A Global View of Creative Destruction

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December 2018

LAEF Seminar Series
UC Santa Barbara Department of Economics

Motivation

- Growing literature on *dynamic* costs and benefits of trade
- Our focus: creative destruction and trade
- Does trade boost rates of innovation and job destruction?

What we do and find (so far)

- Document 8 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:
  - 22% to 28% higher consumption-equivalent welfare
  - 3 to 4 percentage points higher job destruction rate

Related recent papers

Evidence on dynamic costs and benefits

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

Models of trade and growth

- Alvarez, Buera and Lucas (2013)
- Perla, Tonetti and Waugh (2016)
- Buera and Oberfield (2017)
- Akcigit, Ates and Impullitti (2018)

Relation to Atkeson and Burstein (2010)

1. Domestic and international knowledge spillovers (us) vs. no knowledge spillovers (them)
2. Creative destruction (us) vs. no creative destruction (them)
3. Fixed # of varieties (us) vs. endogenous # of varieties (them)
4. Autarky to current trade flows (us) vs. imposing a small trade cost *vis a vis* frictionless trade (them)
5. Long run growth (us) vs. no steady state growth (them)

Classic papers

On trade and growth

- Lucas (1988)
- Rivera-Batiz and Romer (1991)
- Stokey (1991)
- Young (1991)
- Grossman and Helpman (1993)
- Eaton and Kortum (2001)

On trade and job reallocation

- Melitz (2003)
- Bernard, Redding and Schott (2007)

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

Fact 1: Large job flows

	U.S.	Canada
Job Creation Rate	28.9%	32.4%
Job Destruction Rate	39.4%	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	31.5%	15.3%
Fraction of all Job Destruction	80%	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	3%	23%
Fraction of all Job Creation	10%	72%

Jobs from exports = (Exports/Shipments) x Employment

U.S. exports by years since firm began exporting

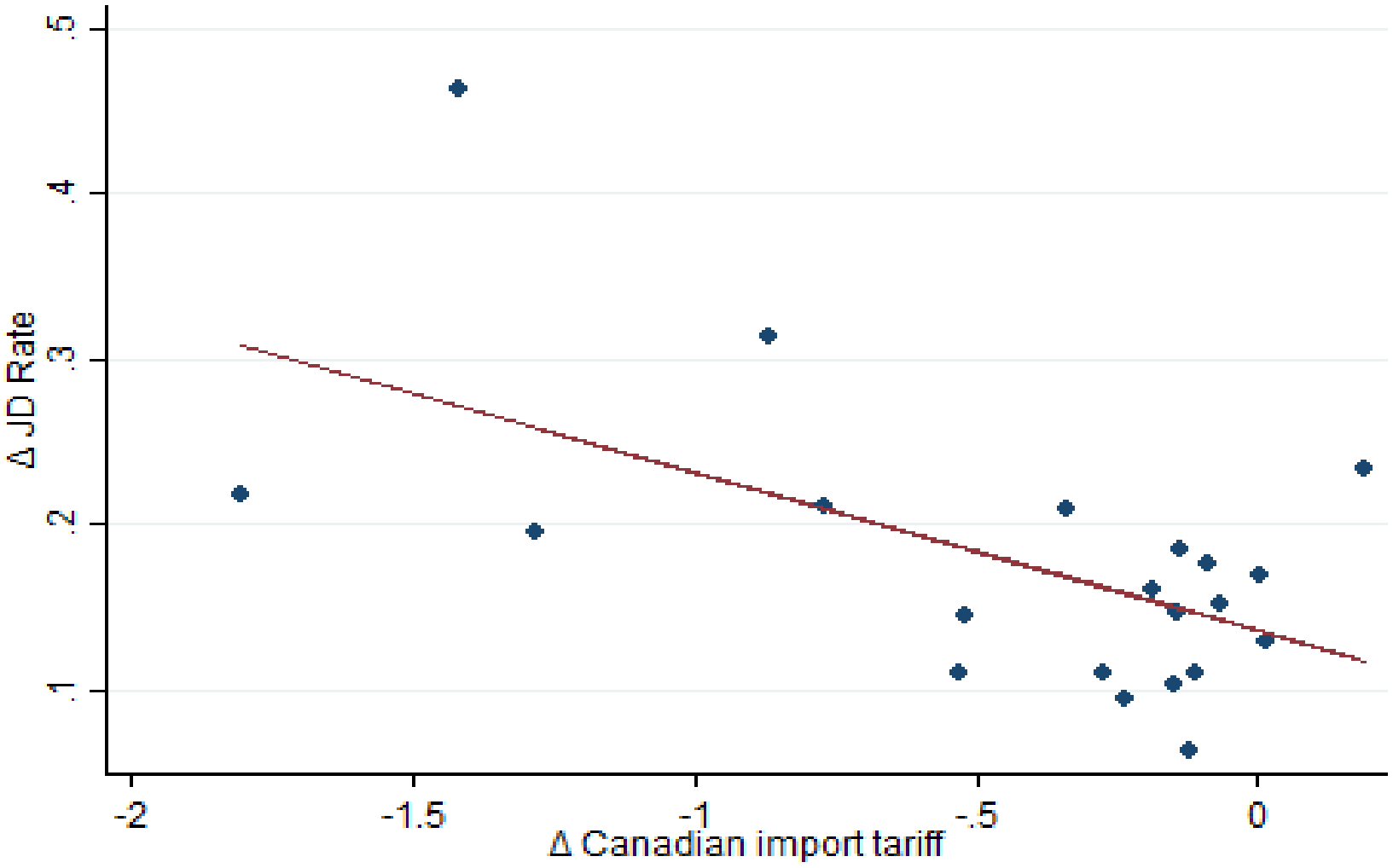
	% of exports in 2002
$<$ 5 years	29%
5 to 9 years	13%
10 to 14 years	12%
15+ years	46%

Source: Lincoln, McCallum and Siemer (2017)

Fact 4: Canadian job flows increased after CUSFTA

	Pre-CUSFTA 1973–1988	Post-CUSFTA 1988–2012
Job Creation Rate	28.0%	36.9%
Job Destruction Rate	26.3%	38.6%

Changes in job destruction and tariffs in Canada



Each observation is a 2-digit industry. Δ JD is the change in the average job destruction rate from 1973–1988 to 1988–2012.

Fact 5: Large firms drove increased job destruction

	Pre-CUSFTA	Post-CUSFTA
Job Destruction Rate	26.3%	38.6%
JD from Larger Firms	18.5%	29.1%

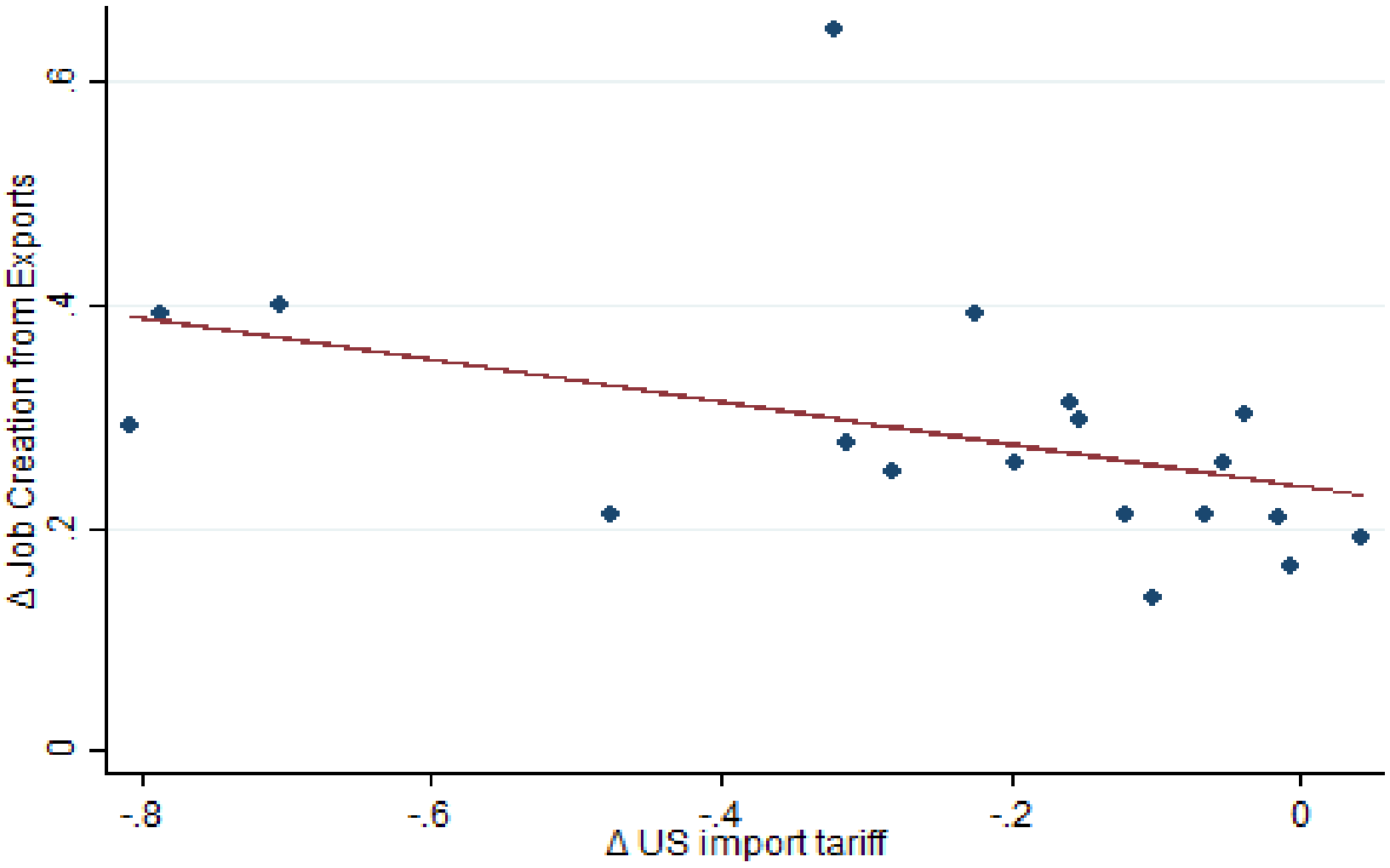
Source: Canadian Annual Survey of Manufacturing

Fact 6: Job creation from exports increased

	Pre-CUSFTA	Post-CUSFTA
Job Creation Rate	28.0%	36.9%
Job Creation from Exports	8.3%	32.3%

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 1974–1989 to 1989–2012.

Job flows in the U.S.

	1972–1987	1987–1992	1992–2012
Job Creation Rate	31.0%	29.9%	28.6%
Job Destruction Rate	29.3%	33.9%	40.7%
Job Destruction from Larger Firms	22.3%	26.0%	32.9%
Job Creation from Exports	–	2.7%	3.1%

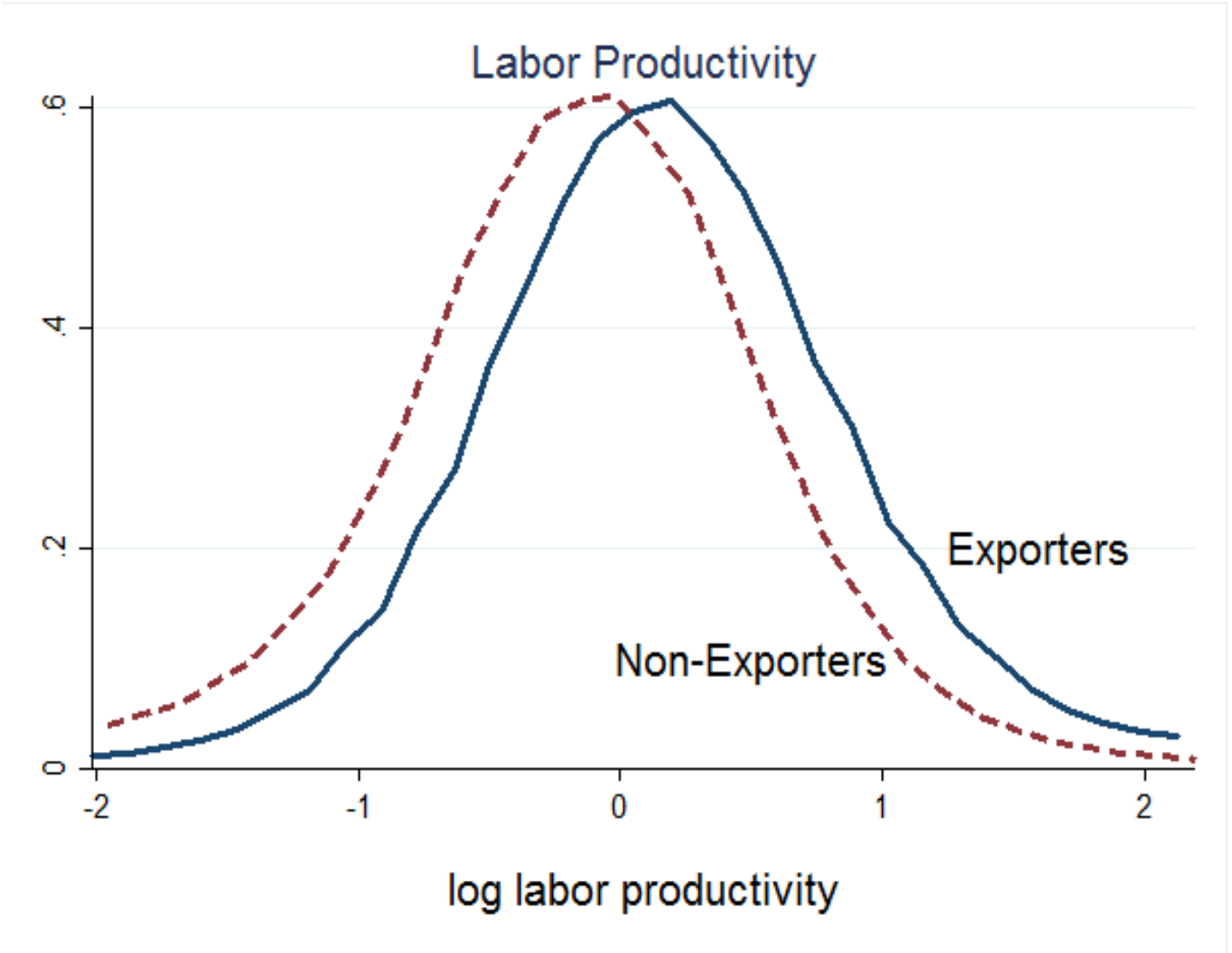
Facts 7 and 8

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

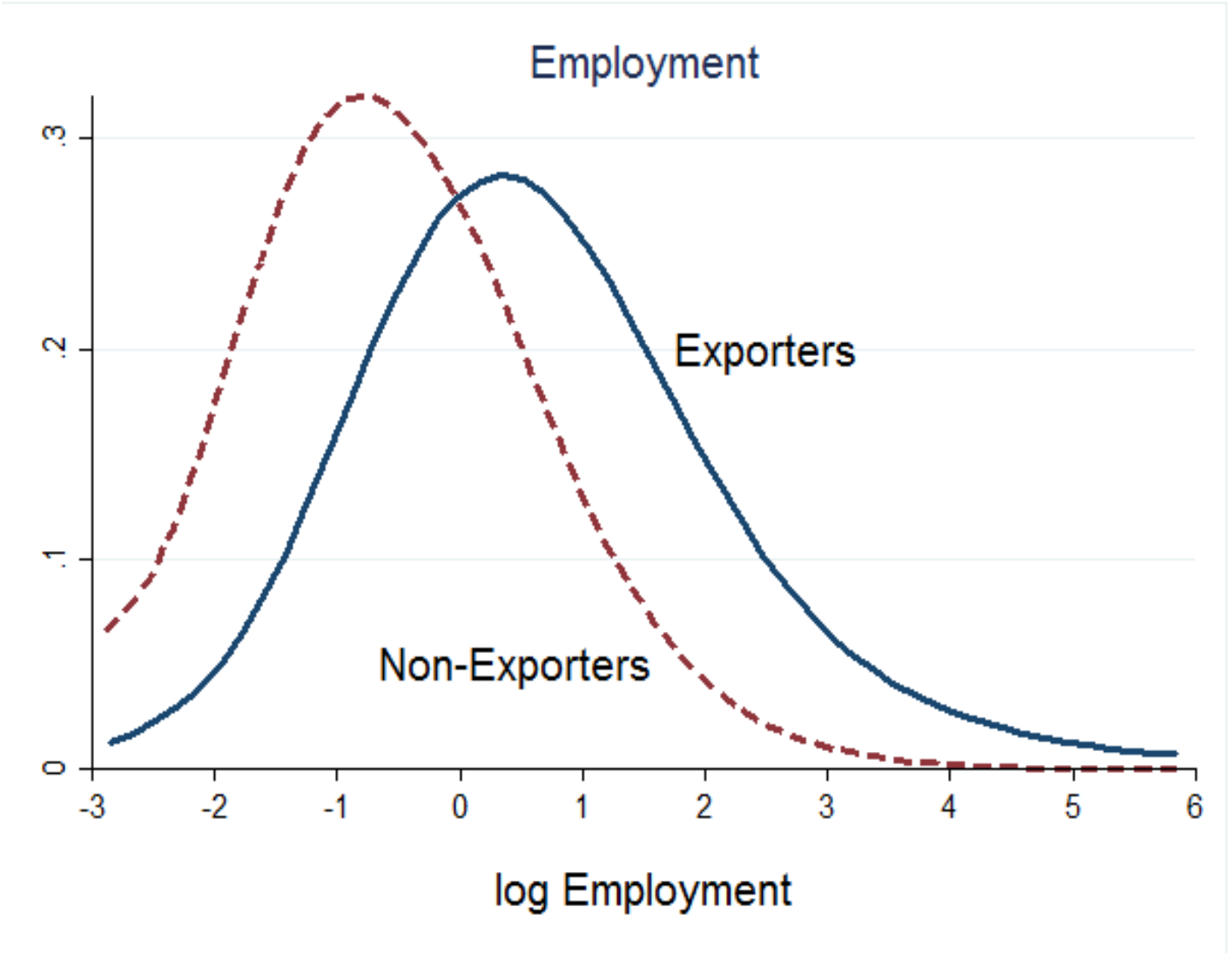
- But there is much overlap in the exporter and non-exporter distributions of labor productivity and employment

Labor productivity = revenue per worker

U.S. labor productivity distribution in 2012



U.S. employment distribution in 2012



Outline

Preferences

$$U = \prod_{j=1}^{M} C_j^{\frac{1}{M}}$$

$$U^* = \prod_{j=1}^{M} C_j^{*\,\frac{1}{M}}$$

M = fixed number of varieties

$$Y_j = A_j L_j$$

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

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

$$L = \sum_{j=1}^{M} L_j, \quad L^* = \sum_{j=1}^{M} L_j^*$$

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

- $j \in [1, x_1]$ are traded and produced at home
- $j \in [x_1, x_2]$ are non-traded
- $j \in [x_2, M]$ are traded and produced abroad

The cutoff products x_1 and x_2 are determined by

$$\frac{A_{x_1}}{\tau} = \omega A_{x_1}^*, \quad A_{x_2} = \frac{\omega A_{x_2}^*}{\tau}$$

When $\tau = 1$, $x_1 = x_2$ and all products are traded

Balanced trade

The relative wage ω is pinned down by balanced trade:

$$\frac{I^*}{\tau M} \cdot x_1 = \frac{I}{\tau M} \cdot (M - x_2)$$

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

LHS = home country exports

RHS = home country imports

GDP and markups

$$I = \frac{\overline{\mu}\, wL}{1 - \frac{1-\tau}{\tau} \cdot \frac{M - x_2}{M}} \qquad \text{and} \qquad I^* = \frac{\overline{\mu}^* w^* L^*}{1 - \frac{1-\tau}{\tau} \cdot \frac{x_1}{M}}$$

$$\frac{1}{\bar{\mu}} \equiv \frac{\sum_{j=1}^{x_2} \frac{1}{\mu_j} + \frac{1}{\tau} \cdot \sum_{j=1}^{x_1} \frac{1}{\mu_j^f}}{x_2 + x_1/\tau}$$

$$\frac{1}{\bar{\mu}^*} \equiv \frac{\sum_{j=x_1}^{M} \frac{1}{\mu_j^*} + \frac{1}{\tau} \cdot \sum_{j=x_2}^{M} \frac{1}{\mu_j^{*f}}}{M - x_1 + (M - x_2)/\tau}$$

Equilibrium consumption wages

$$W = \prod_{j=1}^{x_2} \left(\frac{A_j}{\mu_j} \right)^{\frac{1}{M}} \prod_{j=x_2}^{M} \left(\frac{A_j^*}{\mu_j^*} \cdot \frac{\omega}{\tau} \right)^{\frac{1}{M}}$$

$$W^* = \prod_{j=1}^{x_1} \left(\frac{A_j}{\mu_j} \cdot \frac{1}{\omega\,\tau} \right)^{\frac{1}{M}} \prod_{j=x_1}^{M} \left(\frac{A_j^*}{\mu_j^*} \right)^{\frac{1}{M}}$$

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 is $\frac{1}{\theta-1}$

Expected growth rate of home real wages

$$g = \underbrace{(\lambda + \widetilde{\eta}) \left[\frac{1}{\theta - 1} \right]}_{\text{home innovation}}$$

$$+ \underbrace{\left(\widetilde{\lambda}^* + \widetilde{\eta}^* \right) \cdot \left[\frac{M - x_2}{M} \cdot \frac{1}{\theta - 1} + \frac{x_2}{M} \left(\frac{\omega}{\tau} \right)^{\theta} \left(\frac{\theta}{\theta - 1} \left[\frac{\tau}{\omega} \right] - 1 \right) \right]}_{\text{foreign innovation}}$$

Note: Assuming $\tau > \omega > 1$

Expected growth rate of foreign real wages

$$g^* = \underbrace{\left(\widetilde{\lambda}^* + \widetilde{\eta}^*\right)\left[\frac{1}{\theta - 1}\right]}_{\text{foreign innovation}}$$

$$+ \underbrace{(\lambda + \widetilde{\eta}) \cdot \left[\frac{x_1}{M} \cdot \frac{1}{\theta - 1} + \frac{M - x_1}{M}\left(\frac{1}{\omega\tau}\right)^{\theta}\left(\frac{\theta}{\theta - 1}\left[\omega\tau\right] - 1\right)\right]}_{\text{home innovation}}$$

Home and Foreign growth rates are equal due to the flow of ideas.

Mean reversion in productivity

$$\tilde{a}_j = \tilde{a} + \rho \cdot (a_j - \tilde{a})$$

$$0 < \rho < 1$$

$$a_j \equiv \log(A_j)$$

$$\tilde{a} \equiv \log(\tilde{A})$$

$$\tilde{A} \equiv \prod_{j=1}^{M} A_j^{1/M}$$

Data moments used for calibration

Data Moment	Source	Value
Revenue per worker exp./non-exp.	U.S. mfg 2012	1.066
TFP growth rate	U.S. mfg 1995–2008	3.01%
Value added per worker home/foreign	U.S., OECD mfg 1995–2008	1.29
Employment share of entrants	U.S. mfg 2012	14.4%
Export share of revenues (home)	U.S. mfg 2012	10.2%
Trade elasticity from halving τ	Head and Mayer (2014)	–5
Employment home/foreign	U.S., OECD mfg 1995–2008	0.389
Employment growth rate	OECD mfg 1995–2008	–1.3%

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

Parameter estimates

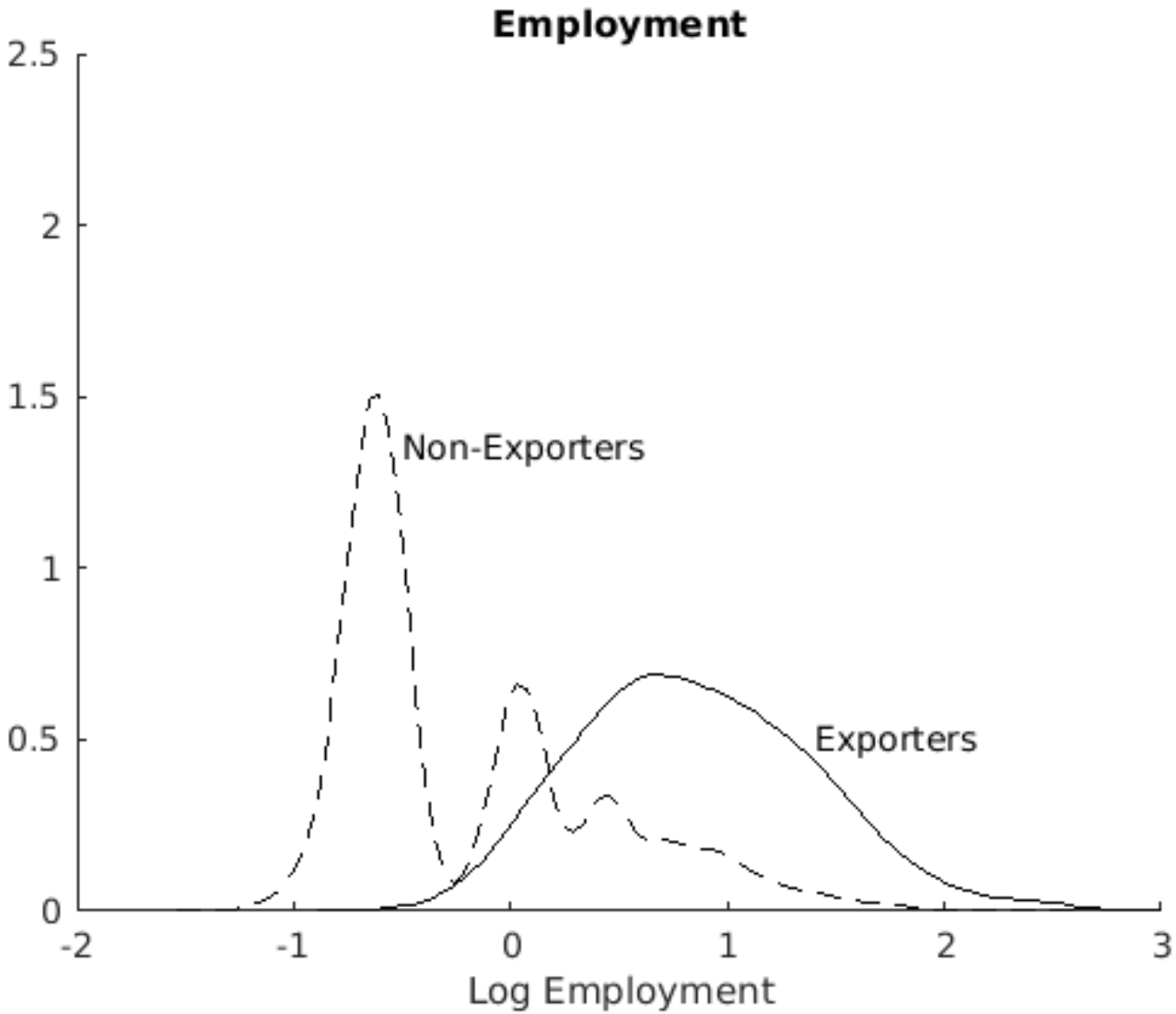
θ	Shape parameter of innovation draws	4.84
λ	Innovate rate, home incumbents	9.98%
$\widetilde{\eta}$	Innovation rate, home entrants	1.57%
$\widetilde{\lambda}^*$	Innovation rate, foreign incumbents + entrants	10.81%
τ	Gross tariff rate	1.474
ρ	Productivity mean reversion	0.92

Firm dynamics: data vs. simulations (untargeted moments)

	U.S. Data	Simulations
Job Creation Rate	28.9%	30.6%
Job Destruction Rate	39.4%	37.1%
Job Destruction from Large Firms	31.5%	21.0%
Job Creation from Exports	3.0%	6.7%
Job Destruction from Imports	–	7.8%

The U.S. data are averages from 1987 to 2012.

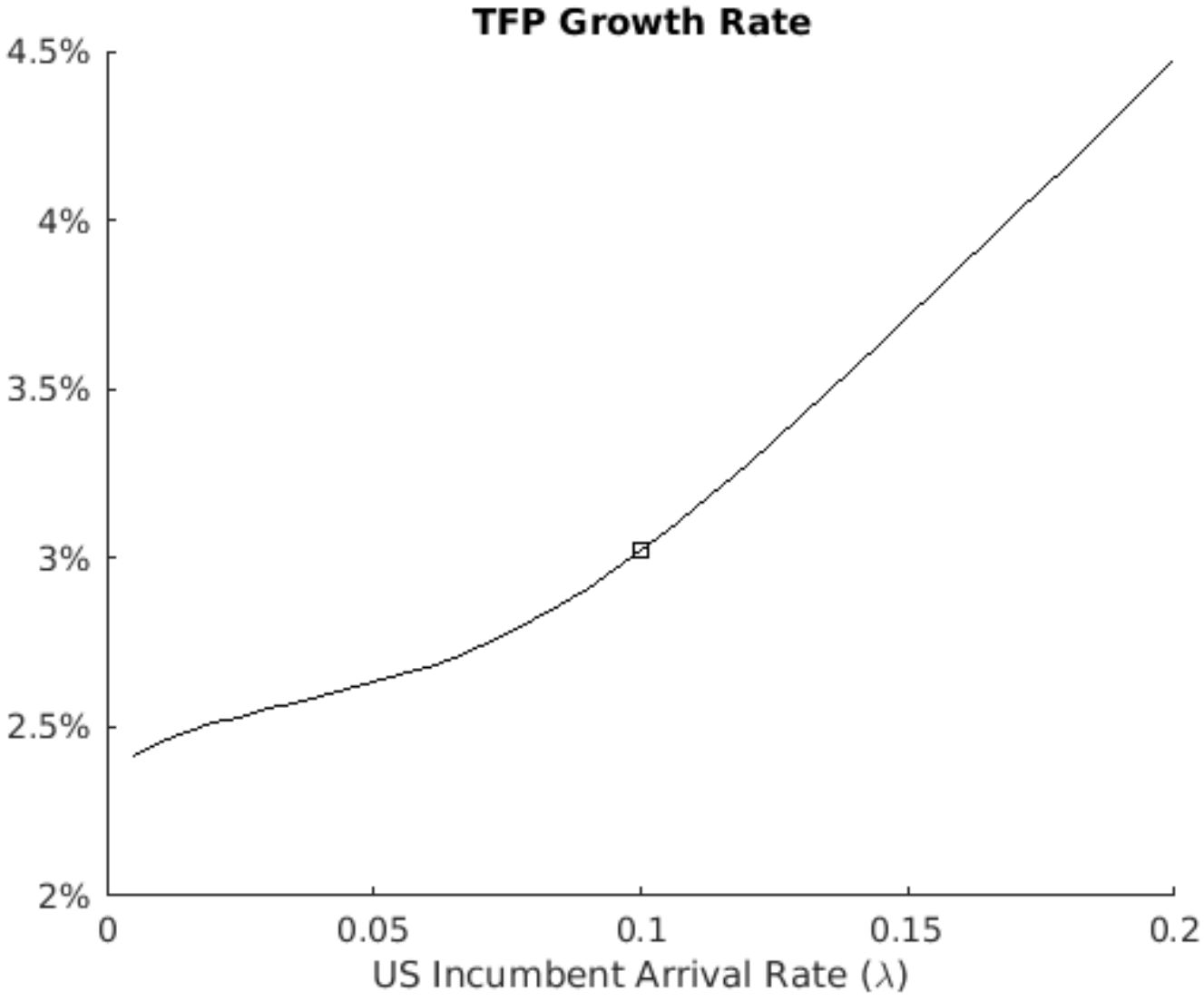
Simulated employment distribution



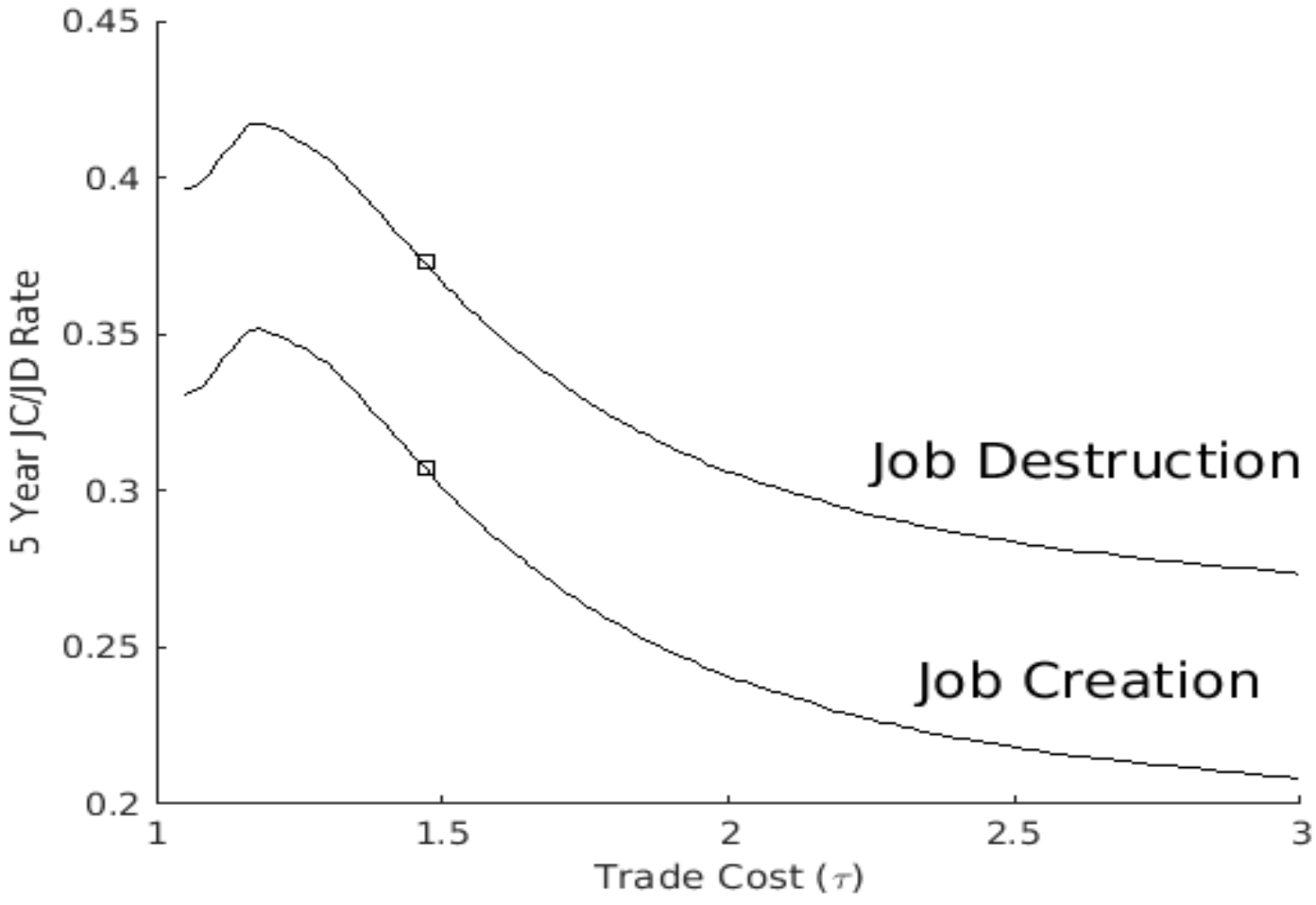
Simulated labor productivity distribution

Effect of home innovation on the home/foreign wage

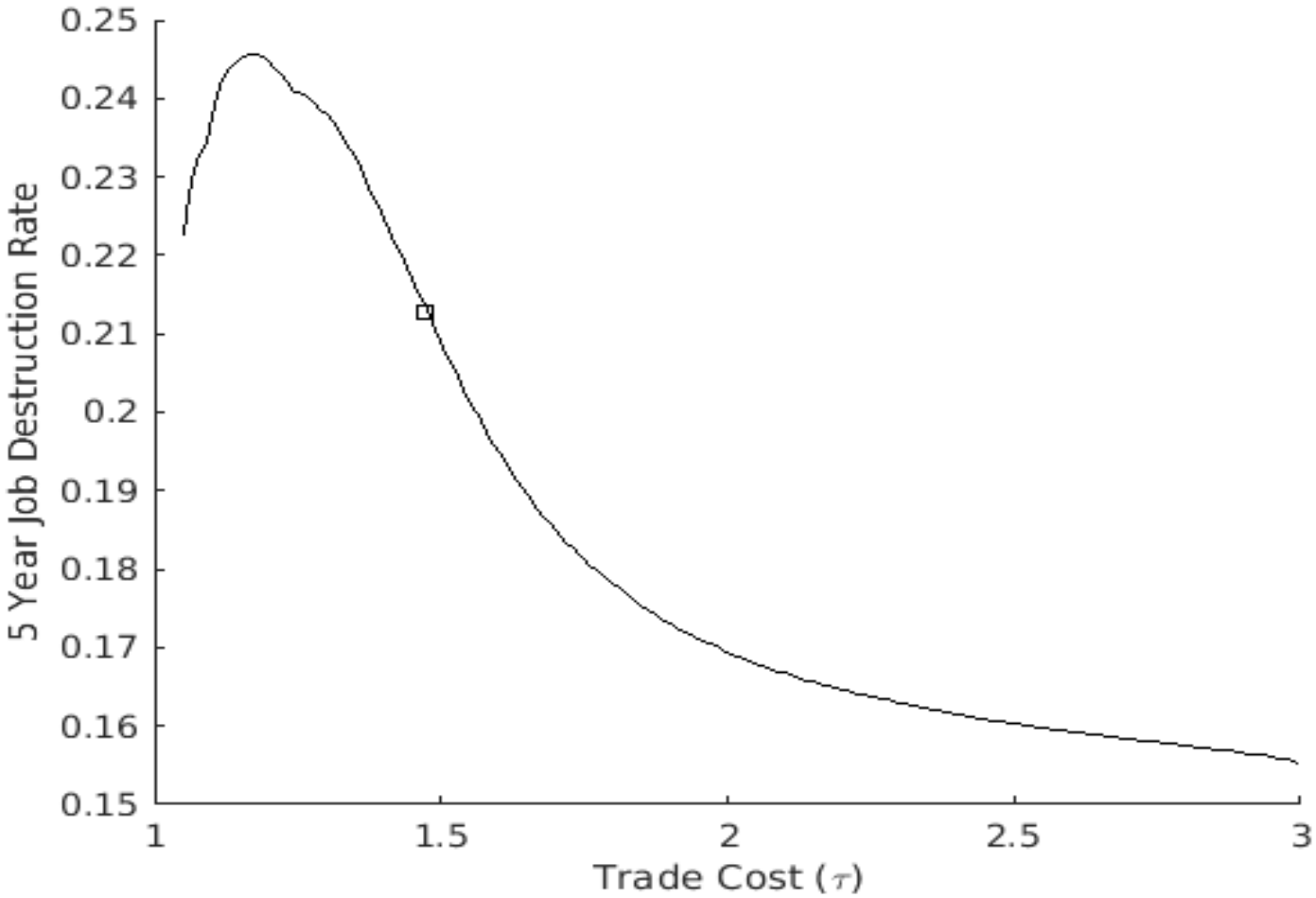
Effect of home innovation on the common growth rate



Simulated job flows vs. trade costs

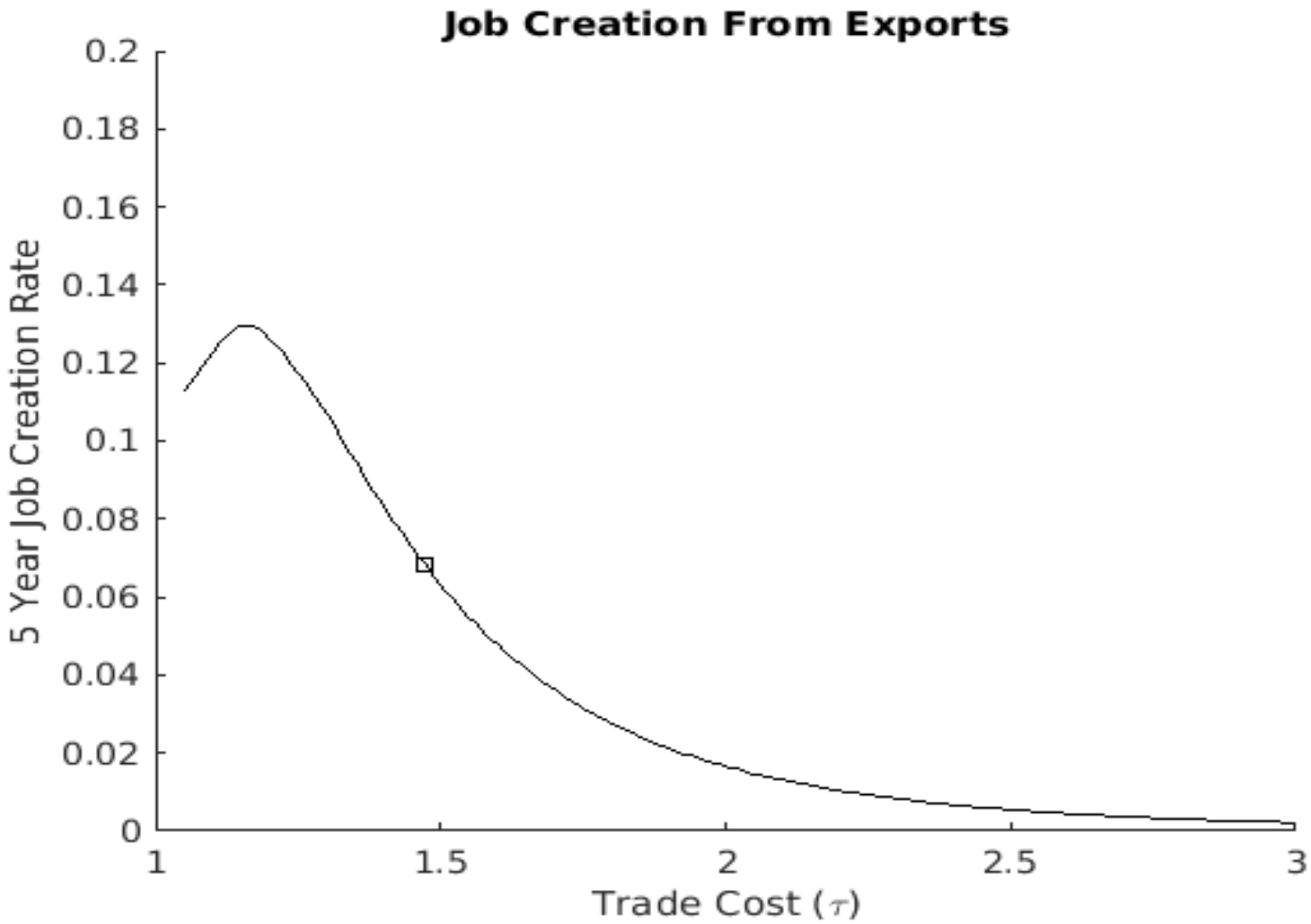


Job destruction from large firms vs. trade costs



Job destruction from imports vs. trade costs

Job creation from exports vs. trade costs



Outline

Incumbent arrival rates

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

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

$\bar{A}$ 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 the external returns to the stock of ideas

Average productivity of sellers into each market

$$\bar{A} = \prod_{j=1}^{x_2} A_j^{\frac{1}{M}} \prod_{j=x_2}^{M} A_j^{*\frac{1}{M}}$$

$$\bar{A}^* = \prod_{j=1}^{x_1} A_j^{\frac{1}{M}} \prod_{j=x_1}^{M} A_j^{*\frac{1}{M}}$$

Entrant arrival rates

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

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 $\bar{A}^*$

Targets for the endogenous innovation case

Free entry conditions for entrant research

First order conditions for incumbent research

Assume linear utility so that $r = \rho$, set $\rho = 0.05$

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

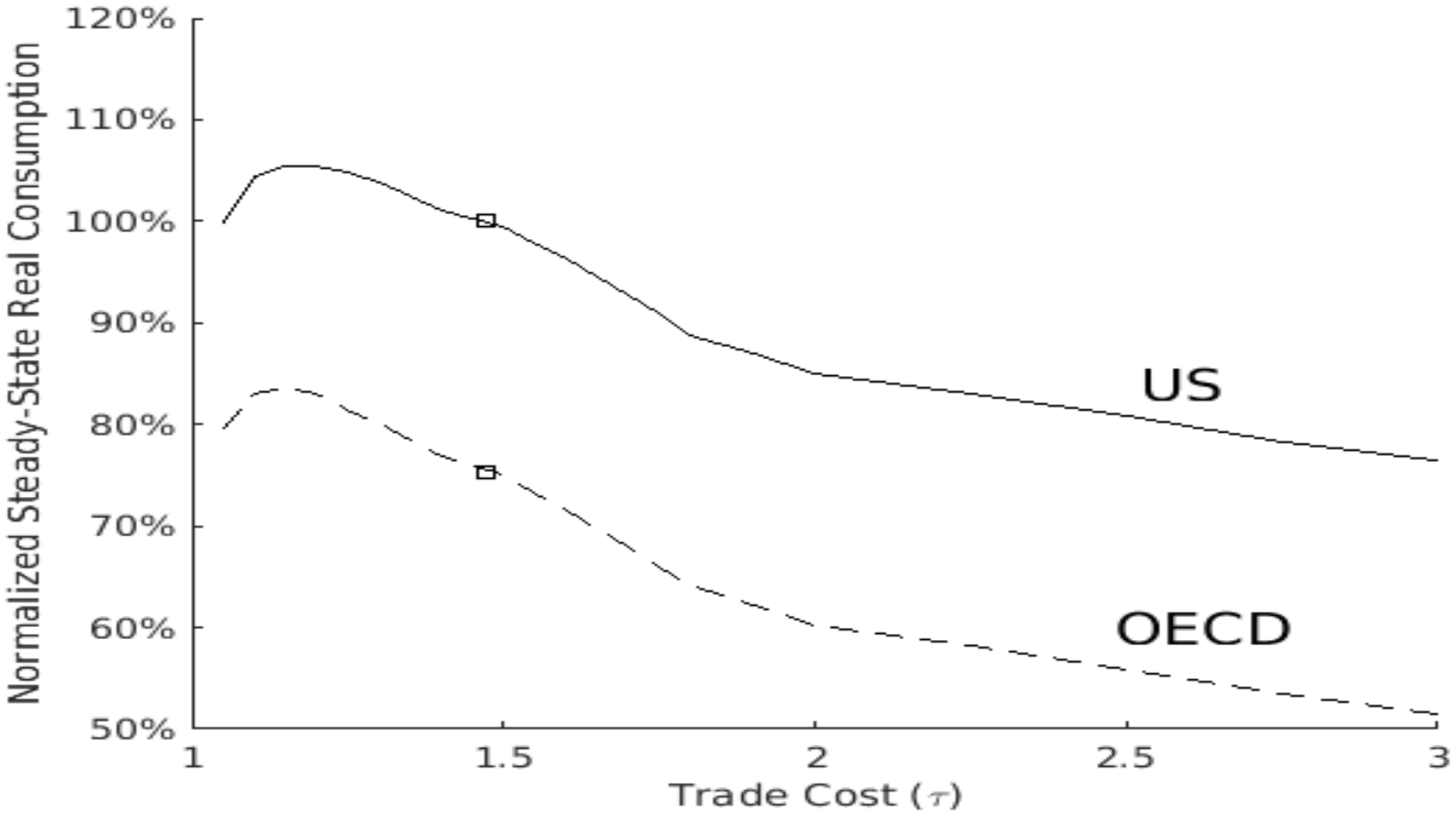
BEA intellectual property investments grew 4.53%, 1995–2008

Such investments averaged 10.4% of value added, 1997–2008

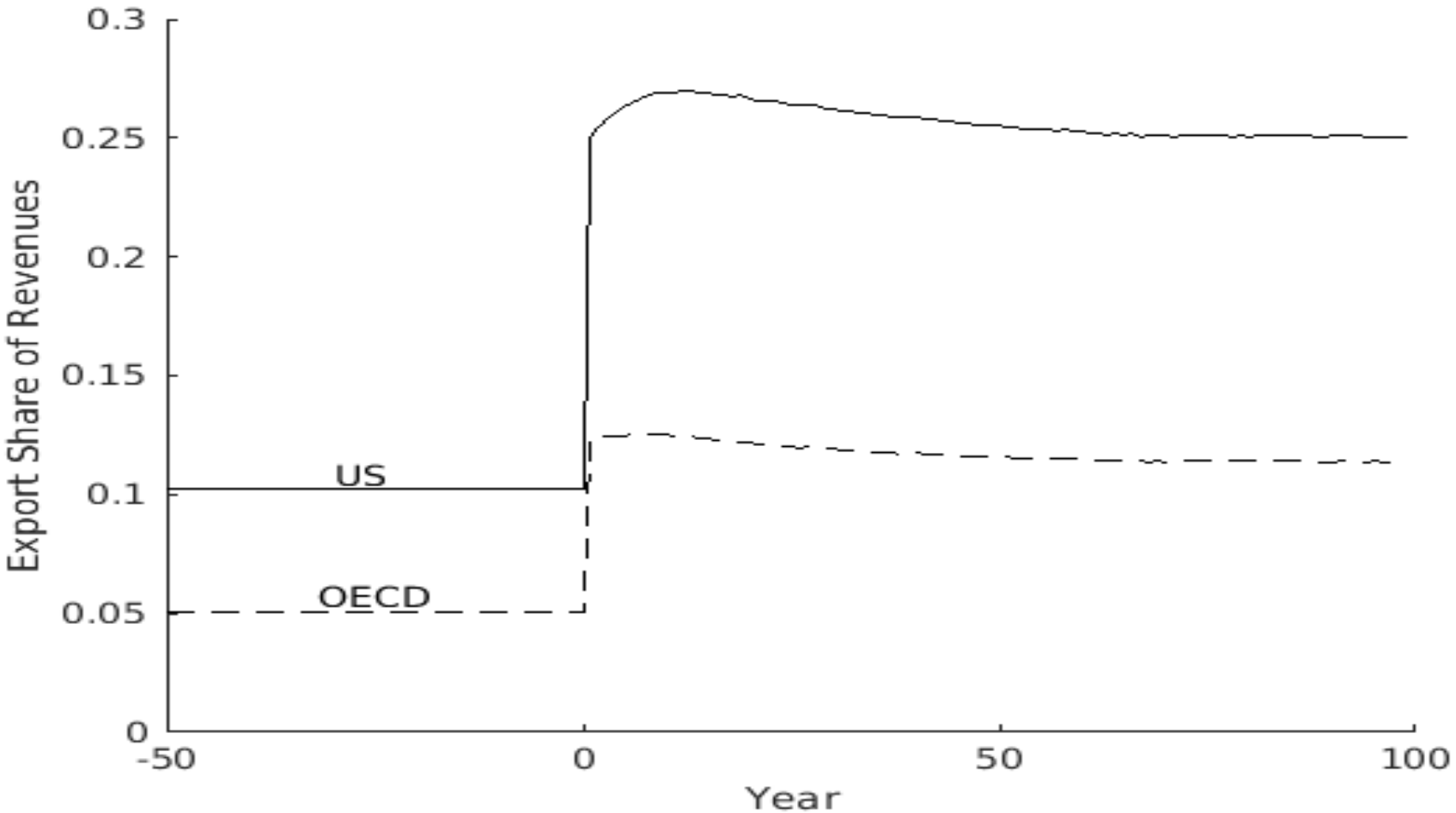
Parameter estimates for endogenous arrivals

ϕ	Return to the stock of ideas	0.22
γ	Return to research intensity	0.52
χ_e/χ_i	Home entrant/incumbent research cost	5.53
χ_i^*/χ_i	Foreign/home incumbent research cost	5.04
χ_e^*/χ_i	Foreign entrant/home incumbent research cost	16.9

Real wages on the constant growth path

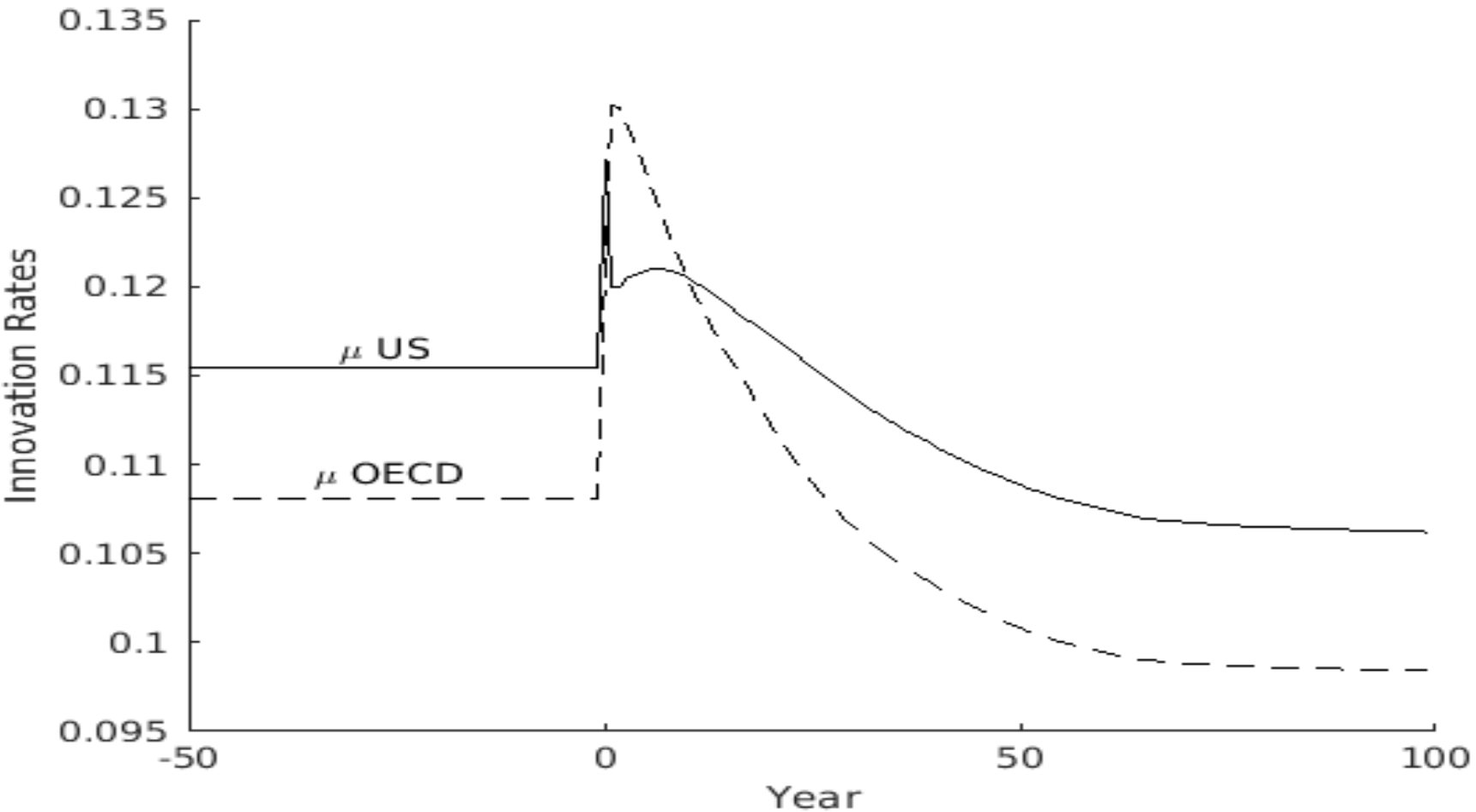


Trade shares after trade liberalization



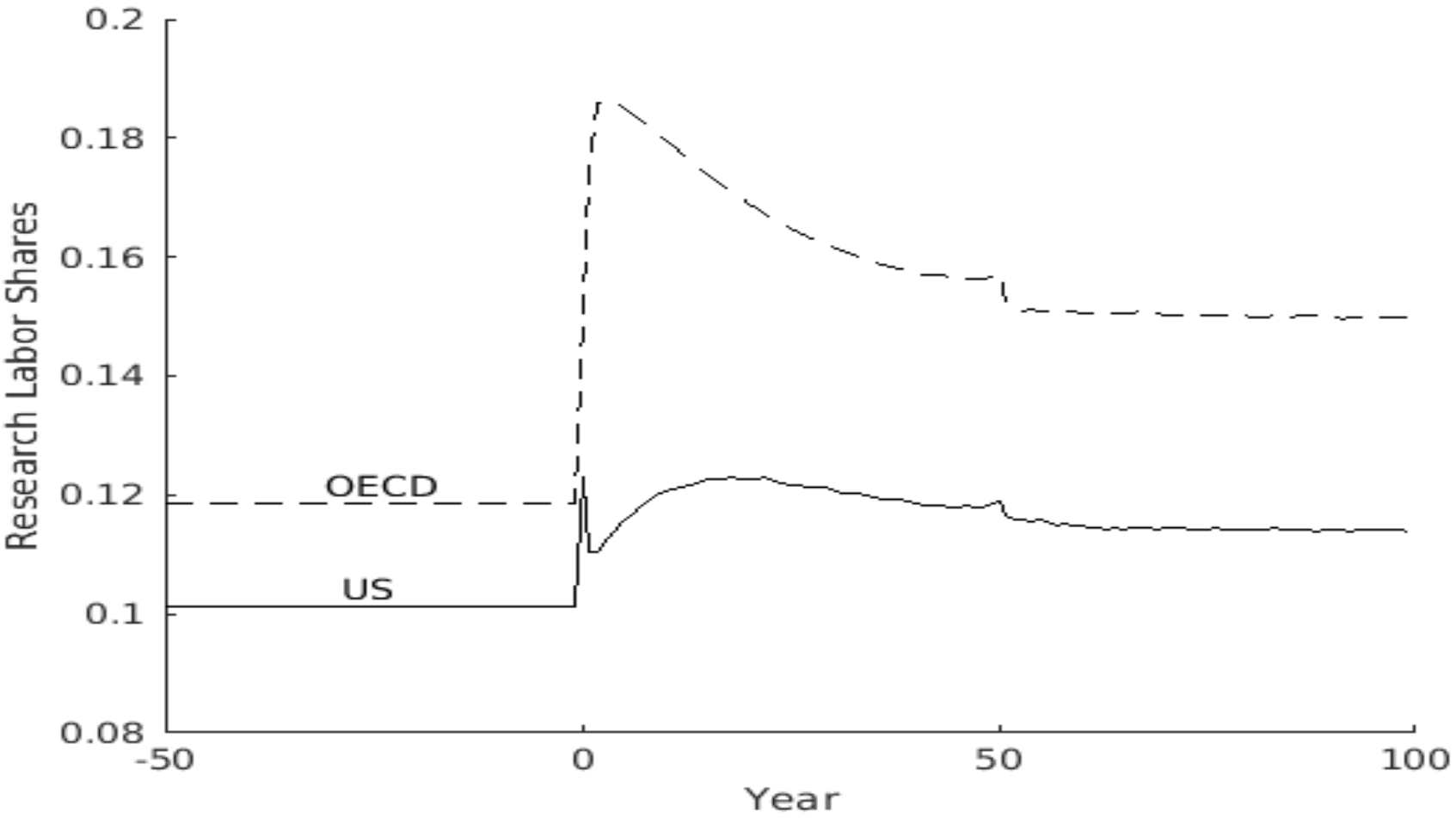
Year 0: τ falls from 1.474 to 1.237

Simulated arrival rates after trade liberalization



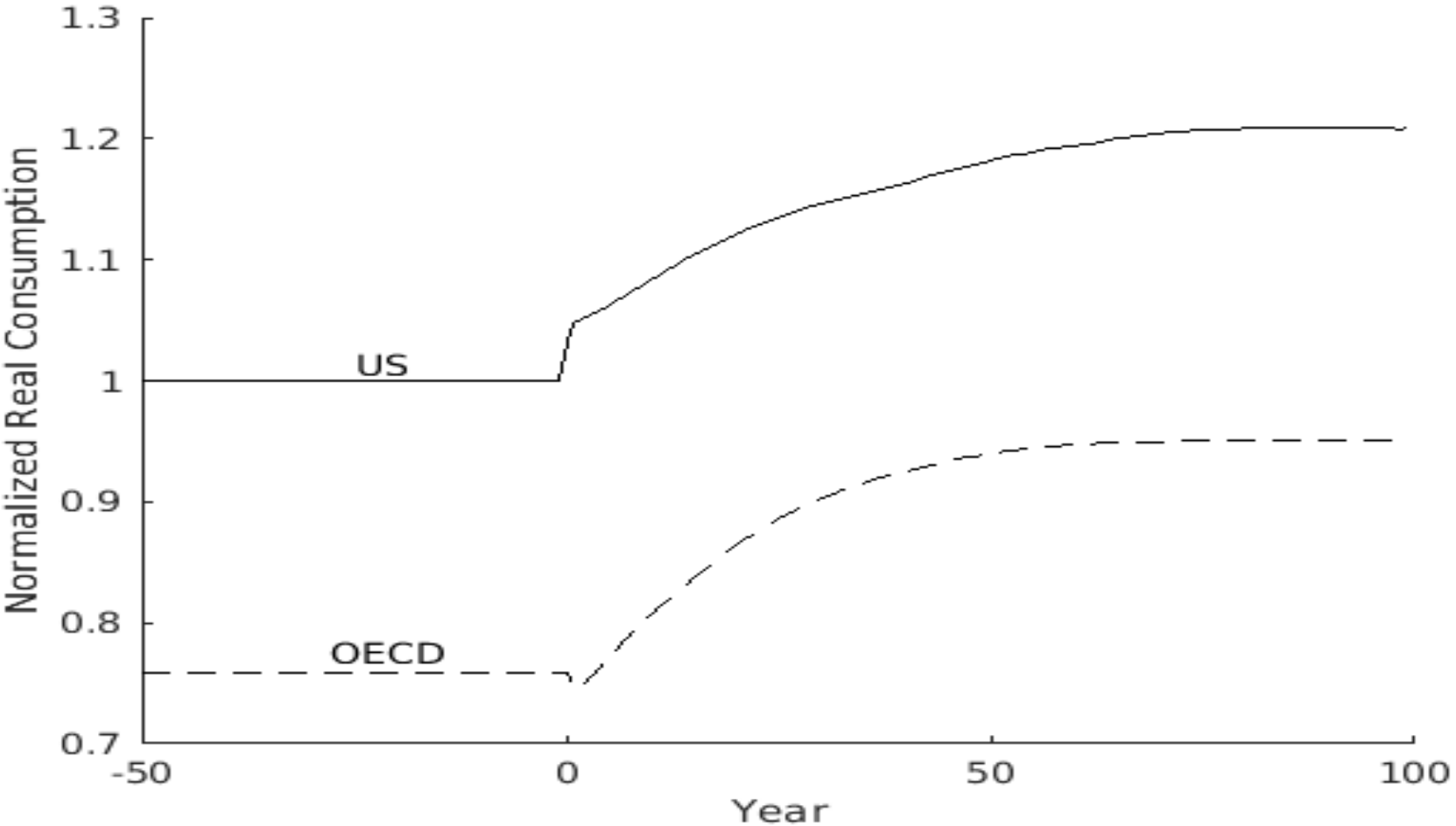
Year 0: τ falls from 1.474 to 1.237

Research labor shares after trade liberalization



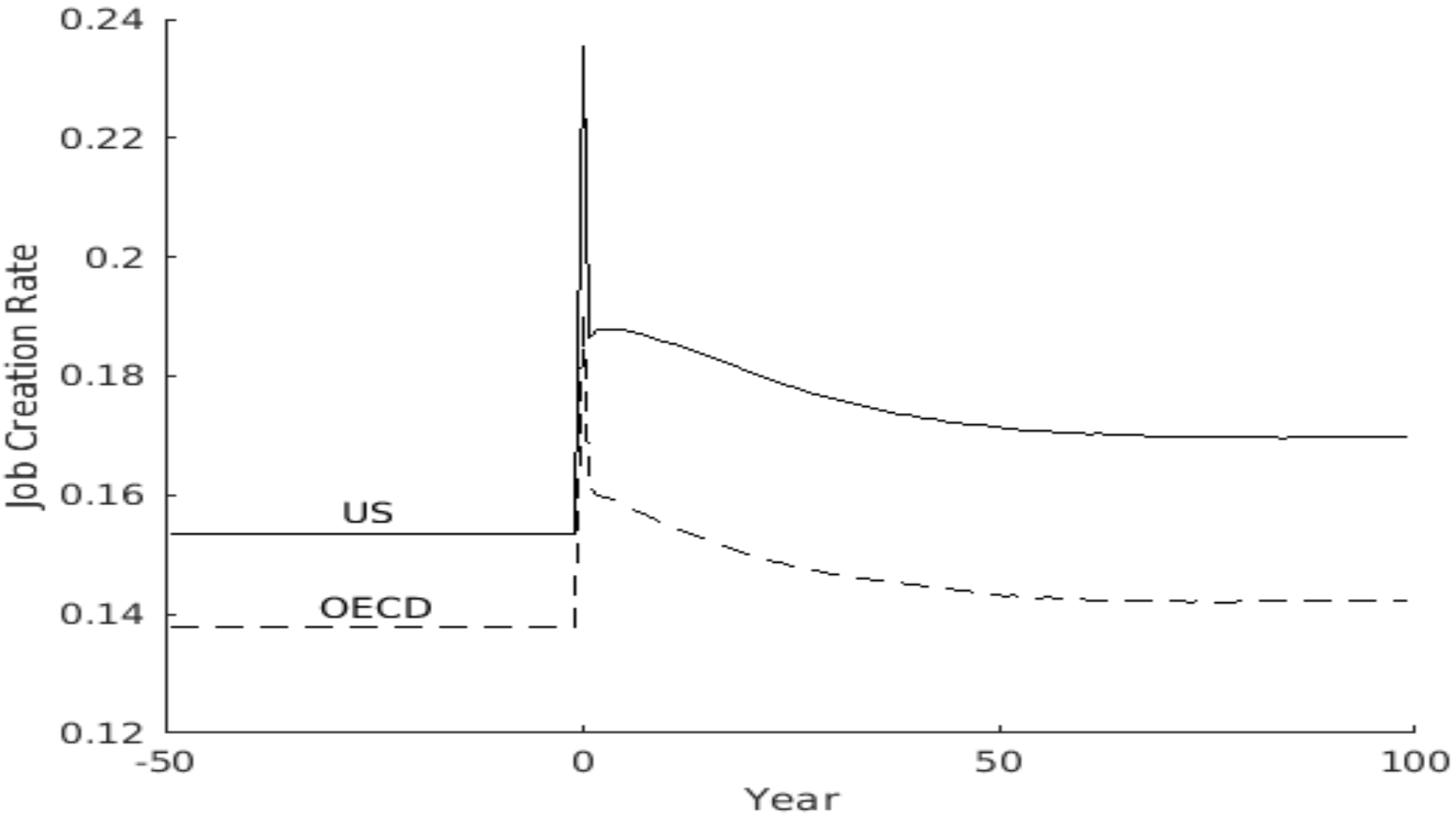
Year 0: τ falls from 1.474 to 1.237

Real consumption after trade liberalization



Year 0: τ falls from 1.474 to 1.237

Job creation rate after trade liberalization



Year 0: τ falls from 1.474 to 1.237

Before vs. after trade liberalization

	Simulated Annual Averages	
	30 years before	30 years after
U.S. Export Share	10.1%	25.7%
OECD Export Share	5.0%	11.9%
U.S. Job Reallocation	13.1%	16.4%
OECD Job Reallocation	11.6%	13.2%

Welfare gains from cutting tariffs in half

	U.S.	OECD
Static Gains	4.9%	3.0%
Dynamic Gains - Exogenous Innovation	18.9%	22.6%
Dynamic Gains - Endogenous Innovation	14.2%	16.0%

PDV of consumption with τ equal to 1.237 relative to 1.474

Welfare gains *vis a vis* autarky

	U.S.	OECD
Static Gains	8.3%	4.8%
Dynamic Gains - Exogenous Innovation	25.7%	45.3%
Dynamic Gains - Endogenous Innovation	22.3%	28.3%

PDV of consumption with τ equal to 1.474 relative to 3

Why much smaller gains with endogenous innovation?

- Labor is diverted from production to research
  - Lowers consumption in the short run
  - Lowers the level of the consumption path
- But the main reason is diminishing returns
  - To the stock of ideas ($\phi < 1$)

Conclusion

- Documented 8 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):
  - 22% to 28% higher consumption-equivalent welfare
  - 3 to 4 percentages point higher job destruction rate

Potential follow-up research

- Learning from producers instead of sellers
  - without versus with research specialization
- Frictions to job reallocation
  - Implications for consumption inequality
- Leader/innovator (OECD) vs. follower/imitator (China?)
- Optimal R&D subsidies (Global Technical Change Accord?)

Preliminary results on learning from domestic producers

Fraction κ of draws on sellers, fraction $1 - \kappa$ on domestic producers.

Changes *vis a vis* autarky:

	$\kappa = 1$	$\kappa = 0.05$
U.S. JC/JD rates	10.0%	8.7%
TFP growth	0.54%	0.04%
U.S. Welfare	25.7%	13.7%
OECD Welfare	45.3%	6.8%

Note: Exogenous arrival rates

Research specialization

Suppose fraction ν of draws are on all product lines.

Fraction $1 - \nu$ are focused on domestically-produced lines.

Conjecture that small κ + small ν will yield:

- Similar boost to JC/JD as with high κ + high ν
- Similar boost to LR growth as with high κ + high ν
- Similar welfare gains as with high κ + high ν