A Global View of Creative Destruction

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Our questions

- Does trade boost rates of innovation and job destruction?
- Are there big dynamic gains from trade?

What we do and find

- Document 9 facts about jobs & trade in U.S. & Canadian mfg.
- Analyze a 2-country Klette-Kortum model
- Target some of the facts and do model counterfactuals
- Relative to autarky, current trade flows result in:
  - $\sim$ 30% higher consumption-equivalent welfare
  - $\sim$ 3 percentage points higher job destruction rate

Related recent papers

Evidence on dynamic costs and benefits

- Autor, Dorn and Hanson (2013, 2016)
- Bloom, Draca and Van Reenen (2016)
- Dix-Carneiro and Kovak (2017)
- Aghion, Bergeaud, Lequien, and Melitz (2018)

Models of trade and growth

- Alvarez, Buera and Lucas (2013)
- Sampson (2016)
- Akcigit, Ates and Impullitti (2018)
- Buera and Oberfield (2019)
- Perla, Tonetti and Waugh (2019)

Outline

Datasets

U.S. Census of Manufacturing

- All establishments with employees
- 1972, 1977, ... 2012
- 300–375k establishments per Census year

Canada's Annual Survey of Manufacturing

- All establishments with $>$ \$30k in sales
- 1973–2012
- 80–100k establishments per year

We calculate moments for *firms*.

Fact 1: Large job flows

	U.S.	Canada
Job Creation Rate	31.4%	32.4%
Job Destruction Rate	36.6%	31.6%

Over 5-year periods in the U.S. 1987–2012, Canada 1973–2012

Fact 2: Job destruction at larger firms

	U.S.	Canada
Job Destruction from Larger Firms	30.7%	15.3%
Fraction of all Job Destruction	84%	48%

Larger = above mean employment in the 1st year of a 5-year period

Fact 3: Job creation from exports

	U.S.	Canada
Job Creation from Exports	2%	23%
Fraction of all Job Creation	6%	72%

$$\text{Jobs from exports} = \frac{\text{Exports}}{\text{Shipments}} \cdot \text{Employment}$$

Fact 4: Export product churn

	U.S.	Rest of OECD
Annual exit rate (bottom 1/2 of products)	15.1%	12.8%
Share of top export product $\frac{t+5}{t}$	66.5%	86.2%

Source: Feenstra et al. (2005) World Trade Flows

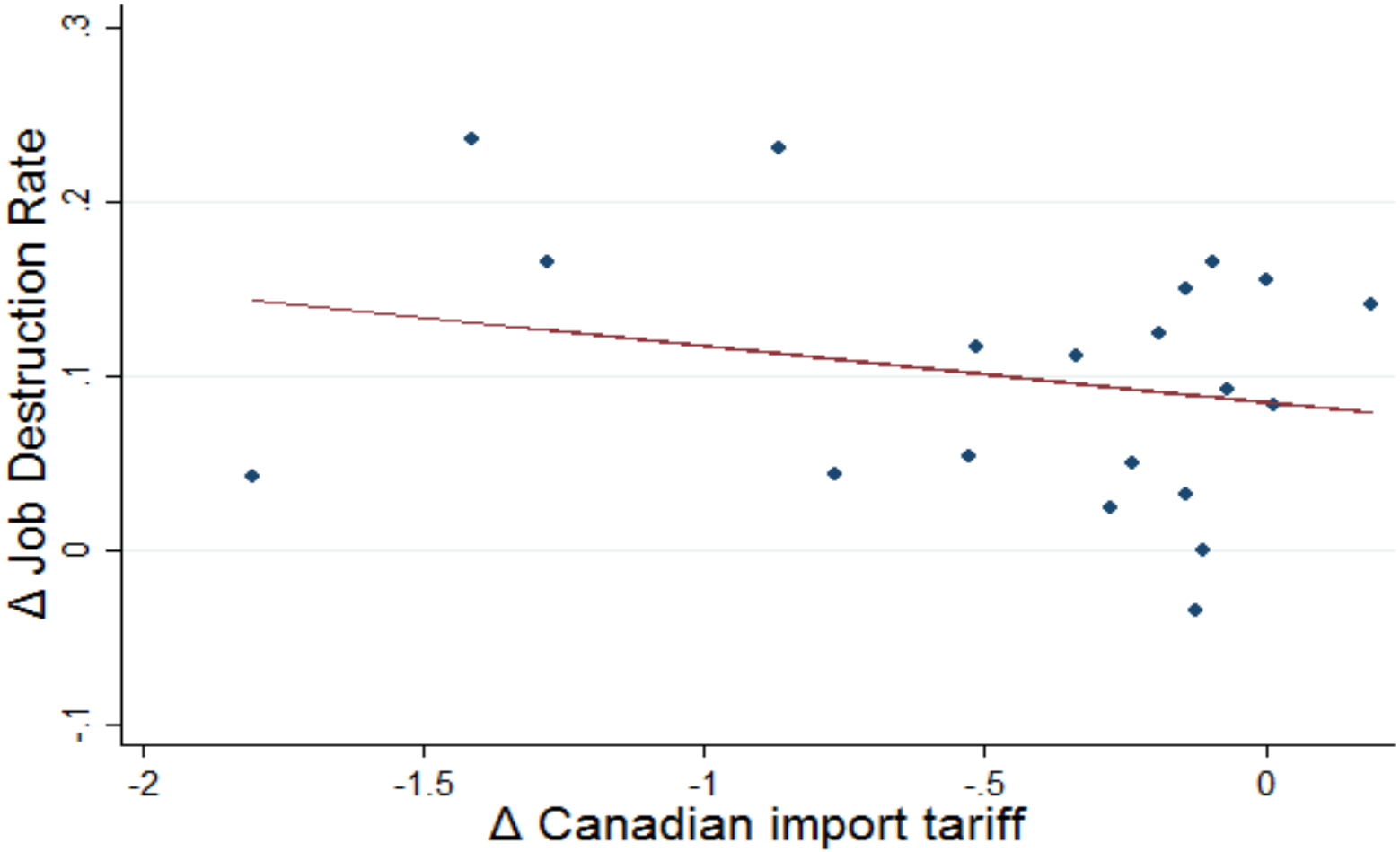
Annual bilateral flows in each of 540 4-digit mfg. industries

Fact 5: Canadian job flows increased after CUSFTA

	Pre-CUSFTA 1978–1988	Post-CUSFTA 1988–2003
Job Creation Rate	30.0%	31.3%
Job Destruction Rate	25.5%	32.7%

Source: *Canadian Annual Survey of Manufacturing*

Changes in job destruction and tariffs in Canada



Each observation is a 2-digit industry. Δ Job Destruction is the change in the average job destruction rate from 1978–1988 to 1988–2003.

Fact 6: Job destruction from larger firms increased

	Pre-CUSFTA 1978–1988	Post-CUSFTA 1988–2003
Job Destruction Rate	25.5%	32.7%
JD from Larger Firms	22.1%	24.0%

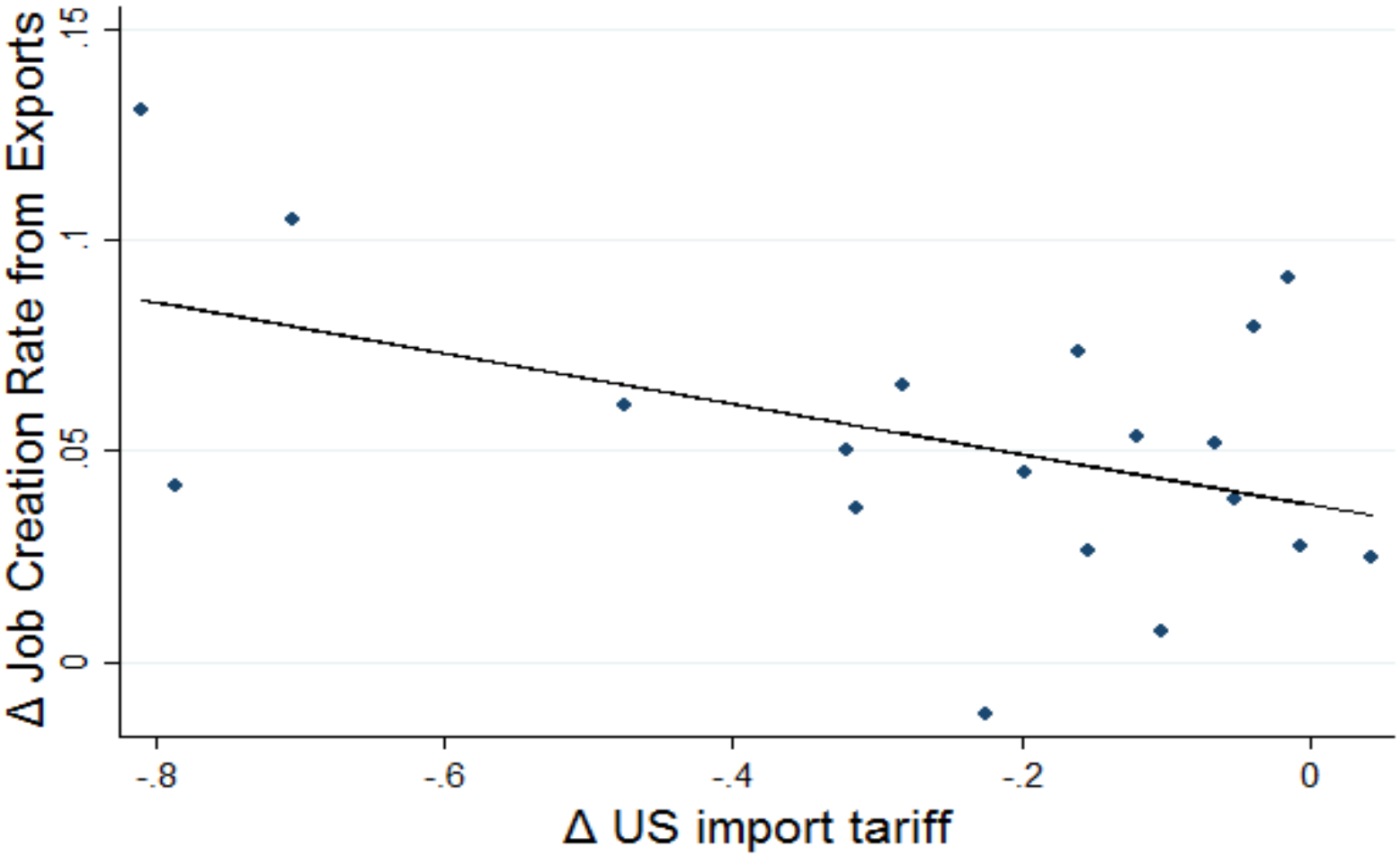
Source: *Canadian Annual Survey of Manufacturing*

Fact 7: Job creation from exports increased

	Pre-CUSFTA 1978–1988	Post-CUSFTA 1988–2003
Job Creation Rate	30.0%	31.3%
Job Creation from Exports	9.0%	17.7%

Source: *Canadian Annual Survey of Manufacturing*

Changes in job creation and tariffs in Canada



Each observation is a 2-digit industry. Δ Job Creation from Exports is the difference from 1978–1988 to 1988–2003.

Job flows in the U.S.

	1977–1987	1987–1992	1992–2012
Job Creation Rate	33.7%	33.0%	31.1%
Job Destruction Rate	31.6%	31.0%	37.8%
Job Destruction from Larger Firms	25.8%	24.9%	32.1%
Job Creation from Exports	–	2.0%	2.0%

Source: *U.S. Census of Manufacturing*

Facts 8 and 9

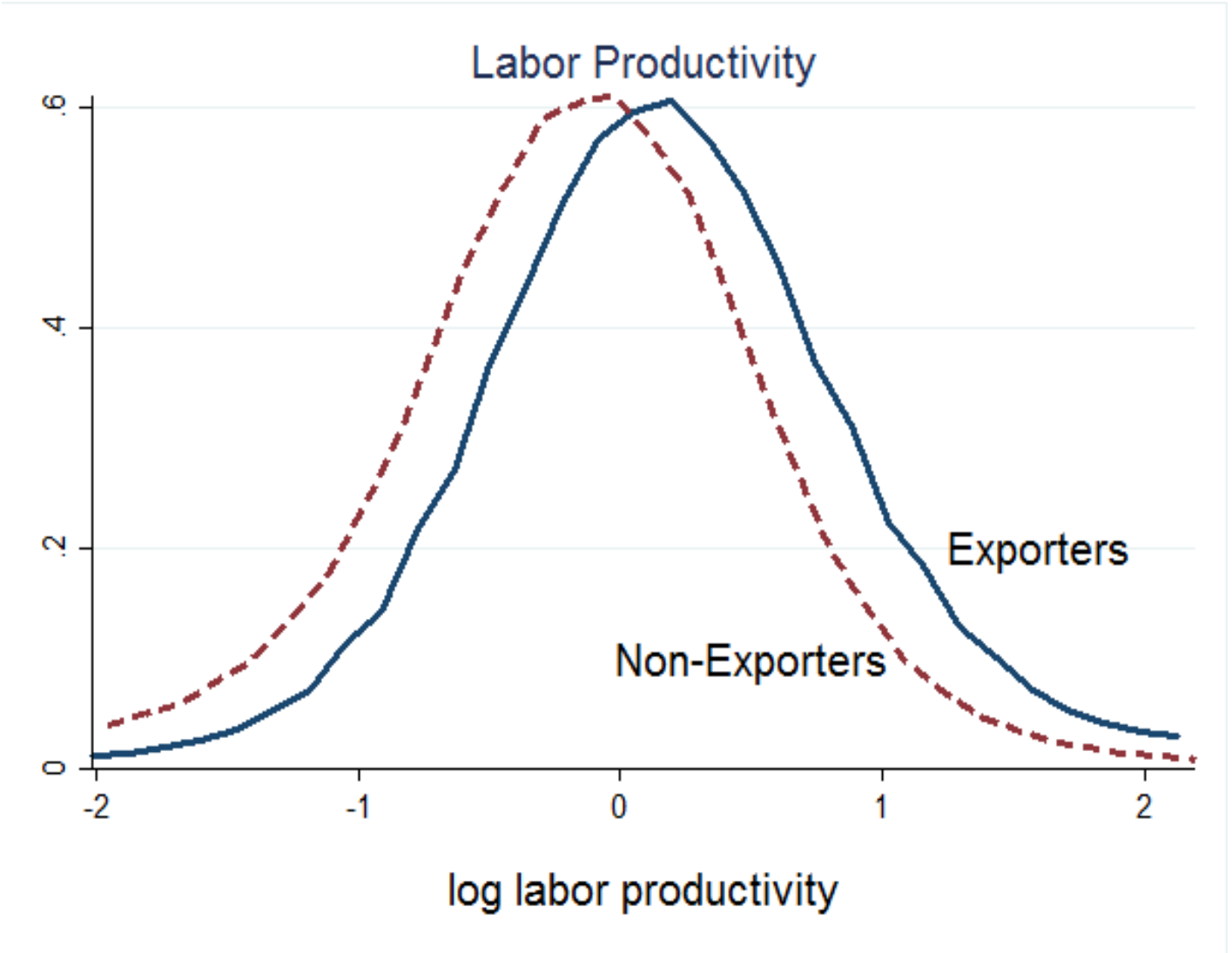
- Average labor productivity and employment is higher at exporters than at non-exporters

- But there is much overlap in the exporter and non-exporter distributions of labor productivity and employment

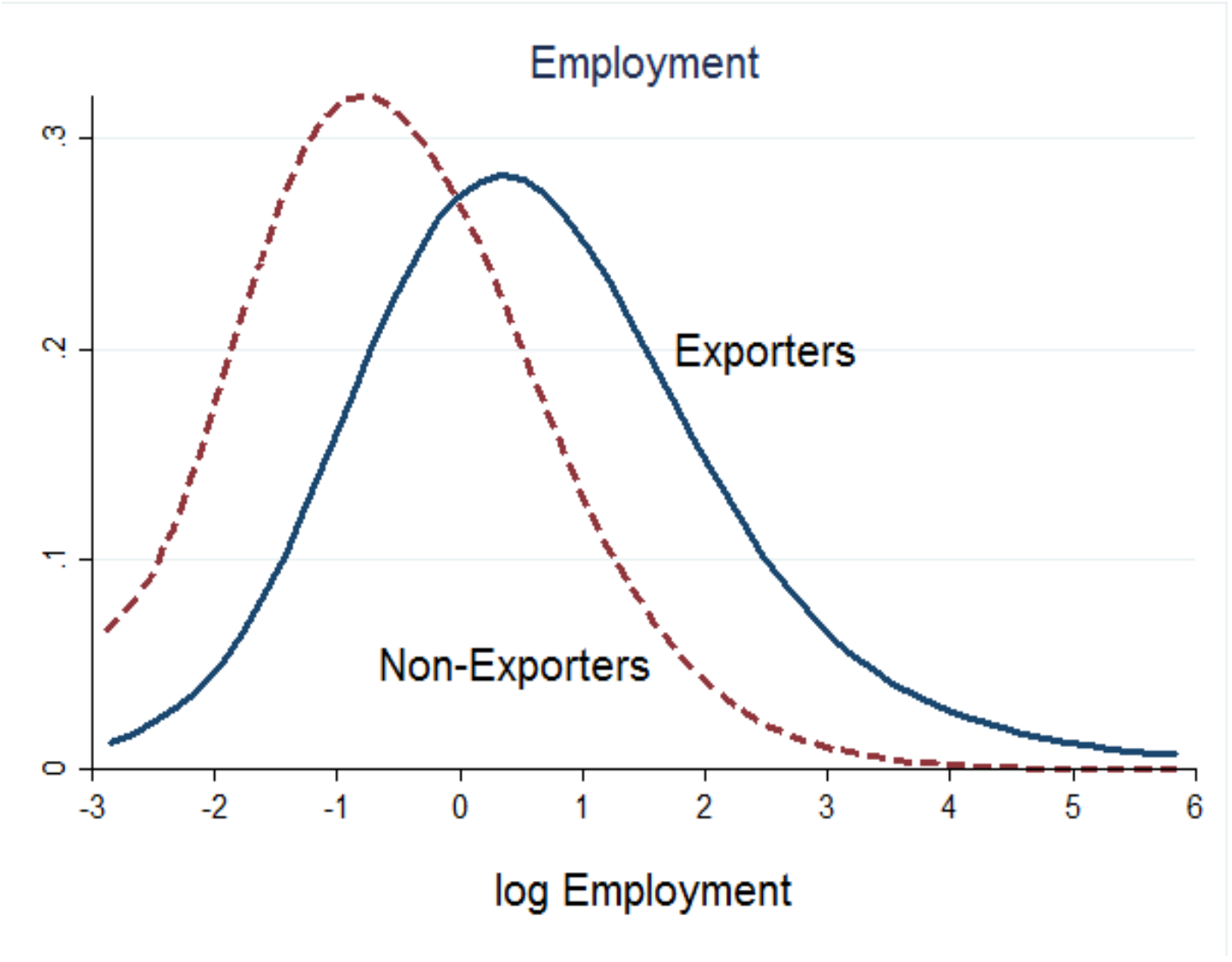
Labor productivity = revenue per worker

See also Bernard, Eaton, Jensen and Kortum (2003)

U.S. labor productivity distribution in 2012



U.S. employment distribution in 2012



Outline

Preferences

$$U = \int_0^1 \ln C_j \, dj$$

$$U^* = \int_0^1 \ln C_j^* \, dj.$$

$$Y_j = A_j L_j$$

$$Y_j^* = A_j^* L_j^*$$

A_j (A_j^*) are the best home (foreign) blueprints

$$L = \int_0^1 L_j \, dj, \quad L^* = \int_0^1 L_j^* \, dj$$

Some useful notation

A'_j and $A^{*\prime}_j$ are the *second-best* home and foreign blueprints

$\tau > 1$ is the symmetric tariff on all traded goods

ω is the relative wage (home relative to foreign)

Markups under Bertrand competition

Home market	Exported or non-traded	$\frac{A_j}{\max\left[A'_j,\ \frac{\omega A^*_j}{\tau}\right]}$
	Imported	$\frac{A^*_j/\tau}{\max\left[\frac{A^{*\prime}_j}{\tau},\ \frac{A_j}{\omega}\right]}$
Foreign market	Imported	$\frac{A_j/\tau}{\max\left[\frac{A'_j}{\tau},\ \omega A^*_j\right]}$
	Non-traded or exported	$\frac{A^*_j}{\max\left[A^{*\prime}_j,\ \frac{A_j}{\omega\tau}\right]}$

Traded and non-traded goods

Ordering products so that A_j/A_j^* is decreasing in j

- $j \in [0, x]$ are traded and produced at home
- $j \in (x, x^*)$ are non-traded
- $j \in [x^*, 1]$ are traded and produced abroad

The cutoff products x and x^* are determined by

$$\frac{A_x}{\tau} = \omega A_x^*, \quad A_{x^*} = \frac{\omega A_{x^*}^*}{\tau}$$

When $\tau = 1$, $x = x^*$ and all products are traded

Balanced trade

The relative wage ω is pinned down by balanced trade:

$$I^* \cdot x \;=\; I \cdot (1 - x^*)$$

I and I^* denote nominal GDP at home and abroad

LHS = home country exports

RHS = home country imports

GDP and markups

$$I = \frac{\overline{\mu}\, wL}{1 - \frac{1-\tau}{\tau} \cdot (1 - x^*)} \qquad \text{and} \qquad I^* = \frac{\overline{\mu}^* w^* L^*}{1 - \frac{1-\tau}{\tau} \cdot x}$$

$$\frac{1}{\overline{\mu}} \equiv \frac{\int_0^{x^*} \frac{1}{\mu_j} dj + \frac{1}{\tau} \cdot \int_0^{x} \frac{1}{\mu_j^f} dj}{x^* + x/\tau} \qquad \text{and} \qquad \frac{1}{\overline{\mu}^*} \equiv \frac{\int_x^{1} \frac{1}{\mu_j^*} dj + \frac{1}{\tau} \cdot \int_{x^*}^{1} \frac{1}{\mu_j^{*f}} dj}{1 - x + (1 - x^*)/\tau}$$

Equilibrium consumption wages

$$\ln W = \int_0^{x^*} \ln\left(\frac{A_j}{\mu_j}\right) dj + \int_{x^*}^1 \ln\left(\frac{A_j^*}{\mu_j^*} \cdot \frac{\omega}{\tau}\right) dj$$

$$\ln W^* = \int_0^{x} \ln\left(\frac{A_j}{\mu_j} \cdot \frac{1}{\omega\,\tau}\right) dj + \int_{x}^1 \ln\left(\frac{A_j^*}{\mu_j^*}\right) dj$$

Arrival rates of quality improvements

	Home	Foreign
Innovation by incumbents	λ	λ^*
Innovation by entrants	η	η^*

Pareto draws build on A of the current ***seller*** into the domestic market

The average improvement in quality (over the seller) is $\frac{1}{\theta-1}$

Expected growth rate for symmetric countries

Autarky

$$(\lambda + \widetilde{\eta}) \frac{1}{\theta - 1}$$

Free trade

$$\left(\lambda + \widetilde{\eta} + \widetilde{\lambda}^* + \widetilde{\eta}^*\right) \frac{1}{\theta - 1}$$

Reflecting barrier

The bottom ψ percent of qualities redraw from the top 1–ψ percent.

- Maintains a stationary quality distribution
- Allows us to match the empirical trade elasticity

In the spirit of Perla, Tonetti and Waugh (2019)'s diffusion.

Data moments used for calibration

Data Moment	Source	Value
Export share of revenues (home)	U.S. mfg 2012	10.2%
Trade elasticity from halving τ	Head and Mayer (2014)	–5
Revenue per worker exp./non-exp.	U.S. mfg 2012	1.066
Employment share of entrants	U.S. mfg 2012	16.9%
Employment home/foreign	U.S., OECD mfg 1995–2008	0.389
Employment growth rate	U.S. mfg 1987–2012	–1.1%
Value added per worker home/foreign	U.S., OECD mfg 1995–2008	1.29
TFP growth rate	U.S. mfg 1995–2008	3.01%

Sources: U.S. Census of Manufacturing
U.S. BLS Multifactor Productivity Database
KLEMS for OECD countries

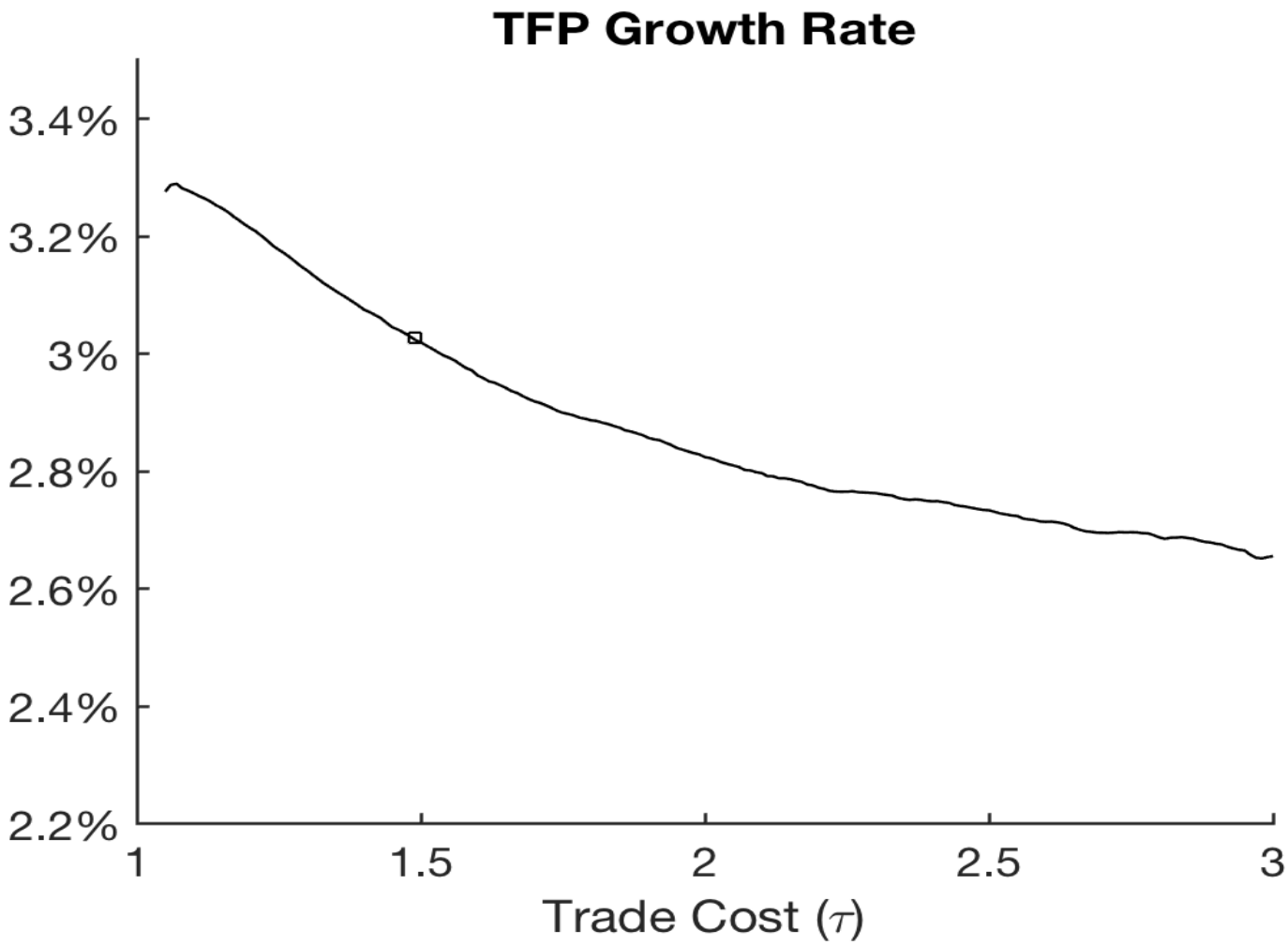
Parameter estimates

θ	Shape parameter of innovation draws	10.9
λ	Innovate rate, home incumbents	13.5%
$\widetilde{\eta}$	Innovation rate, home entrants	3.0%
$\widetilde{\mu}^*$	Innovation rate, foreign incumbents + entrants	14.9%
τ	Gross tariff rate	1.49
ψ	Reflecting barrier for product quality	1.1%

Firm dynamics: untargeted moments

	U.S. Data	Simulations
Job Creation Rate	31.4%	31.6%
Job Destruction Rate	36.6%	38.2%
Job Destruction from Larger Firms	30.7%	22.3%
Job Creation from Exports	2.0%	5.7%
Probability of losing an export product	15.1%	12.8%
Top export product mean reversion	66.5%	77.5%

Simulated growth vs. trade costs



Simulated relative wage vs. trade costs

Outline

Incumbent arrival rates

$$\lambda = \left(\frac{R_i}{\gamma \chi_i \overline{A}^{(1-\phi)/\gamma}} \right)^{\gamma}$$

R_i is labor used for research by incumbents (per variety)

$\overline{A}$ is the average productivity of ***sellers*** into the home market

χ_i is a home research cost parameter

$\gamma < 1$ captures the internal returns to research effort

ϕ captures research spillovers from the stock of ideas

Average productivity of sellers into each market

$$\ln \overline{A} = \int_0^{x^*} \ln A_j dj + \int_{x^*}^1 \ln A_j^* dj$$

$$\ln \overline{A}^* = \int_0^{x} \ln A_j dj + \int_{x}^1 \ln A_j^* dj$$

Entrant arrival rates

$$\widetilde{\eta} = \left(\frac{R_e}{\gamma \chi_e \overline{A}^{(1-\phi)/\gamma}} \right)^{\gamma}$$

R_e is labor used for research (per variety) by potential entrants

χ_e is another research cost parameter

Analogous equations for $\widetilde{\lambda}^*$ and $\widetilde{\eta}^*$ involve R_i^*, χ_i^*, R_e^*, χ_e^*, and $\overline{A}^*$

Targets for the endogenous innovation case

Free entry conditions for entrant research

First order conditions for incumbent research

Additive linear utility across time so that $r = \rho$, set $\rho = 0.05$

BLS TFP growth = 3.01% per year from 1995–2008

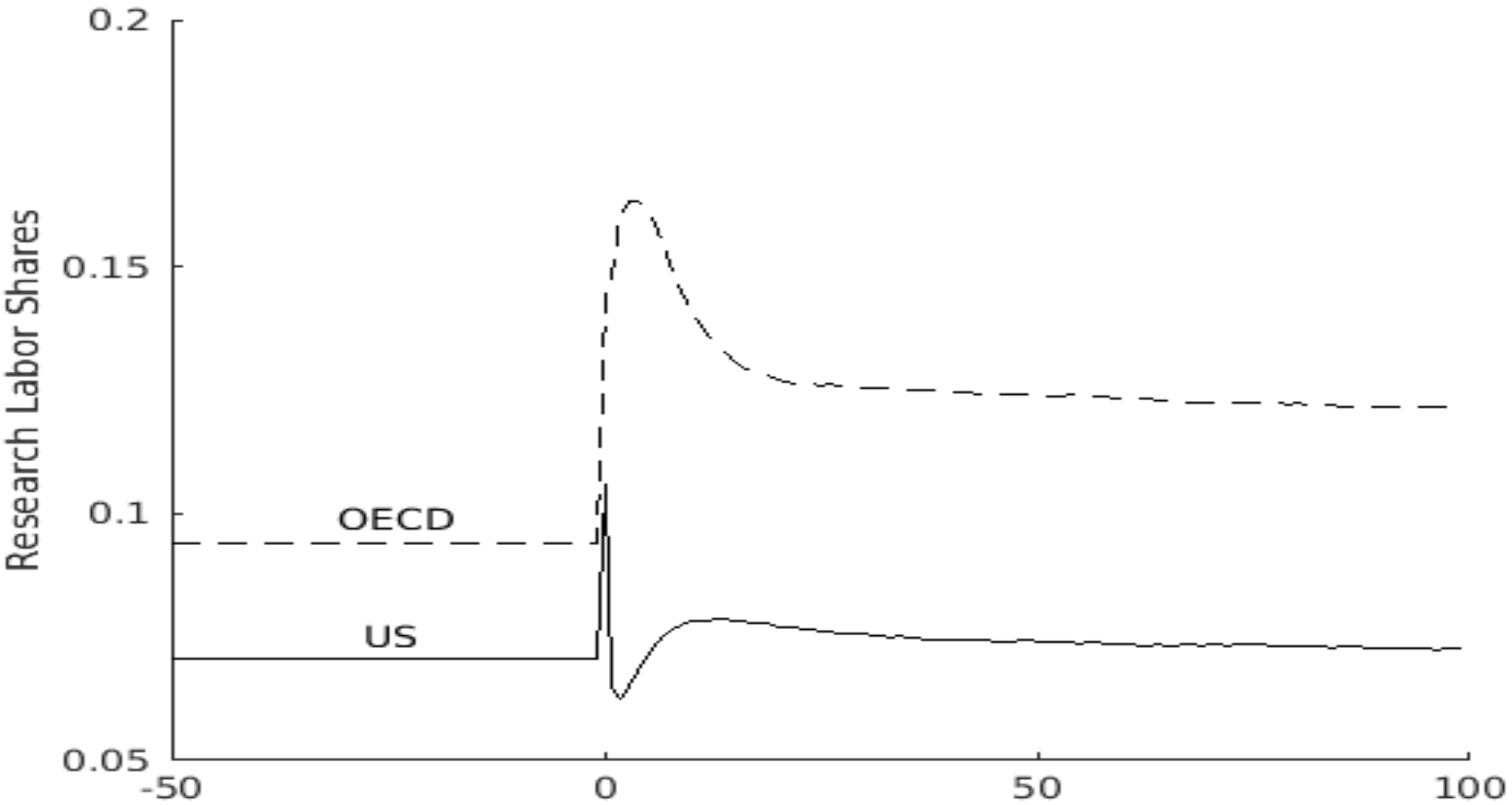
BEA intellectual property investments grew 4.12%, 1995–2008

Such investments averaged 7.03% of value added, 1997–2008

Parameter estimates for endogenous arrivals

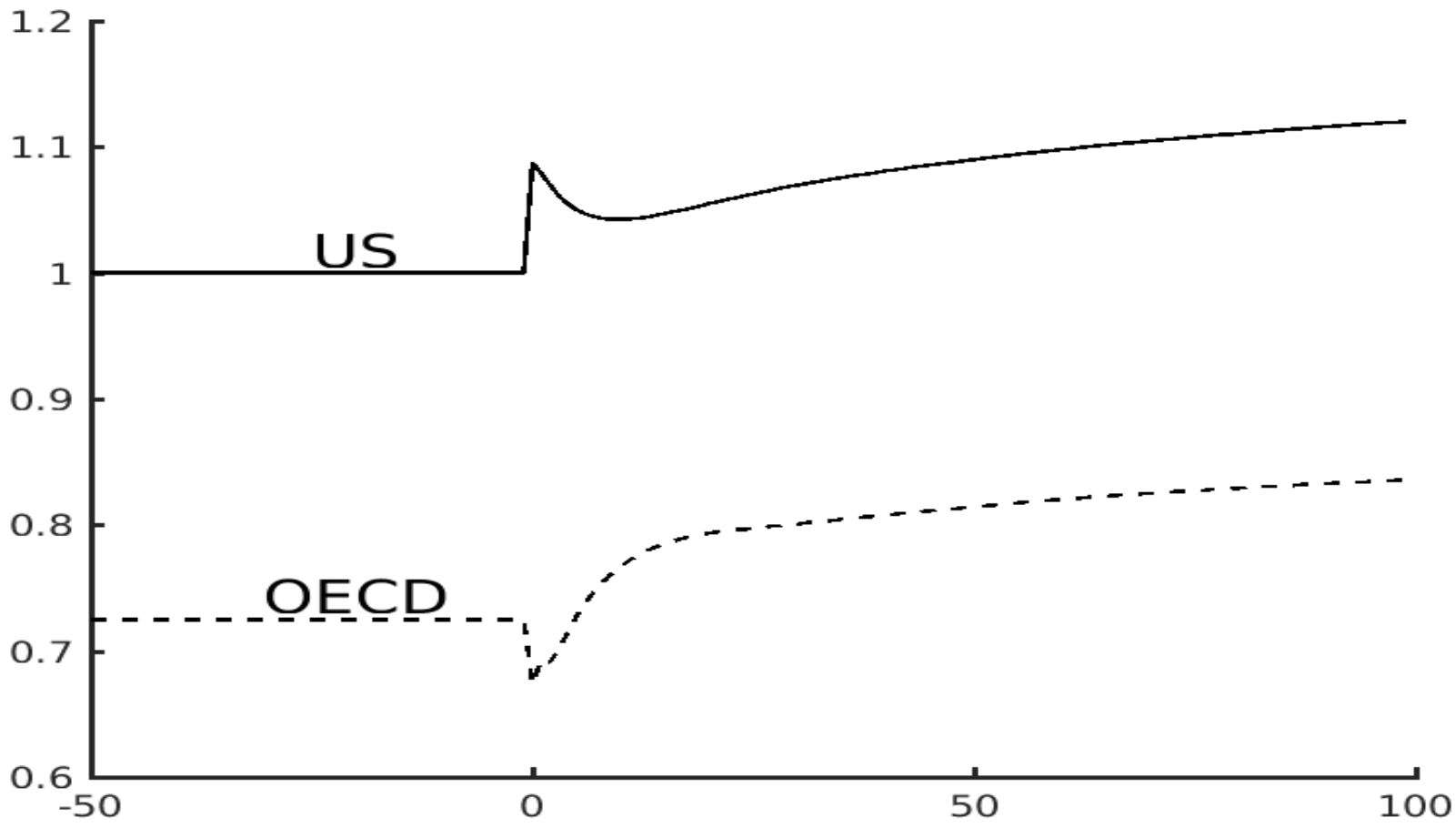
ϕ	Research spillovers from the stock of ideas	0.165
γ	Return to research intensity	0.610
χ_e/χ_i	Home entrant/incumbent research cost	2.89
χ_i^*/χ_i	Foreign/home incumbent research cost	7.26
χ_e^*/χ_i	Foreign entrant/home incumbent research cost	17.0

Research labor shares after trade liberalization



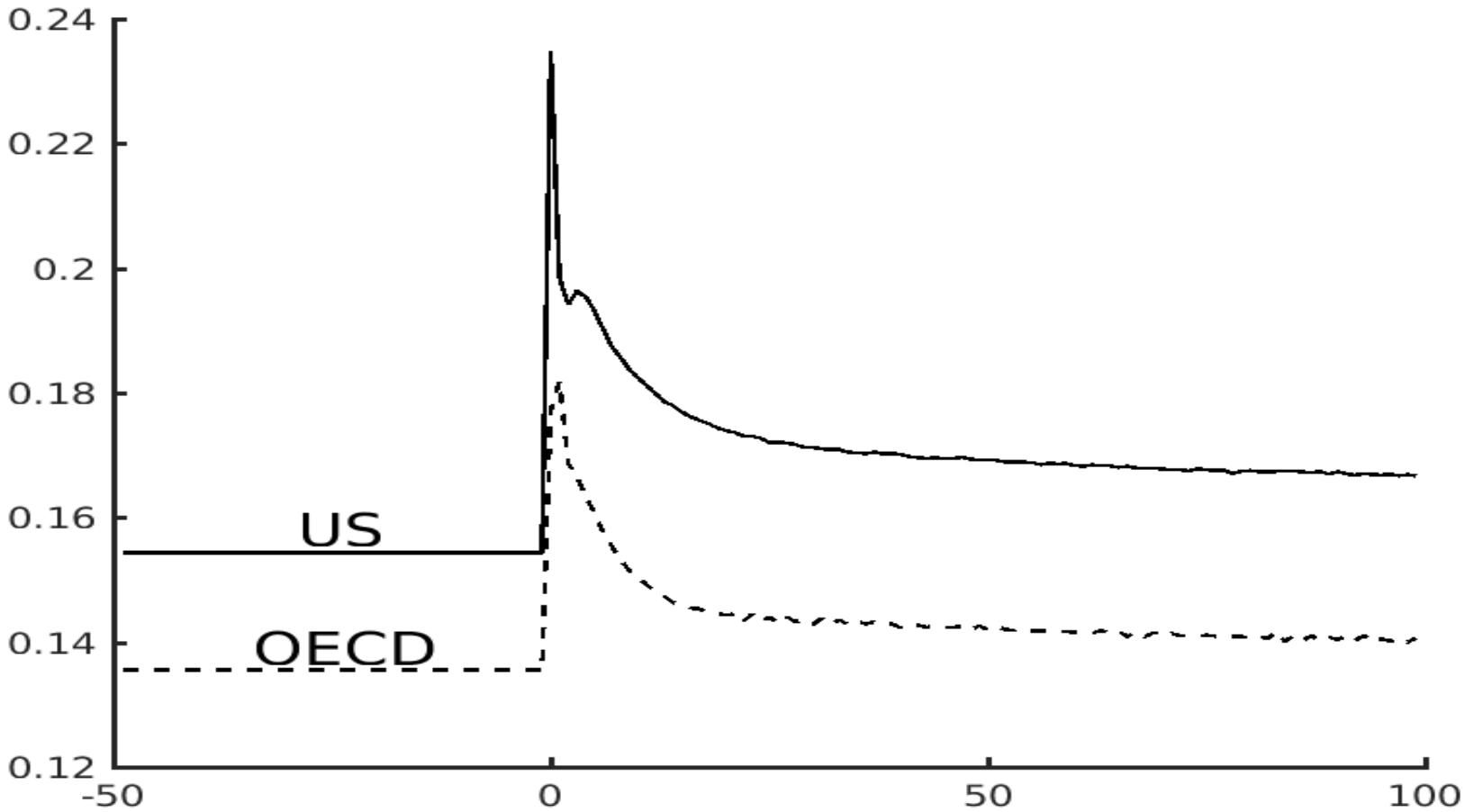
Year 0: τ falls from 1.491 to 1.245

Simulated real consumption after trade liberalization



Year 0: τ falls from 1.491 to 1.245

Simulated job flows after trade liberalization



Year 0: τ falls from 1.491 to 1.245

Welfare gains from cutting tariffs in half

	U.S.	OECD
Static Gains according to the ACR formula	3.0%	1.2%
Static Gains in our Model	4.2%	5.0%
Dynamic Gains - Exogenous Innovation	9.6%	15.5%
Dynamic Gains - Endogenous Innovation	9.7%	13.8%

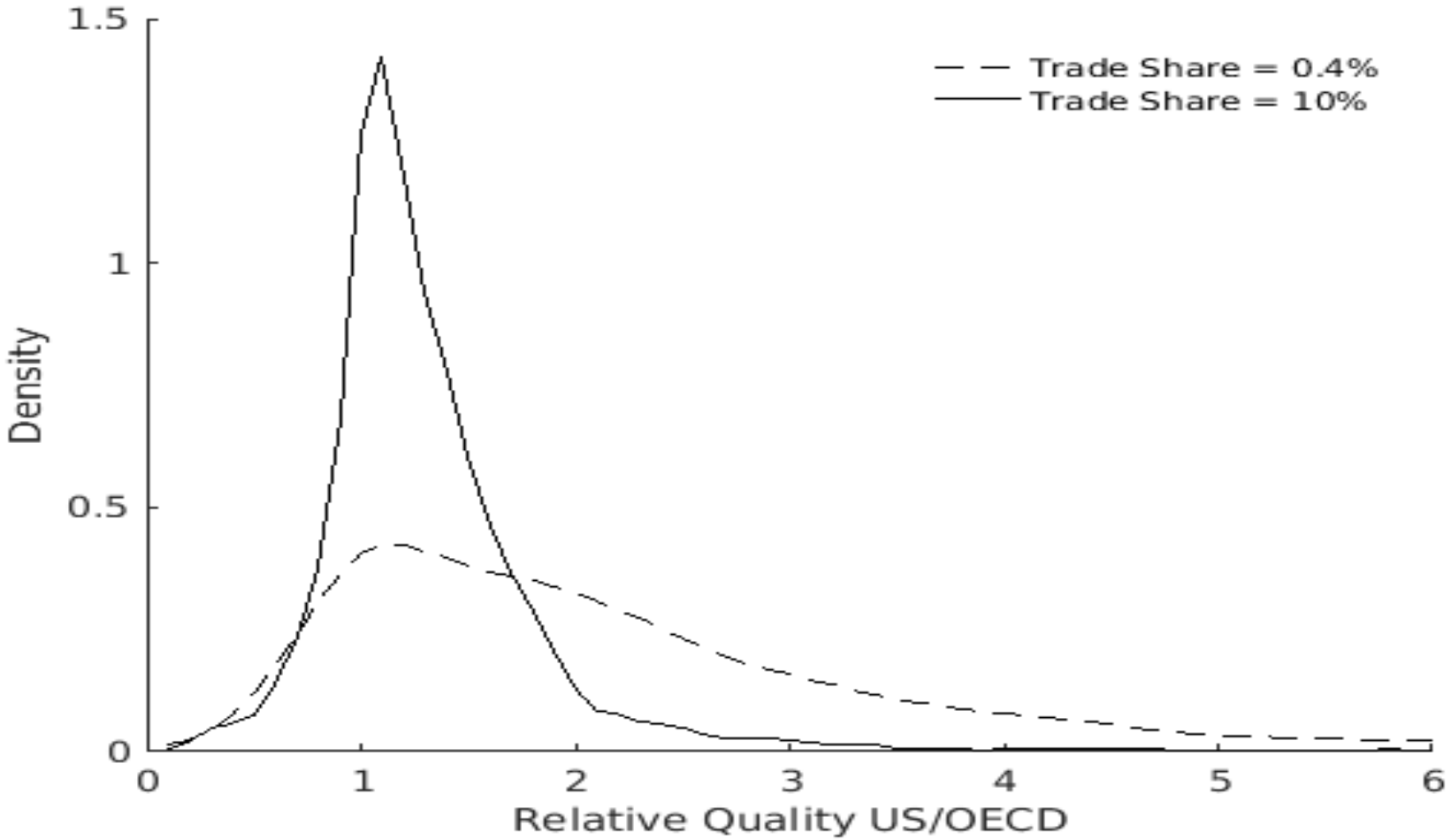
PDV of consumption with τ equal to 1.245 relative to 1.491

Welfare gains *vis a vis* autarky

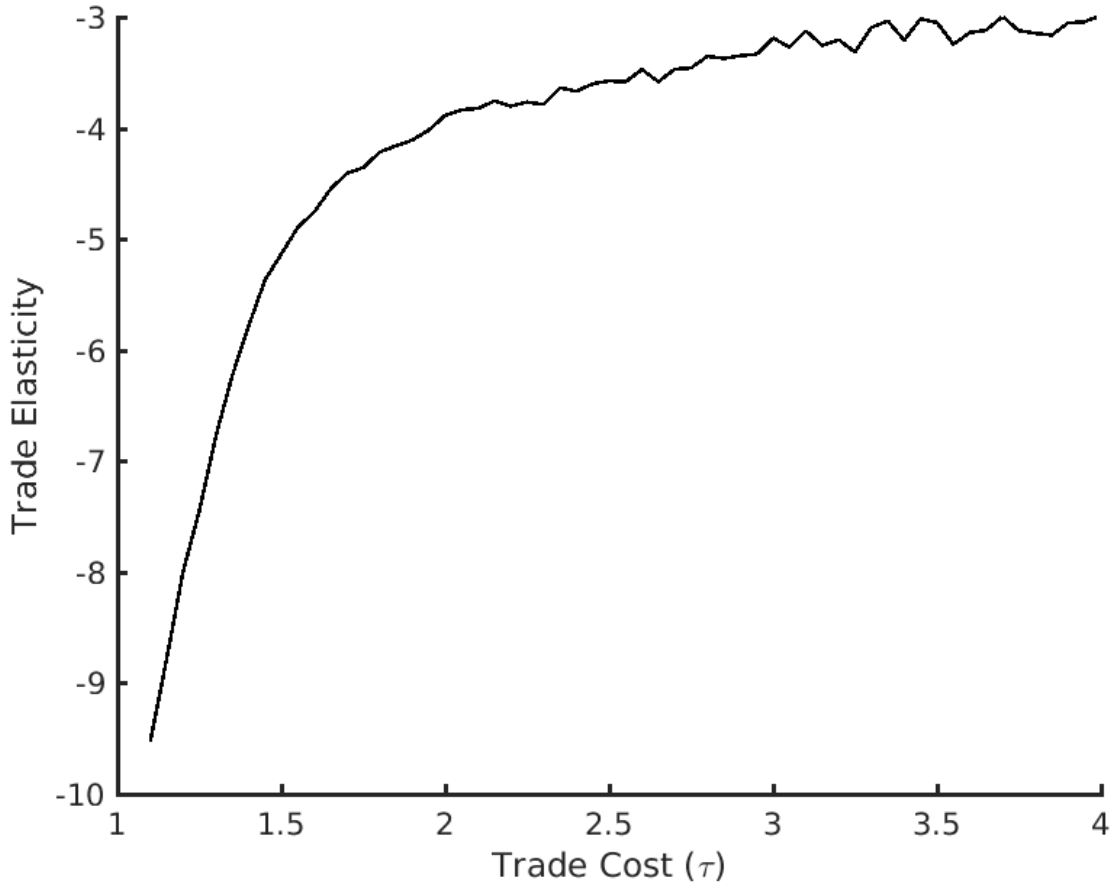
	U.S.	OECD
Static Gains according to the ACR formula	1.1%	1.0%
Static Gains in our Model	13.3%	15.5%
Dynamic Gains - Exogenous Innovation	37.0%	104%
Dynamic Gains - Endogenous Innovation	30.1%	44.5%

PDV of consumption with τ equal to 1.491 relative to 4

Relative quality distribution



Trade elasticities and trade costs



Outline

1. Facts
2. Model with exogenous arrival rates
3. Model with endogenous arrival rates
4. **Models with limited idea flows**

Alternative model assumptions

- Learning from domestic *producers*
  - When innovating on an imported variety:
    - fraction κ of draws on sellers
    - fraction $1 - \kappa$ on (dormant) domestic producers
- Learning from domestic producers with specialized innovation
  - Fraction ν of draws on all products
  - Fraction $1 - \nu$ of draws on products a country produces

Trade liberalization with alternative model assumptions

	Baseline $\kappa = 1$ $\nu = 1$	Limited idea flows $\kappa = 0.3$ $\nu = 1$	Research specialization $\kappa = 0.3$ $\nu = 0.3$
Δ in Annual Growth	0.47%	0.13%	0.48%
Gains from Trade U.S.	37.0%	27.3%	40.3%
Gains from Trade OECD	104.0%	47.8%	33.1%

Notes: Trade share goes from 0.4% to 10% in all cases.
Exogenous arrival rates for simplicity.

Choosing between alternative models

	Data	Baseline $\kappa = 1$ $\nu = 1$	Limited idea flows $\kappa = 0.3$ $\nu = 1$	Research specialization $\kappa = 0.3$ $\nu = 0.3$
Product Exit Rate from Exporting	15.1%	12.8%	5.9%	1.1%
Top Export Category Reversion	66.5%	77.5%	87.9%	95.4%

Canada post-CUSFTA vs. pre-CUSFTA

	Data	Baseline $\kappa = 1$ $\nu = 1$	Limited idea flows $\kappa = 0.3$ $\nu = 1$	Research specialization $\kappa = 0.3$ $\nu = 0.3$
Δ Job Creation Rate	1.3%	6.7%	4.0%	4.3%
Δ Job Destruction Rate	7.2%	6.7%	4.0%	4.3%
Δ Job Creation from Exports	8.7%	8.7%	5.8%	6.1%

Note: Exogenous arrival rates

What if knowledge diffusion is independent of trade?

Pros

- Can still generate export product turnover
- Helps explain why small countries are not poor
  (Ramondo, Rodriguez-Clare, Saborio-Rodriguez, 2016)

Cons

- No sustained increase in job reallocation after trade liberalization
- No dynamic gains from trade liberalization
  (vs. Feyrer, Coe-Helpman-Hoffmaister reduced-form evidence)

Conclusion

- Documented 9 facts about jobs & trade in U.S. & Canadian mfg.
- Analyzed a 2-country model of creative destruction and growth
- In the calibrated model, under current trade (relative to autarky):
  - $\sim$ 30% higher consumption-equivalent welfare
  - $\sim$ 3 percentages point higher job destruction rate

Potential follow-up research

- Frictions to job reallocation
  - Implications for consumption inequality
- The Rise of China and Global Innovation
- Optimal R&D subsidies (Global Technical Change Accord)