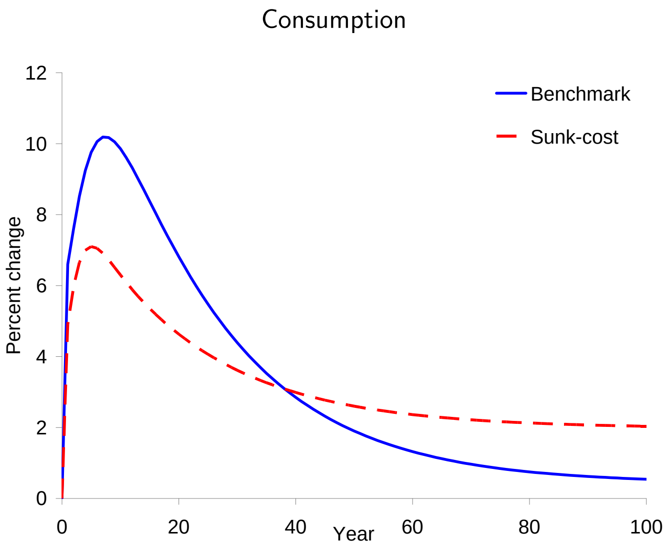
- Literature has focused on sunk costs as a source of persistent exporting
- Sunk cost model misses out on aspects of new exporter dynamics.
- Ask: How well does this simpler dynamic model of exporter approximate trade/welfare predictions of the benchmark model?

The sunk-cost model

- Literature has focused on sunk costs as a source of persistent exporting
- Sunk cost model misses out on aspects of new exporter dynamics.
- Ask: How well does this simpler dynamic model of exporter approximate trade/welfare predictions of the benchmark model?
- Answer: Not so good on trade, pretty good on consumption/welfare



Trade elasticity
Percent change
14
12
10
8
6
4
2
0
0
20
40
60
80
100
Year
Benchmark
Sunk-cost
No-cost



Consumption
12
10
8
6
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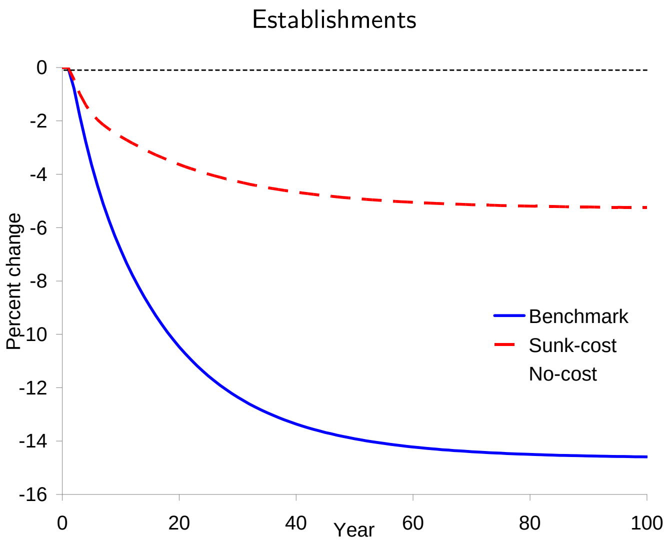
2
0
Percent change
0
20
40
Year
60
80
100
Benchmark
Sunk-cost



Establishments
Percent change
0
-2
-4
-6
-8
-10
-12
-14
-16
0
20
40
60
80
100
Year
Benchmark
Sunk-cost
No-cost

The sunk-cost model

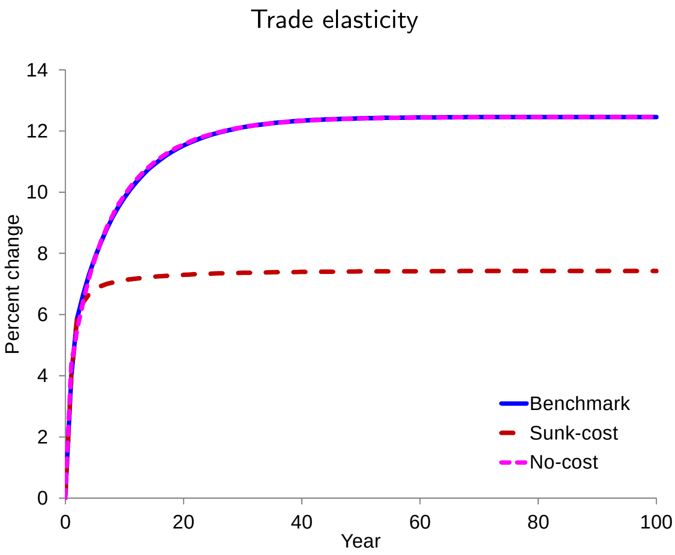
Change	**Benchmark**	**Sunk-cost**	**No-cost**
Welfare gain	6.30	4.75	
Avg. trade elasticity ($\bar{\varepsilon}_t$)	10.2	6.9	
Δ SS. Consumption	0.42	1.98	
SS. Trade elasticity	11.5	7.2	

Welfare gain is x: $\sum_{t=0}^{\infty} \beta^t U\left(C_{-1} e^x\right) = \sum_{t=0}^{\infty} \beta^t U\left(C_t\right)$

$$\bar{\varepsilon}_t = (1-\beta) \sum_{t=0}^{\infty} \beta^t \varepsilon_t .$$

How important is endogenous exporting?

- Krugman (1980): all firms export
- Requires two main changes
  1. Change θ to get LR trade elasticity
  2. Add adjustment friction to get dynamics of trade elasticity


Trade elasticity
Percent change
14
12
10
8
6
4
2
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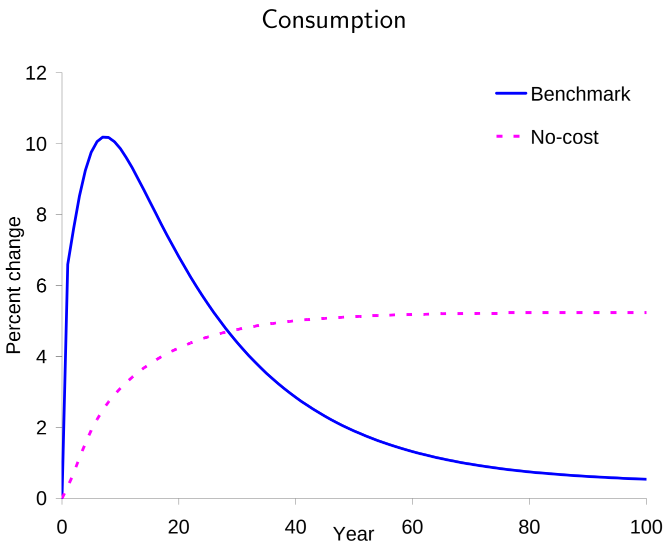
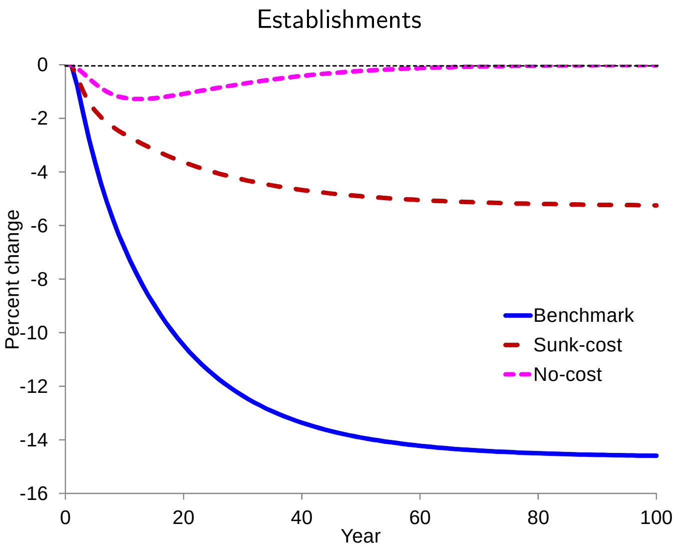
0
20
40
60
80
100
Year
Benchmark
Sunk-cost
No-cost


Consumption
Benchmark
No-cost
Percent change
0
2
4
6
8
10
12
0
20
40
60
80
100
Year


Establishments
0
-2
-4
-6
-8
-10
-12
-14
-16
Percent change
0
20
40
60
80
100
Year
Benchmark
Sunk-cost
No-cost

Modified Krugman (1980) model

Change	**Benchmark**	**Sunk-cost**	**No-cost**
Welfare gain	6.30	4.75	2.34
Discounted trade elasticity	10.2	6.9	10.2
Δ SS. Consumption	0.42	1.98	3.93
SS. Trade elasticity	11.5	7.2	11.5

Welfare gain is x: $\sum_{t=0}^{\infty} \beta^t U(C_{-1} e^x) = \sum_{t=0}^{\infty} \beta^t U(C_t)$

$$\bar{\varepsilon}_t = (1-\beta) \sum_{t=0}^{\infty} \beta^t \varepsilon_t .$$

Unilateral liberalization

- Only home country eliminates tariff
- Financial autarky; non-contingent bond; complete markets
- Asymmetry generates
  - Unbalanced trade
  - Real exchange rate movements

Unilateral liberalization

Change		**Benchmark**		**No-cost**
		Bond	Complete Markets	Bond
Welfare				
	Home	0.51		
	Foreign	5.70		
SS Consumption				
	Home	–2.43		
	Foreign	2.82		

Welfare gain is x: $\sum_{t=0}^{\infty} \beta^t U\left(C_{-1} e^x\right) = \sum_{t=0}^{\infty} \beta^t U\left(C_t\right)$

Unilateral liberalization

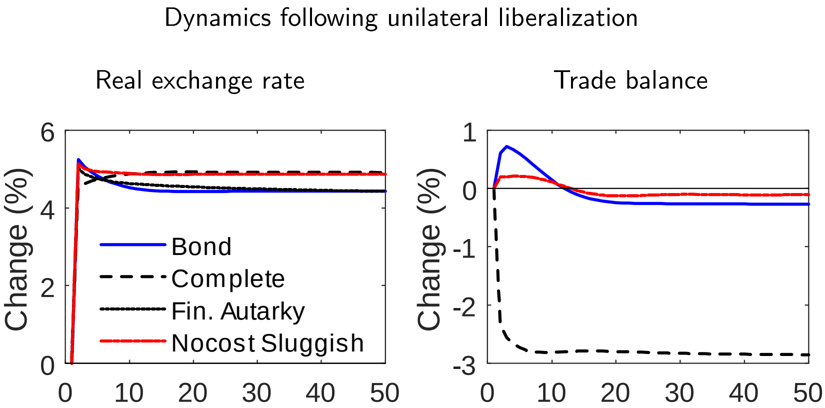
Change		Benchmark		No-cost
		Bond	Complete Markets	Bond
Welfare				
	Home	0.51	4.34	
	Foreign	5.70	1.91	
SS Consumption				
	Home	–2.43	1.45	
	Foreign	2.82	–1.00	

Welfare gain is x: $\sum_{t=0}^{\infty} \beta^t U\left(C_{-1}e^x\right) = \sum_{t=0}^{\infty} \beta^t U\left(C_t\right)$

Unilateral liberalization

Change		**Benchmark**		**No-cost**
		Bond	Complete Markets	Bond
Welfare				
	Home	0.51		–0.62
	Foreign	5.70		4.92
SS Consumption				
	Home	–2.43		–0.06
	Foreign	2.82		5.49

Welfare gain is x: $\sum_{t=0}^{\infty} \beta^t U\left(C_{-1}e^x\right) = \sum_{t=0}^{\infty} \beta^t U\left(C_t\right)$


Dynamics following unilateral liberalization
Real exchange rate
Trade balance
Change (%)
Bond
Complete
Fin. Autarky
Nocost Sluggish
0
2
4
6
1
-1
-2
-3
10
20
30
40
50

Unilateral liberalization

- Developed general model of fixed/variable cost trade-off
- Selection effect weakened - producers & exporters quite substituteable
- Transition boost gains even through trade grows slowly
- Micro trade dynamics (and micro data) determine gains from trade
- Need more micro- and macro work measuring export dynamics