IEA Lecture Series
Consequences of Globalization
Globalization and Innovation

Marc Melitz
Harvard University

Part I

Introduction

Recent Developments in the Trade Literature

- The literature on firms and trade has progressively incorporated many additional firm decisions regarding their global operations, including:
  - How to reach customers in Foreign destination
    - Ownership/operating status of Foreign distribution
  - How to adapt product quality for the export markets
  - How to adapt technology to the global scale of production
  - Where and from whom should inputs be sourced
    - Boundary of the firm
- Initially, most of these decisions were analyzed in isolation
- New developments following this research now explore how these decisions are interconnected

Recent Developments in the Trade Literature (Cont.)

New developments following this research: Firms are making joint decision on many facets of their global operations:

- Where/what to sale and Foreign distribution
  - Structure of their global supply chains
  - Status of technology
  - To what extent, where, and with whom to innovate
  - Which technologies to use where (including automation)
- Today, will focus on interconnections between global operations and innovation

Implications for Trade Policy

The implications for trade policy are crucial:

- Must recognize how trade policy will affect those joint decisions – even if it is meant to only impact a single dimension
- Most basic example is that trade policy meant to address firms/workers in one specific sector/country will reverberate across global supply chains
  - ... Affecting the incentives on how much/where to innovate

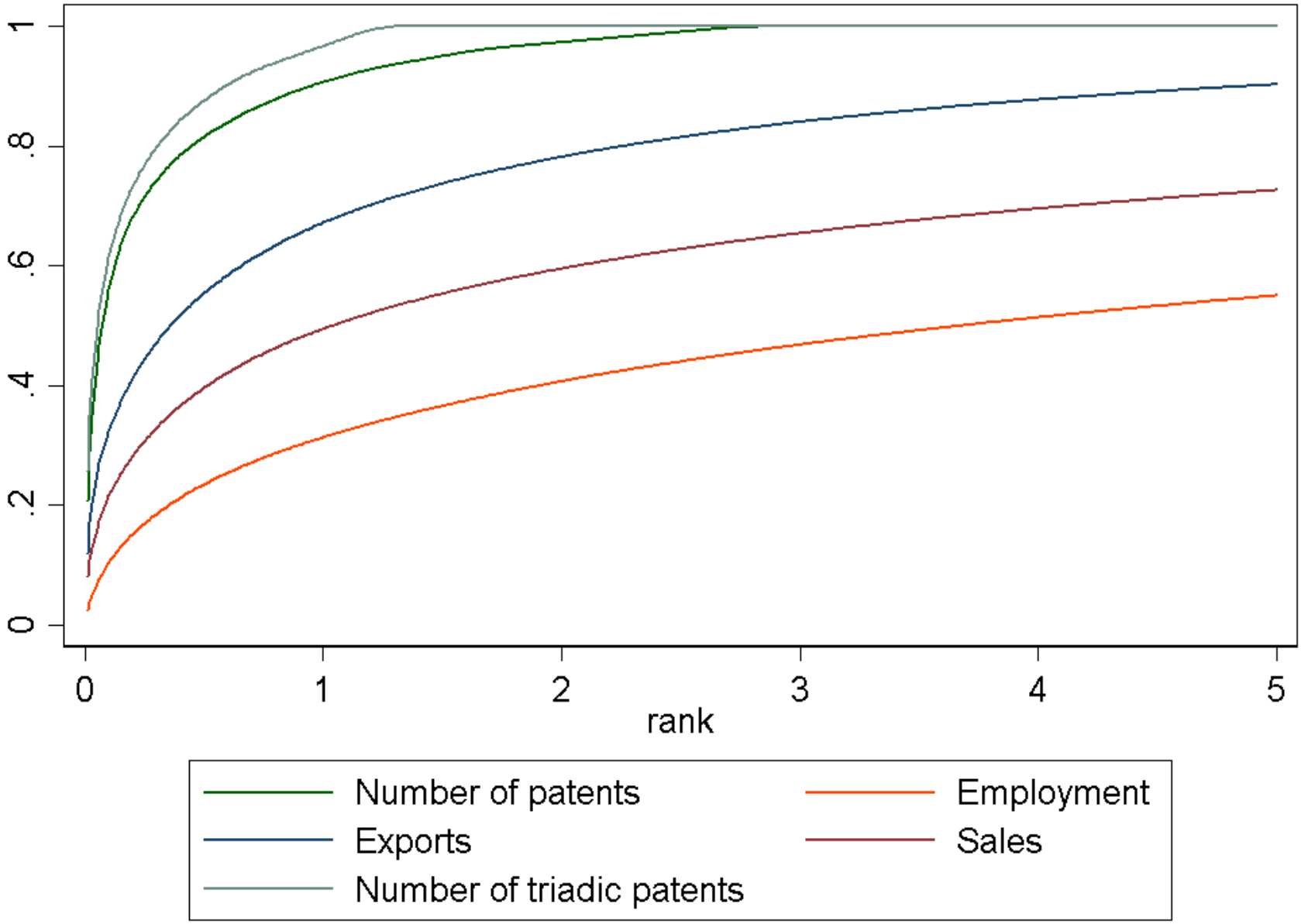
Part II

Evidence on Globalization and Innovation

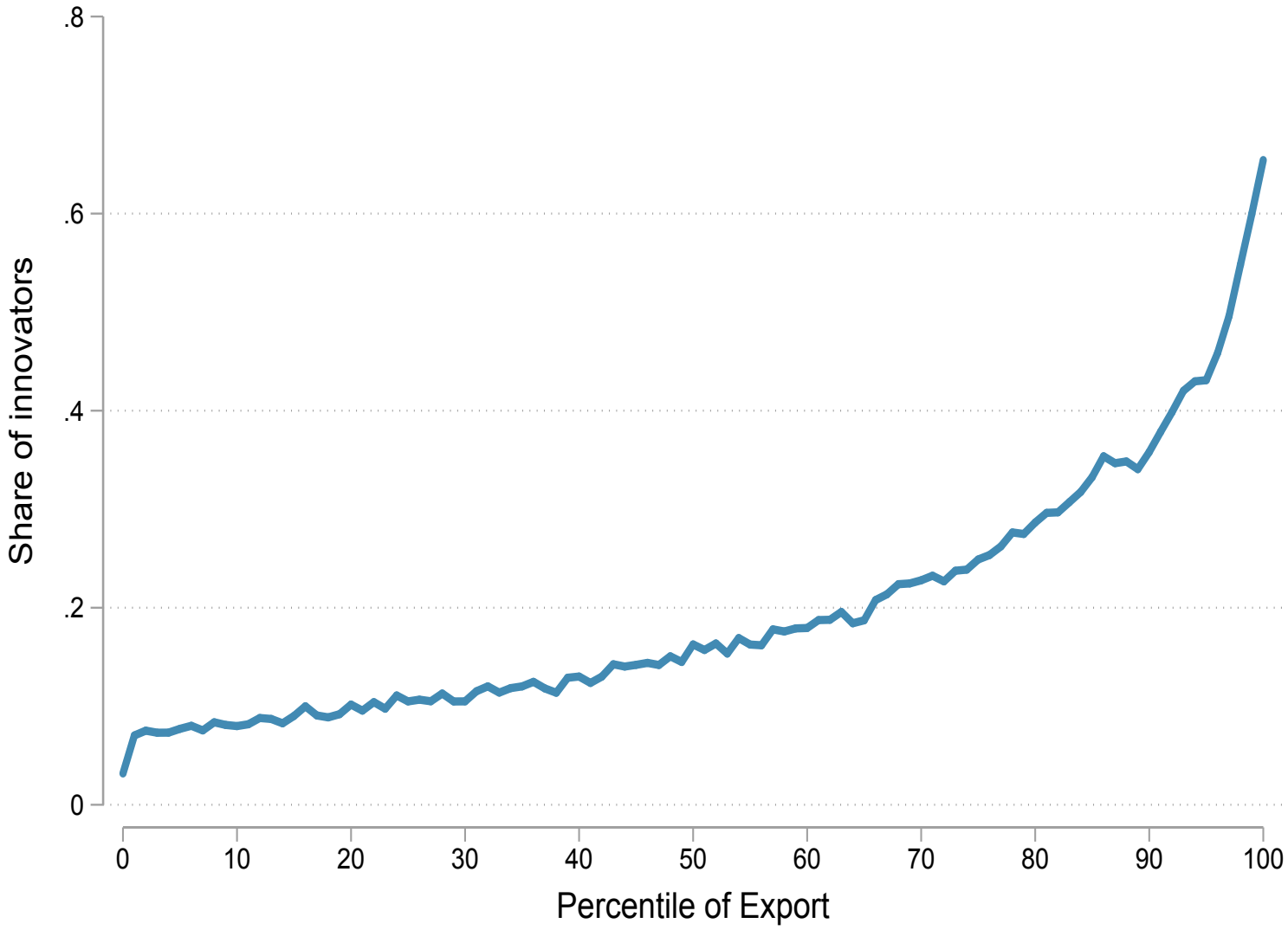
"Interconnected" Global Production Networks

- World trade is dominated by firms that perform *all* of the following:
  - Operate in multiple destinations (MNE)
  - Export *and* import to multiple destinations
    - Not just to/from their own affiliates
  - Generate most the world's innovation (as measured by patents)
- This is not just a consequence of size: global expansion of MNEs does not follow standard gravity forces
  - Antras, Fadeev, Fort, and Tintelnot: "Exporting, Global Sourcing, and Multinational Activity: Theory and Evidence from the United States." ReStat Forthcoming.

French Exporters and Innovators: Skewness



French Exporters and Inovators: Skewness (Cont.)



French Exporters and Innovators: Premia

Panel 1: Premium for being an exporter (among all manufacturing firms)

	(1)	(2)	(3)	Obs.	Firms
log Employment	0.851	0.762	-	931,309	90,688
log Sales	1.613	1.474	0.417	972,956	103,404
log Wage	0.132	0.097	0.110	929,756	90,653
log Value Added Per Worker	0.217	0.171	0.176	918,062	90,055

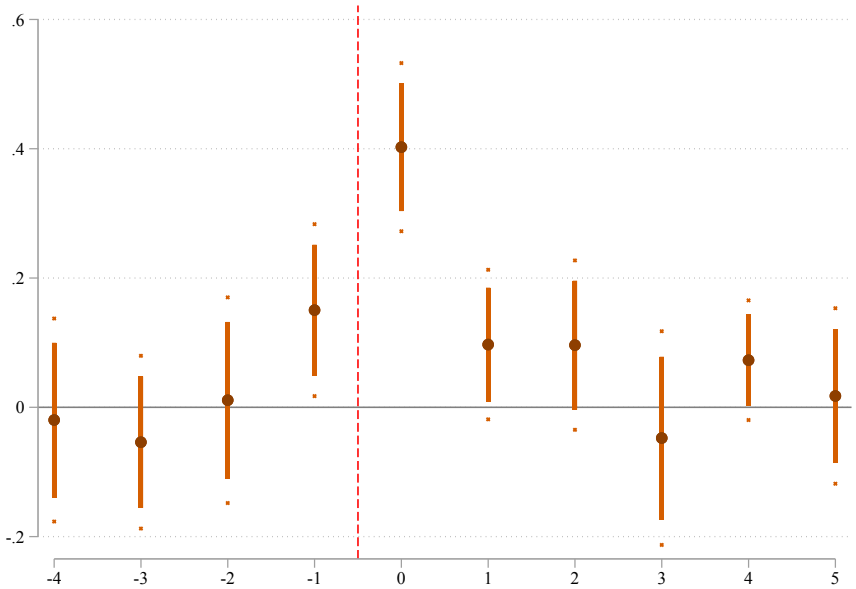
Panel 2: Premium for being an innovator (among all exporting manufacturing firms)

	(1)	(2)	(3)	Obs.	Firms
log Employment	1.038	0.993	-	639,938	57,267
log Sales	1.277	1.233	0.197	650,013	57,901
log Wage	0.15	0.095	0.110	638,955	57,253
log Value Added Per Worker	0.203	0.173	0.180	629,819	56,920
log Export Sales (Current period exporters)	2.043	1.970	0.859	433,456	56,509
Number of destination countries	13	12	7	656,609	57,991

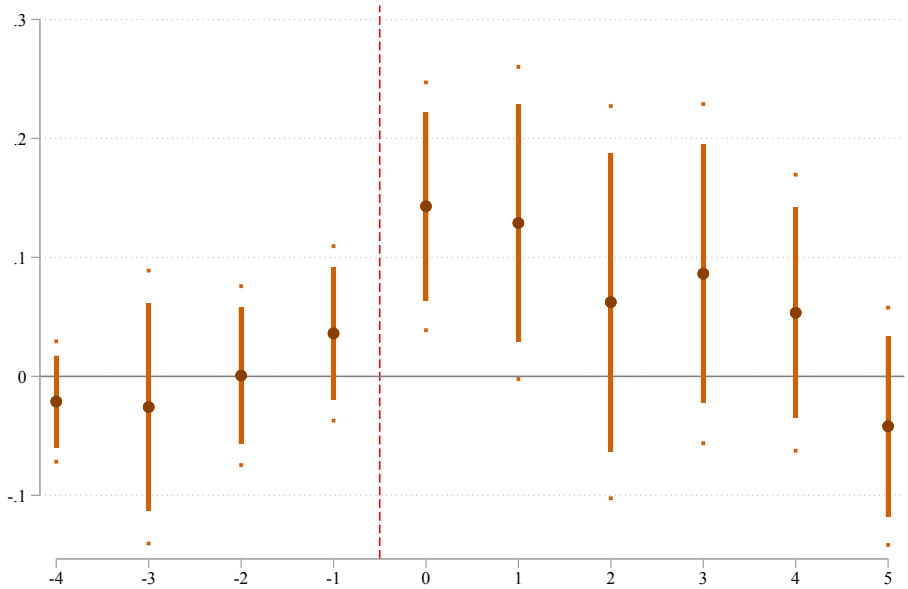
Market Size Impact on French Innovators

Aghion et al (ReStat, 2024): "The Heterogeneous Impact of Market Size on Innovation: Evidence from French Firm-Level Exports"

Sales

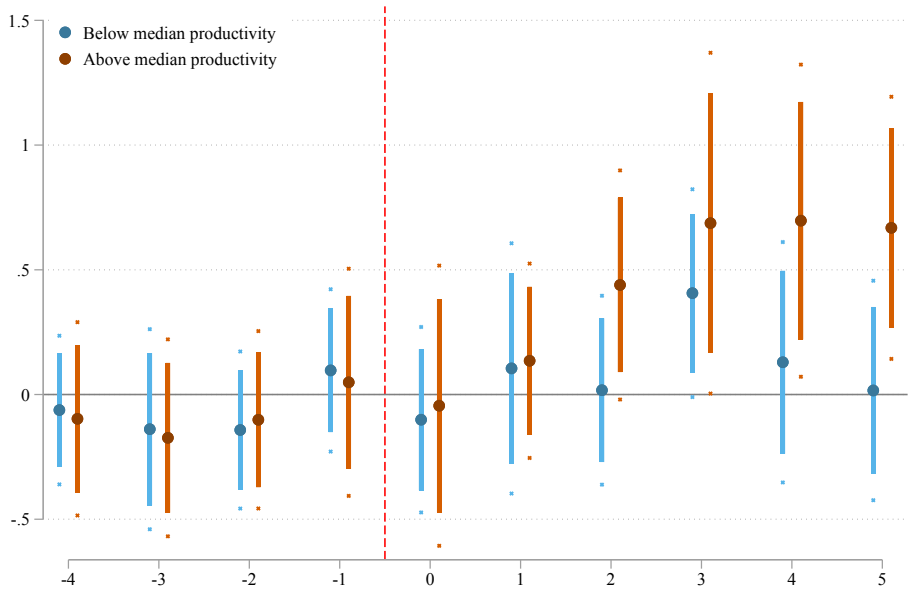


Employment

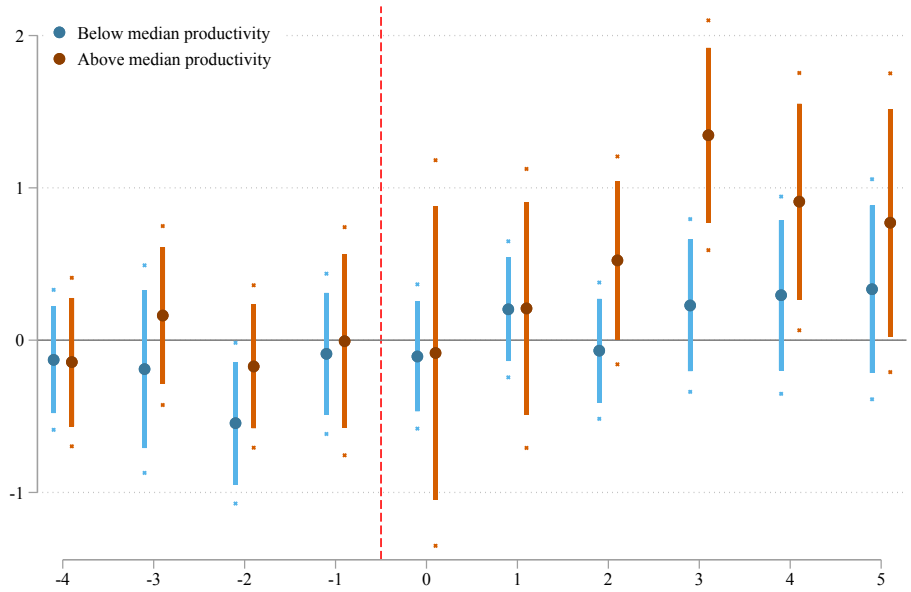


Market Size Impact on French Innovators

Priority Patents



Citations w/in 5 yrs



Trade Liberalization and Innovation: CUSFTA

Isolates one specific trade liberalization episode:

- Unanticipated, sudden change in trade policy
- Relatively large changes in trade costs for some sectors

CUSFTA: Quantifying the Reallocations

The Effects of the FTA on overall Canadian Manufacturing Productivity
Within- and Between-Plant decomposition

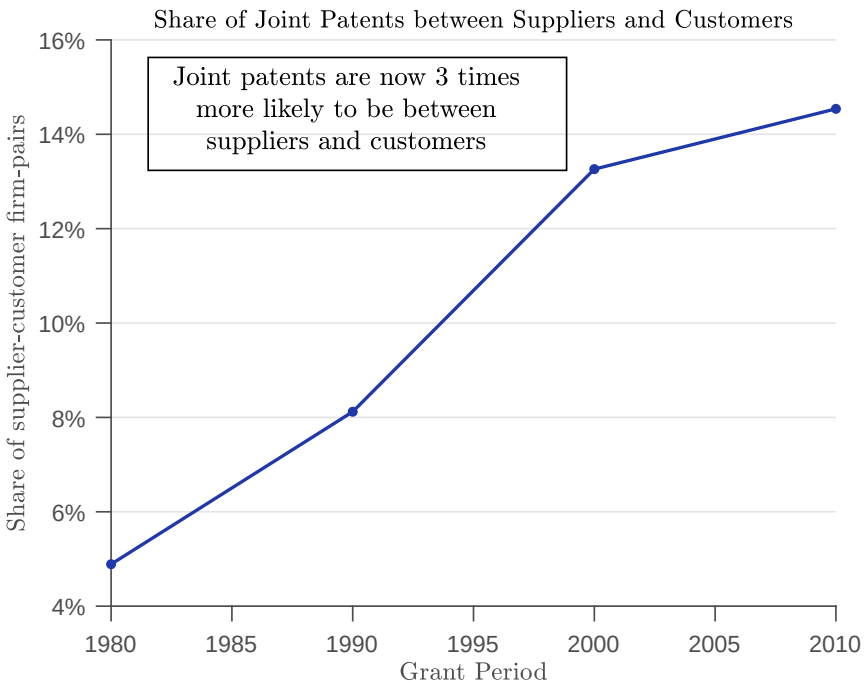
Selection/Reallocation (Between Plants)	
Growth of exporters (most-productive plants)	4.1%
Exit of least-productive plants	4.3%
Within-Plant Growth	
New exporters invest in raising productivity	3.5%
Existing exporters invest in raising productivity	1.4%
Improved access to U.S. intermediate inputs	0.5%
Total	
Total	13.8%

International Knowledge Sharing and Spillovers

- Using patent citation links and joint patents, can connect innovation and trade links:
  - Technology sharing between buyers and suppliers
  - ... and more generally knowledge spillovers through trade links

Technology Sharing between Buyers and Suppliers

Fadeev (2022): "Creative Construction: Knowledge Sharing in Production Networks"



(a) Share of Joint Patents Among Suppliers and Customers.

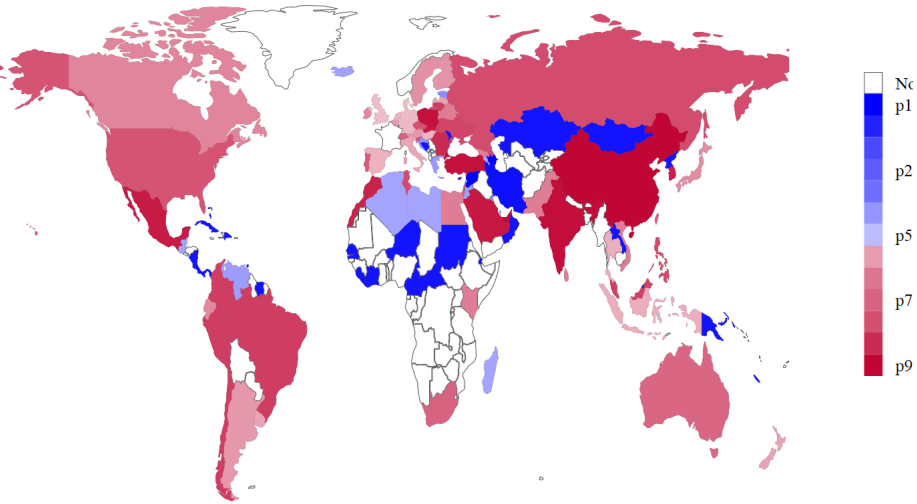
(b) Share of Suppliers and Customers who have Joint Patents.

Also shows that a supplier's patent is 38% more likely to be cited by its buyer $\longrightarrow$ Those new patents are associated with higher growth in firm sales and stockmarket value

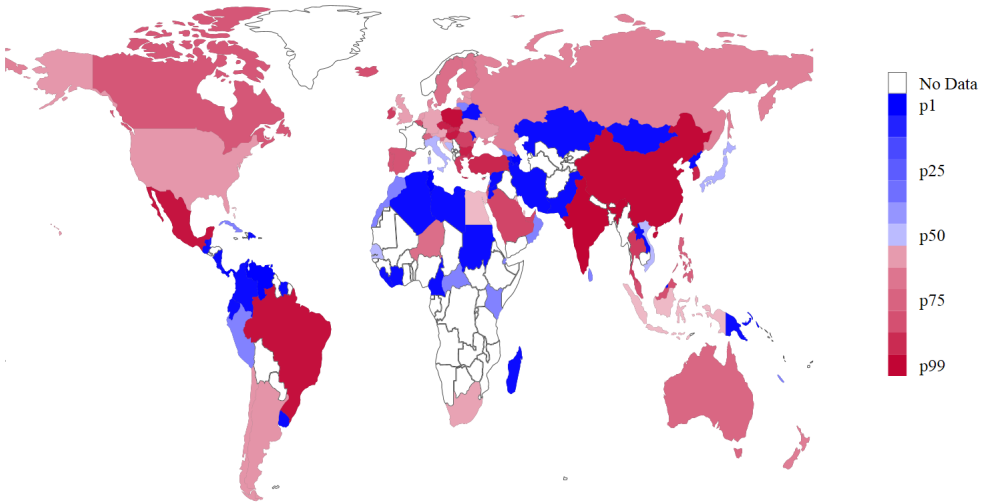
Knowledge Spillovers from Trade Links

Aghion et al (2022): "Exporting Ideas: Knowledge Flows from Expanding Trade in Goods"

Number of French Exporters

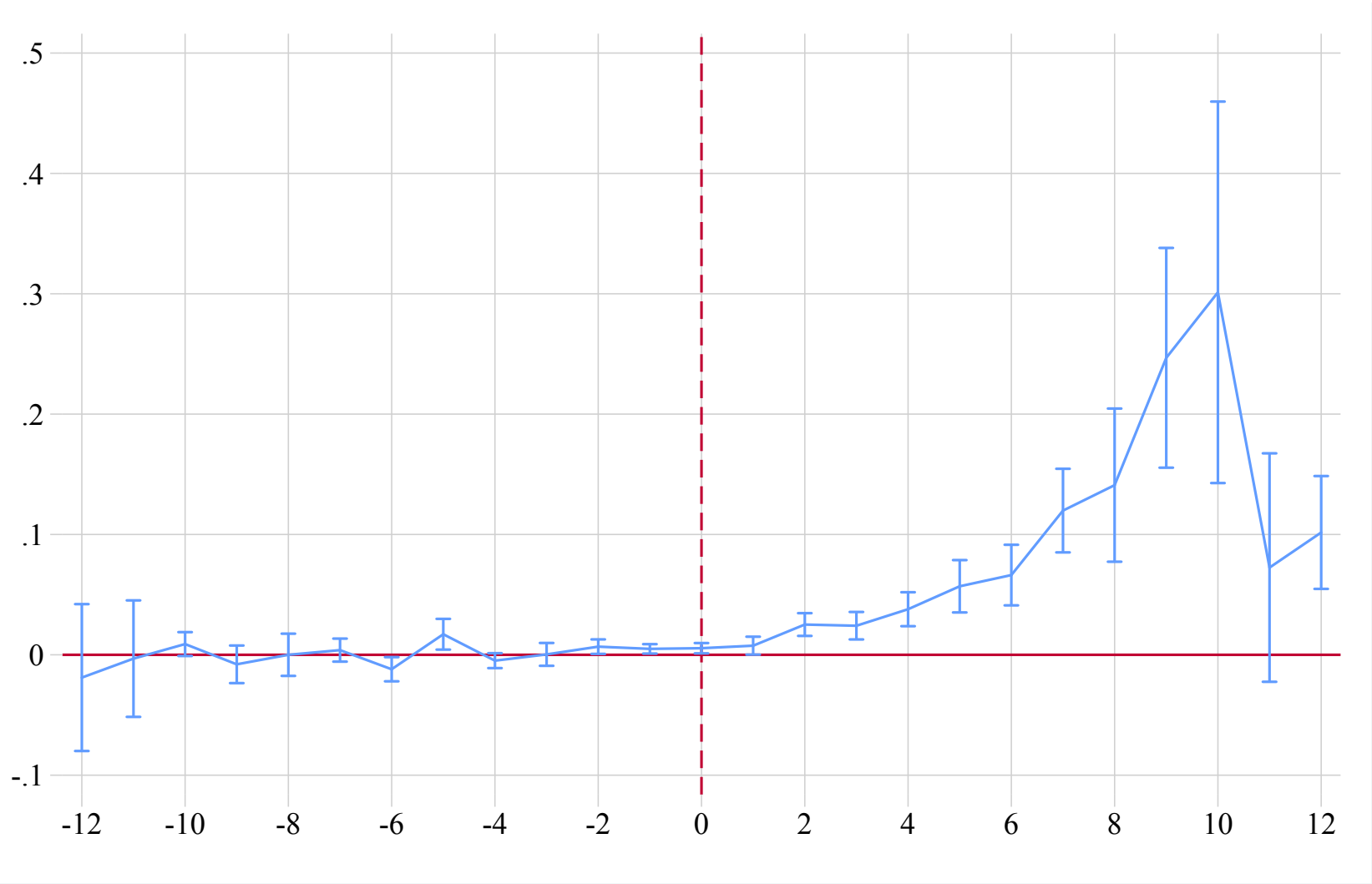


Patent Citations



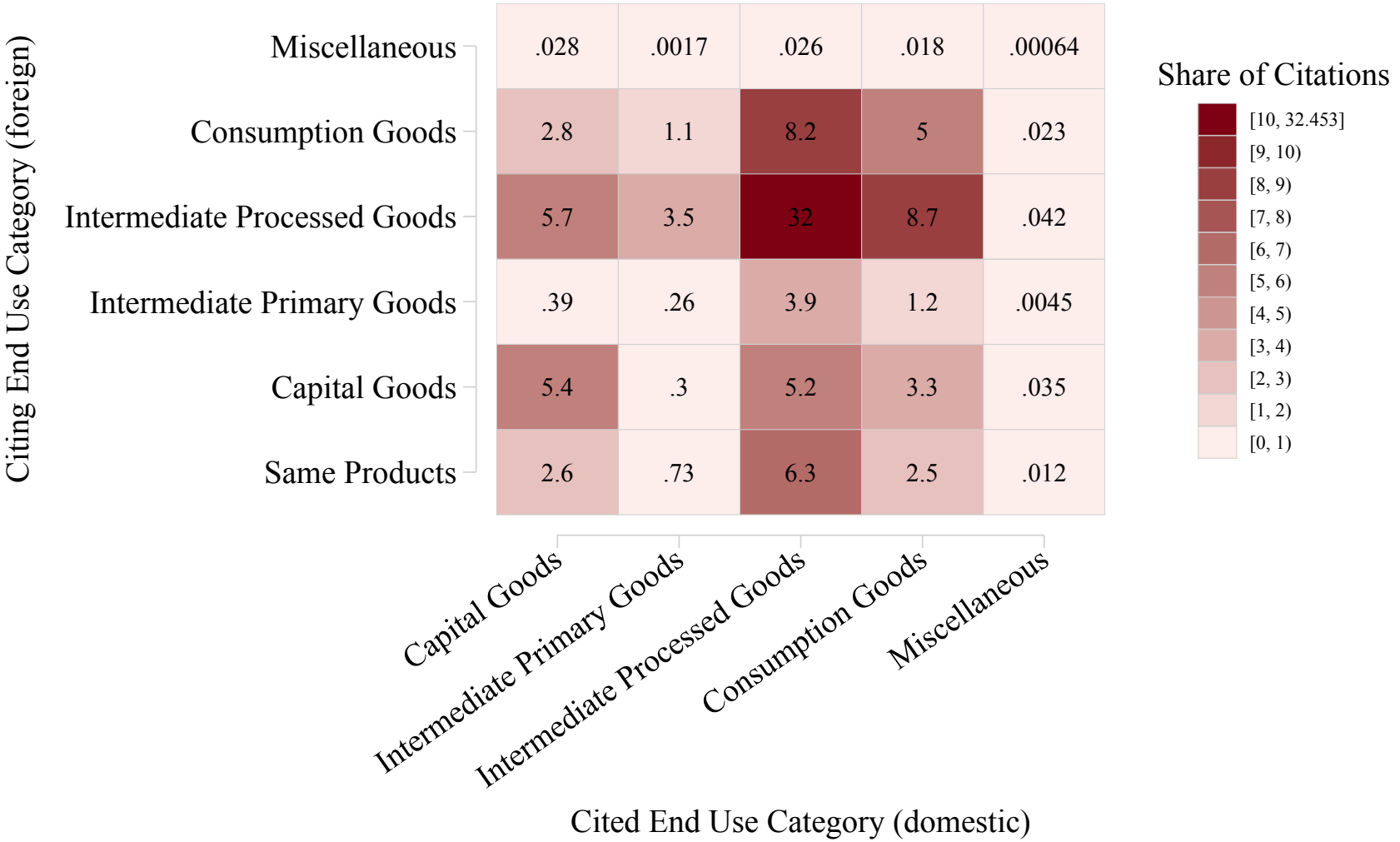
Growth in new patents citing French exporters is strongly linked to pattern of export market entry by French firms

New Citing Patents by Year of Export Market Entry

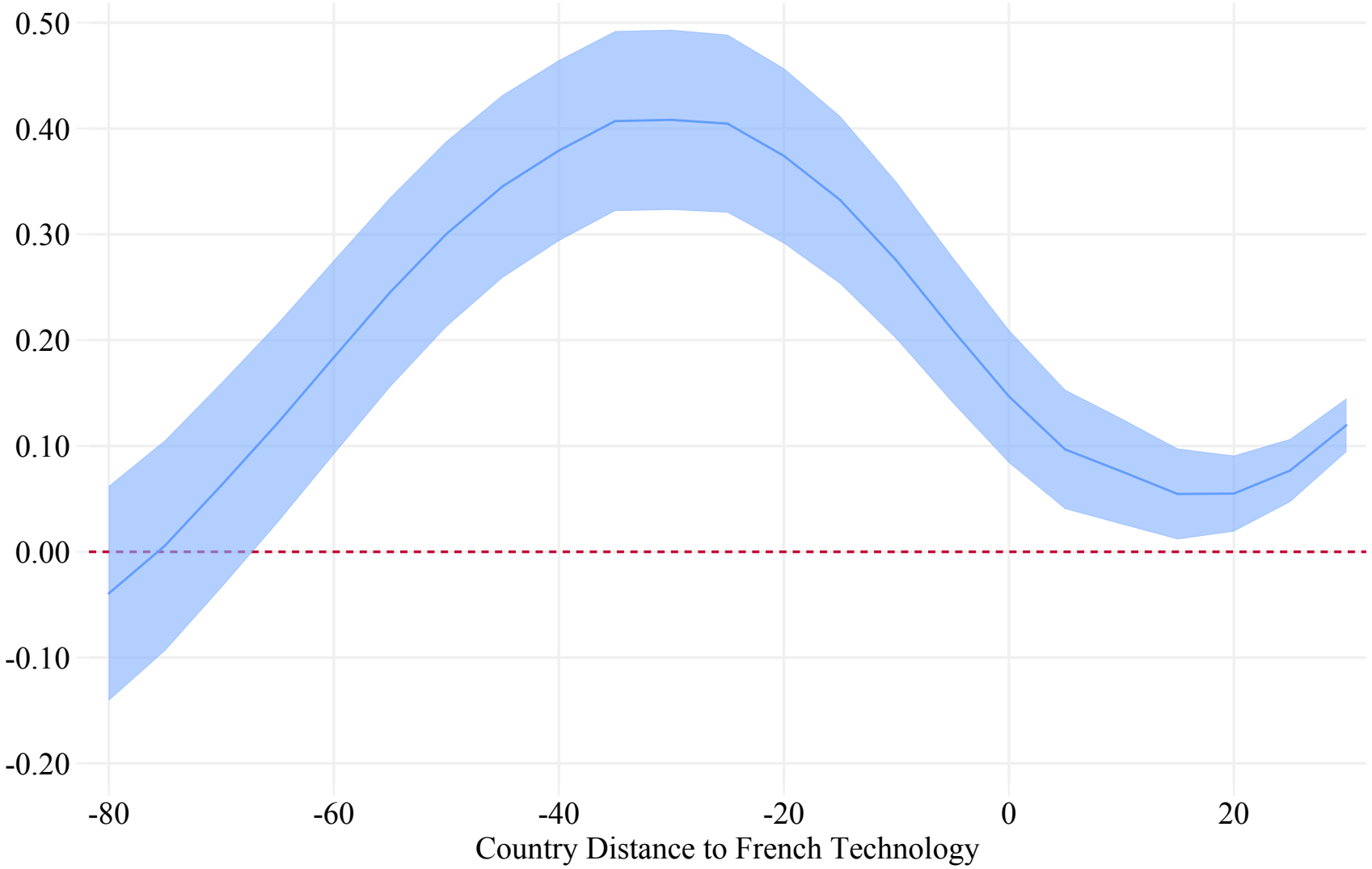


- Includes Firm-Year and Destination-Sector-Year fixed effects
- Magnitude: Over 6 years, represents a 74.5% increase in citing patents from the export destination country

Citing and Cited Patents by Type



New Citing Patents by Technological Distance



Part III

Theory: Market Size and Innovation

Main Assumptions (For Now...)

- No learning spillover/externality
- No pro-competitive effects

CES Preferences

Assumptions

- C.E.S product differentiation with elasticity $\sigma > 1$ within a sector:

$$Q = \left[\int_{\omega \in \Omega} q(\omega)^{(\sigma-1)/\sigma} d\omega \right]^{\sigma/(\sigma-1)}$$

  - Note: quantities $q(\omega)$ are quality-adjusted (so enter preferences symmetrically)

Implications

- Residual demand is $q(\omega) = Ap(\omega)^{-\sigma}$ where

$$A = XP^{\sigma-1}, \quad P = \left[\int_{\omega \in \Omega'} p(\omega)^{1-\sigma} d\omega \right]^{1/1-\sigma}$$

Production

- Composite factor L with unit cost w
- For example, can have $L = \bar{\eta} S^{\eta} U^{1-\eta}$ where $\bar{\eta}$ such that unit cost $w = w_S^{\eta} w_U^{1-\eta}$
- This factor is used (with same aggregation) in all productive uses $\longrightarrow$ including all fixed costs (overhead, entry, export)
- There is a continuum of firms, each choosing to produce a different variety ω
- Input usage in production is linear in output:

$$l = f + \frac{q}{\varphi}$$

  All firms share the same fixed cost $f > 0$ but have different productivity levels indexed by $\varphi > 0$
- Each firm's constant marginal cost is given by

$$MC(\varphi) = \frac{w}{\varphi}$$

Firm Behavior and Exports

- Each firm faces a residual demand curve with constant elasticity σ
- A firm with productivity φ will set a price

$$p(\varphi) = \frac{\sigma}{\sigma - 1} \frac{w}{\varphi}$$

leading to revenue

$$r(\varphi) = Ap(\varphi)^{1-\sigma} = A \left(\frac{\sigma - 1}{\sigma} \right)^{\sigma - 1} w^{1-\sigma} \varphi^{\sigma - 1}$$

and profit

$$\pi(\varphi) = \frac{r(\varphi)}{\sigma} - wf = B\varphi^{\sigma - 1} - wf, \qquad B = \frac{(\sigma - 1)^{\sigma - 1}}{\sigma^{\sigma}} w^{1-\sigma} A$$

Consider exports to destination X subject to variable (iceberg) cost τ and fixed cost f_X:

- If firm exports to F, it earns additional export profits

$$\pi_X(\varphi) = \tau^{1-\sigma} B^F \varphi^{\sigma - 1} - wf_X$$

- Export market selection: Only firms with productivity $\varphi \geq \varphi_X^*$ export
  - ... such that $\pi_X(\varphi_X^*) = 0$

Joint Innovation and Export Decision

- A binary innovation choice: Adoption of a new technology (Bustos AER 2011)
  - New technology increases productivity φ by a factor $\iota > 1$ to $\iota\varphi$
  - Firm pays fixed cost f_I to upgrade to the new technology
- Implications: There is a threshold φ_I^* for technology adoption
  - Depending on parameters, can have either $\varphi_I^* <> \varphi_X^*$
  - $\longrightarrow$ Strong correlation between export status and technology adoption

Innovation Intensity and Export Decision

Consider the following model for a continuous innovation decision (Atkeson & Burstein, JPE 2010):

- Rescale productivity measure $\phi = \varphi^{\sigma-1}$
  - Changes in ϕ are proportional to firm size and variable profits
- Successful innovation increases productivity ϕ by a factor $\iota > 1$ to $\iota\phi$
- Probability of successful innovation is α
- Innovation intensity: firm choose α given a (convex) innovation cost function $c_I(\alpha)$
  - Innovation cost scales up proportionally to firm size on domestic market
    $\longrightarrow$ Total innovation cost is $\phi c_I(\alpha)$
    $\longrightarrow$ Big firms choose same α
    $\longrightarrow$ Delivers Gibrat's in a dynamic version

Innovation Intensity and Export Decision (Cont.)

Closed Economy

- Consider a firm ϕ that would produce even if innovation were not successful:

$$E[\pi(\phi)] = [(1-\alpha) + \alpha\iota]\, B\phi - \phi c_I(\alpha) - f$$

FOC for α:

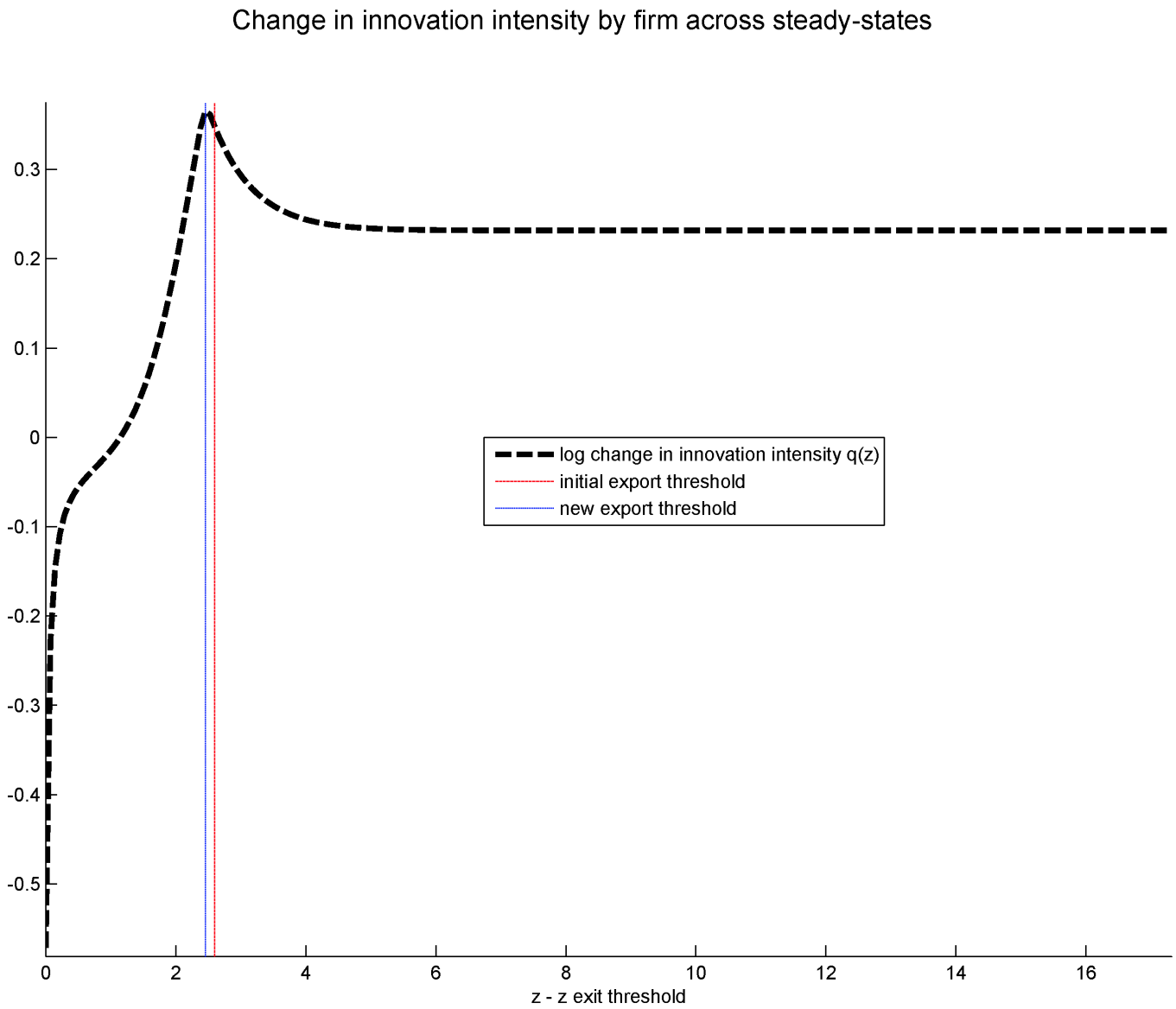
$$c_I'(\alpha) = (\iota - 1)\, B$$

so all firms (above a given cutoff) choose same innovation intensity

Open Economy

- Market size impact for innovation: exporters choose a higher innovation intensity
  - Market demand increases from B to $B + \tau^{1-\sigma} B^F$

Export Market Selection and Firm Productivity Dynamics: Increased Innovation by Non-Exporters



Permanence of Trade Liberalization

- For these endogenous changes in productivity and trade volumes (arising from changes in endogenous innovation) to be important, trade liberalization must be perceived to be long lasting
- If trade liberalization is perceived to be temporary:
  - Innovation response to liberalization can be drastically muted

Anticipation Effects: Response of Endogenous Innovation

- Anticipation effects for innovation: rise in innovation precedes reduction in trade costs if the latter is anticipated.
  - What has been viewed as "exogenous" differences in productivity driving export market selection can also have an endogenous component
- With uncertainty and sunk export costs:
  - Option values associated with entry and export decision
  - Anticipation of trade liberalization affects these option values ahead of actual changes in trade costs

Part IV

Theory: Innovation and Competition

Competition & Innovation: Motivating Empirical Evidence

- Cross-section: bigger firms innovate more
- Positive effect of competition on innovation:
  - Nickell (JPE 1996)
    - Competition measured as lower firm rents and lower concentration
    - Innovation as TFP growth
  - Blundell, Griffith, VanReenen (ReStud 1999)
    - Competition measured as lower concentration and higher imports
    - Innovation "counts" from British survey
  - Aghion et al (JEEA 2004)
    - Competition as foreign firm entry
    - Innovation as citation-weighted patents
  - Aghion et al, Inverted-U (QJE 2005)
    - Competition as industry-average price-cost margins
    - Innovation as citation-weighted patents
  - Bloom, Draca, VanReenen (ReStud 2016)
    - Competition as imports from China into OECD countries
    - Innovation as patents in OECD countries

Model Setup (Closed Economy)

For details, see Akcigit & Melitz, "International Trade and Innovation", Handbook of International Economics Vol 5

- Final good production:

$$Y_t = \frac{L^\beta}{1-\beta} \int_0^N q_{jt}^\beta k_{jt}^{1-\beta} dj$$

  - k_{jt}: **quantity** of intermediate good j
  - q_{jt}: **quality** of intermediate good j
  - L: aggregate labor supply (country size)
  - N: number/mass of intermediate goods
    - Assume exogenous (but can also incorporate endogenous entry)
  - Note: $\beta \in (0,1)$ plays dual role as share of fixed factor (labor) and the inverse elasticity of substitution between intermediate goods ... and it also normalizes units of quality

Model Setup (Cont.)

- From here on out, drop time subscripts...
- Recall final good production:

$$Y = \frac{L^{\beta}}{1-\beta} \int_0^N q_j^{\beta} k_j^{1-\beta} dj$$

  - Normalize its price to 1
- Sector is competitive, so inputs valued at their marginal product (drop time subscript):

$$\begin{aligned} w &= \frac{\beta}{1-\beta} L^{\beta-1} \int_0^N q_j^{\beta} k_j^{1-\beta} dj \\ p_j &= L^{\beta} q_j^{\beta} k_j^{-\beta} \end{aligned}$$

Model Setup: Intermediate Goods Sector

- Each variety j produced by monopolist using its own intermediate good with linear cost ηk_j (constant MC)
- Solves:

$$\pi_j = \max_{p_j, k_j} \{p_j k_j - \eta k_j\}$$

Leading to equilibrium quantity and price:

$$\begin{aligned} k_j &= \left[\frac{1-\beta}{\eta}\right]^{\frac{1}{\beta}} L q_j \quad \text{(scale)} \\ p_j &= \frac{\eta}{(1-\beta)} \quad \text{(markup pricing)} \end{aligned}$$

- So profit is proportional to quality:

$$\pi_j = \Upsilon L q_j, \quad \Upsilon \equiv \left(\frac{1-\beta}{\eta}\right)^{\frac{1-\beta}{\beta}} \beta$$

Innovation and Exogenous Competition

Innovation

- Successful innovation increases quality q_j by step $\lambda > 0$ to $(1 + \lambda)q_j$
- Endogenous innovation effort affects probability x_j of success
- Convex cost of innovation scaled by quality: $\theta q_j x_j^2$

Exogenous Competition

- Exogenous probability of entry z_j: displaces incumbent, drives profits to zero

Myopic Innovation Outcome

- Incumbent only considers next period expected profit:

$$\mathbb{E}\pi_j = (1 - z_j)\left[x_j \pi_j (1 + \lambda) + (1 - x_j)\pi_j\right] - \theta q_j x_j^2$$

Leading to equilibrium innovation choice:

$$x_j = (1 - z_j)\frac{\lambda \Upsilon L}{2\theta}$$

- Positive impact of market size L
- Negative impact of exogenous competition z_j

Export Market Selection and Innovation (Myopic)

- Now add export destination F with market size L^F subject to variable (iceberg) trade cost τ and fixed cost f_X

Implications:

- Export market selection: quality threshold
- Exporters innovate at higher rate due to higher market size:

$$L + \tau^{-\frac{1-\beta}{\beta}} L^F > L$$

- Thus, for given liberalization (decrease in τ):
  - New exporters increase innovation by more than existing exporters

Escape (Endogenous) Competition

Back to closed economy...

Modeling Setup

- Multiple incumbents compete (Bertrand) to produce (homogeneous) variety j:

$$Y = \frac{L^{\beta}}{1-\beta} \int_0^N \left[\sum_f q_{fj}^{\frac{\beta}{1-\beta}} k_{fj} \right]^{1-\beta} dj$$

- Only producer with highest quality (leader) produces
- With myopic innovation: no incentive for a follower (non-leading quality) to innovate (and hence never produces)
- 2 possible equilibria:
  - Single leader: assume that λ is high enough that leader is not constrained by limit-pricing and chooses monopoly markup $\longrightarrow$ same innovation choice as monopolist:

$$x_{1j} = (1 - z_j) \frac{\lambda \Upsilon L}{2\theta}$$

  - Neck-in-neck leaders: Bertrand competition drives profits to zero

Neck-in-Neck Leaders

- Consider neck-in-neck firm $f = 0$ with (highest) quality q_{0j} along with $N_j \geq 1$ other firms
- Firm only earns positive profits next period if:
  - Its innovation is successful **and** its rivals are not **and** no entry
    $\longrightarrow$ probability: $(1 - z_j)\, x_{0j} \Pi_{f \neq 0} (1 - x_{fj})$
- Expected (myopic) next period profits:

$$\mathbb{E}\pi_{0j} = (1 - z_j)\, x_{0j} \Pi_i (1 - x_{ij})\, \Upsilon L q_{0j} (1 + \lambda) - \theta q_{0j} x_{0j}^2$$

  Leading to innovation choice: $\dfrac{x_{0j}}{(1 - x_{0j})^{N_j}} = (1 - z_j)(1 + \lambda) \dfrac{\Upsilon L}{2\theta}$

- Contrast with single leader's innovation choice: $x_{1j} = (1 - z_j)\lambda \dfrac{\Upsilon L}{2\theta}$
  - Escape competition: Impact of $1 + \lambda$ vs λ
  - If λ is small enough: $x_{0j} > x_{1j}$
    $\longrightarrow$ Positive impact of **endogenous** competition on innovation
- Industry evolution: assume that entrants enter 1-step ahead: so single leader is not absorbing state

"Fully" Dynamic Version in Continuous Time

- Entry and innovation probabilities z_j and x_j are flow-rates
- Firms maximize the NPV of their profit flow $\pi_j = \Upsilon L q_j$
  - Endogenous interest rate r determined by household's intertemporal utility maximization
- In closed economy (no escape competition), this value is proportional to the firm's quality:

$$V(q_j) = \nu q_j, \qquad \nu = \frac{[r + z_j] - \sqrt{[r + z_j]^2 - \frac{\lambda^2}{\theta}\Upsilon L}}{\frac{\lambda^2}{2\theta}}$$

  Leading to innovation:

$$x_j = \frac{z_j + r}{\lambda} - \sqrt{\left(\frac{z_j + r}{\lambda}\right)^2 - \frac{\Upsilon L}{\theta}}$$

- Just as in myopic case:
  - Positive impact of market size L and negative impact of exogenous competition z_j
- Escape competition: See Akcigit, Ates, Impulliti (NBER 2018)
  - Followers now have incentive to innovate

Normative Implications

- Relative to Atkeson & Burstein, growth is generated by spillover from incumbents to entrants
  - Note: in open economy version, also generate similar prediction that new exporters innovate at highest rate (higher than incumbent exporters)
- There is also under-investment by incumbents due to probability of displacement (business stealing)
- Both forces lead to under-investment in R&D (from a welfare-maximizing planner's perspective)