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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- Significant fraction of entry cost is sunk

- Missing: Exporter life cycles
  - Existing models don't match exporter dynamics data
  - Important for aggregate dynamics

Our model

- GE model with producer-level export dynamics
- Keep 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)

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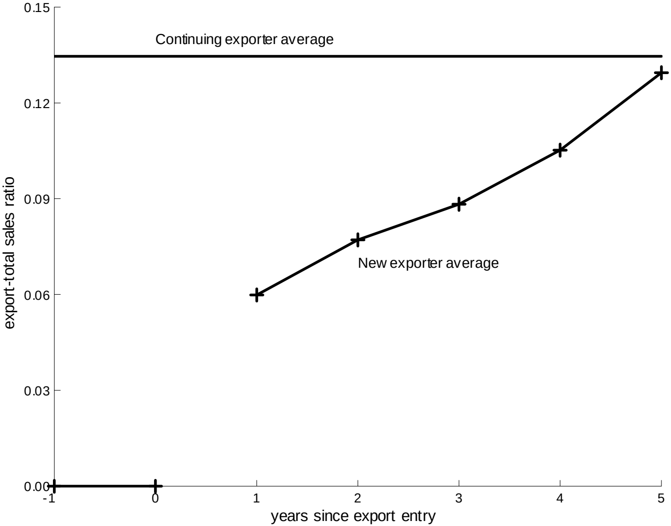
4. New exporters start with low *export intensity*

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

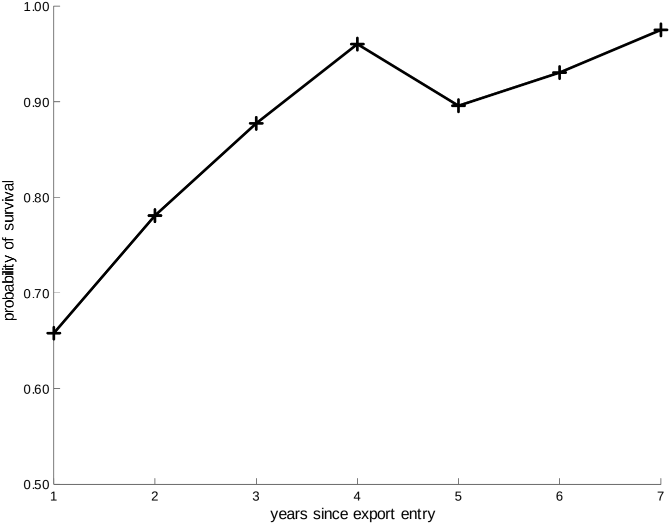
5. New exporters take time (5yrs) to get to average exporter levels

6. New exporters have high exit rates

Export intensity of Colombian exporters (Ruhl & Willis, 08)



Survival probability of Colombian new exporters (Ruhl & Willis, 08)



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, $\phi\left(z'|z\right)$
  - Fixed export cost: $f = \{f_H, f_L\}$ (paid in labor)
  - Iceberg costs: $\xi = \{\xi_L, \xi_H, \infty\}$
  - Measure of establishments: $\varphi_{i,t}\left(z, \xi, f\right)$

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  - 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: draw ξ' w prob. $\rho_\xi(\xi'|\infty)$

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  - If not: exit raises cost to ∞

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- 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

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

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

- 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 *

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

Competitive final good producers

- Combine domestic and imported intermediates, produce goods for
  - Consumption
  - Investment
  - Input into production by domestic firms

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

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

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

Calibration

- Target usual plant-level moments: participation rate, starter rate, etc.
- Export technology: $\{\xi_L, \xi_H\}, \{\rho(\xi_H|\xi_H), \rho(\xi_L|\xi_L), \rho(\xi_H|\infty)\}$

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  - $\rho(\xi_H|\infty) = 1$
  - $\rho(\xi_H|\xi_H) = \rho(\xi_L|\xi_L) = \rho_\xi$

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- Micro-dynamic moments
  1. Initial export intensity 1/2 of avg. intensity (Ruhl&Willis 08)
  2. 5 years to reach avg export intensity (Ruhl&Willis 08)

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 08)
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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)

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

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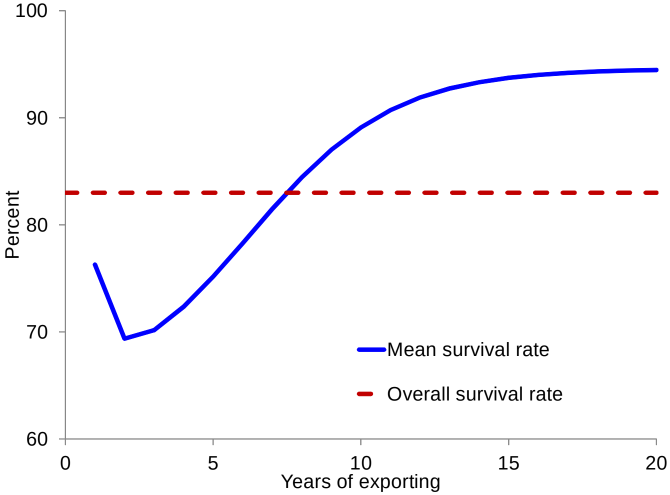
Estimate of benchmark export technology

- 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)



Alternative model: Sunk cost export technology

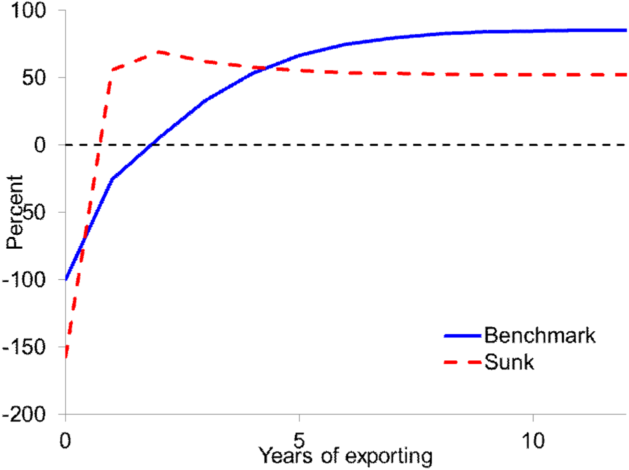
- Restriction: $\xi_H = \xi_L$

	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 (net/entry cost) of marginal starters

$$\left(E\pi_{x,t} - f\right) / f_H^{bench}$$



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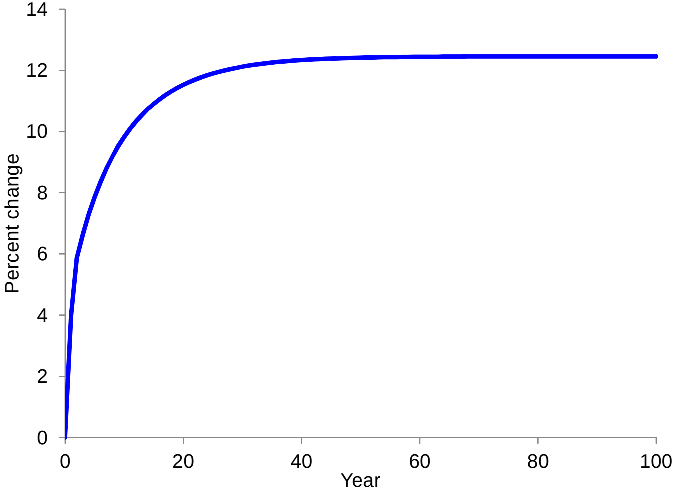
3 experiments

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, $\tau = 0.1 \rightarrow \tau = 0$

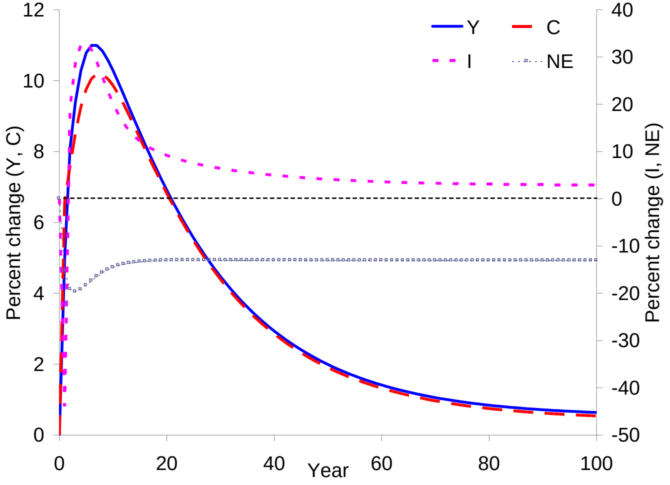
Dynamics following elimination of 10 percent tariff

Benchmark Model: Trade elasticity



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		
SS. Consumption	0.42		
SS. Trade elasticity	11.5		

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

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
- Size rationalization: fewer, but larger plants

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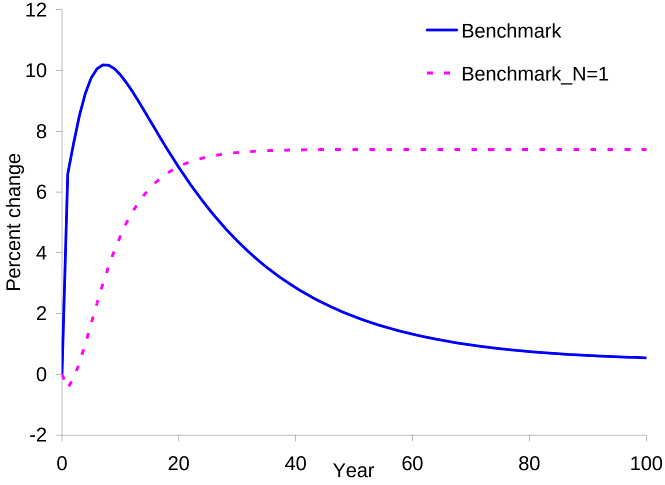
- These establishments can be converted at a low cost to exporters
- Size rationalization: fewer, but larger plants

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

Dynamics following elimination of 10 percent tariff

Aggregate Output



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?

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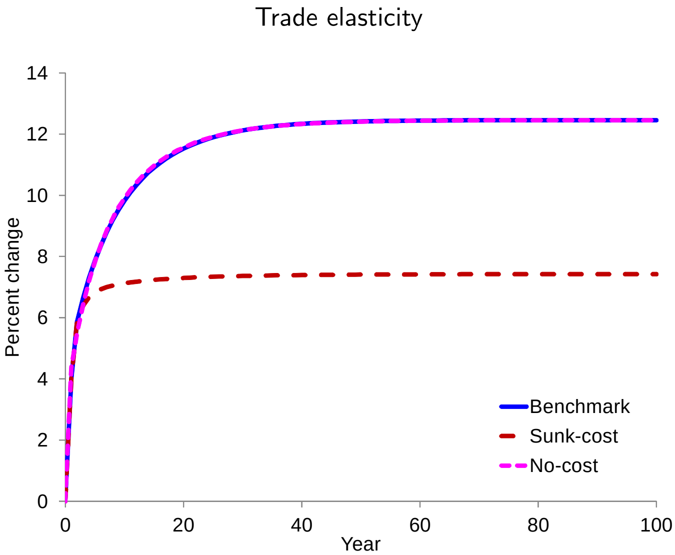
- Sunk cost model misses out on aspects of new exporter dynamics.
- Ask: How well does this simpler dynamic model of exporter approximate trade/welfare predictions of the benchmark model?
- Answer: Not so good on trade, pretty good on consumption/welfare


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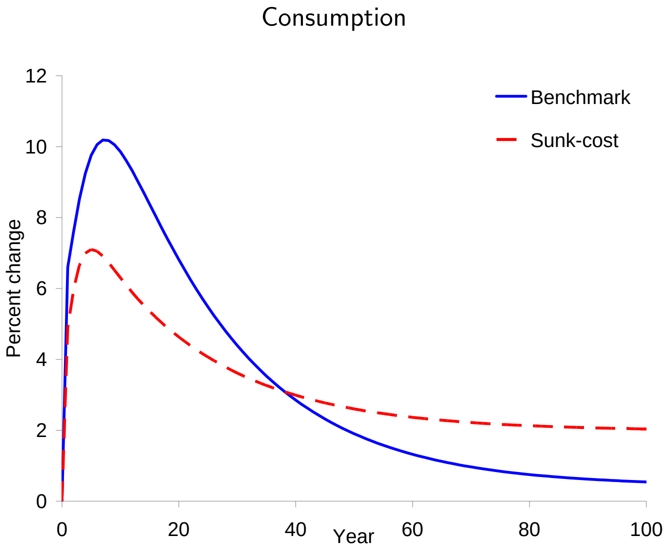
20
40
60
80
100
Year
Benchmark
Sunk-cost
No-cost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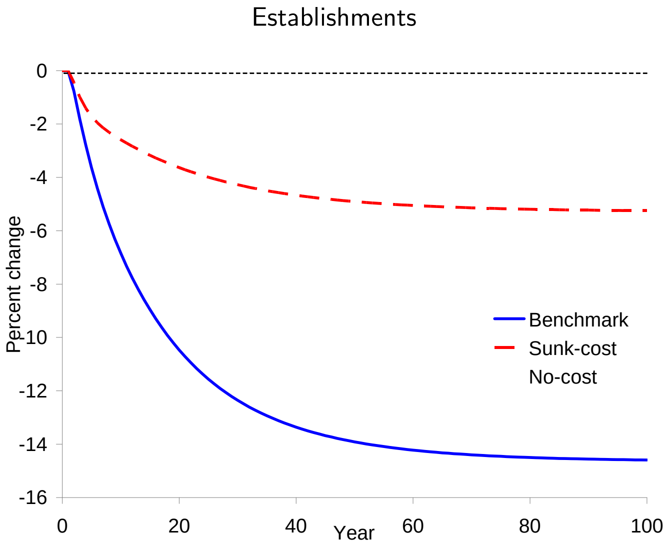

Establishments
0
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-10
-12
-14
-16
Percent change
0
20
40
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80
100
Year
Benchmark
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No-cost

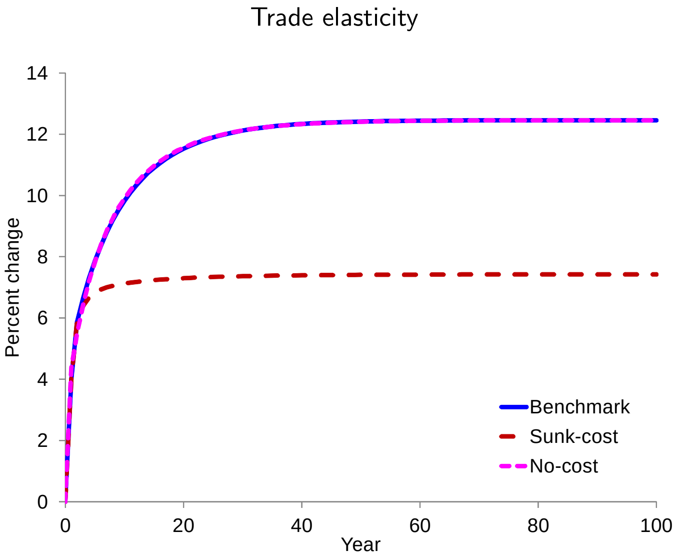
The sunk-cost model

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

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

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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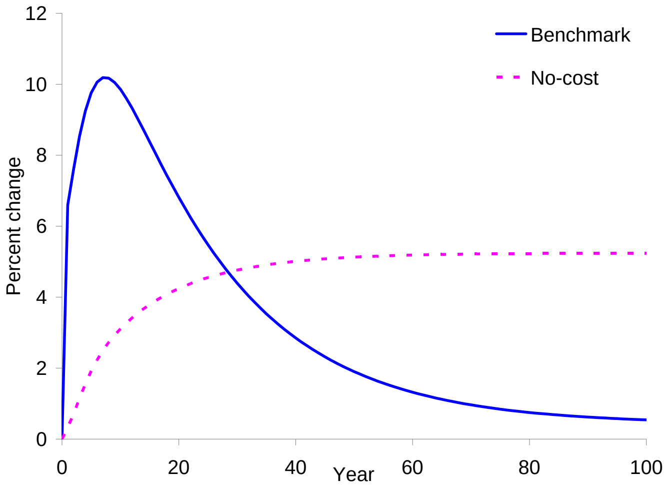
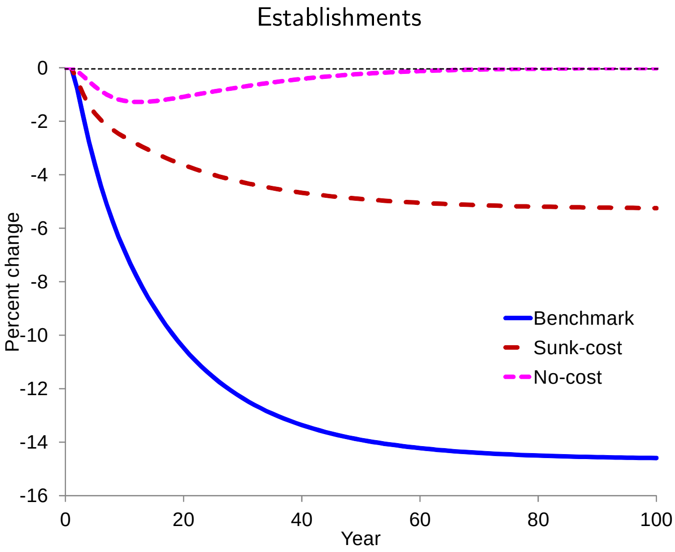
Consumption





Establishments
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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
Consumption	0.42	1.98	3.93
Trade elasticity	11.5	7.2	11.5

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