Innovation and Trade Policy in a Globalized World

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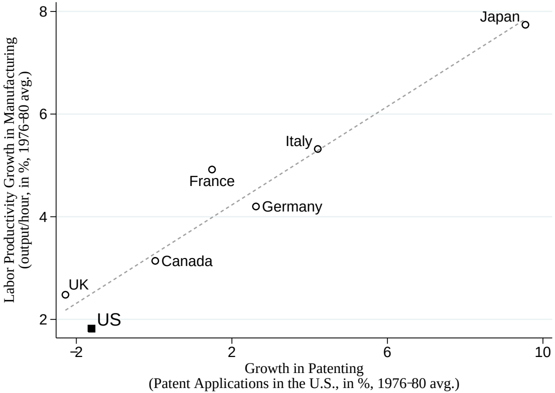
Motivation - United States in the Late 1970s



Akcigit, Ates, Impullitti (2017)

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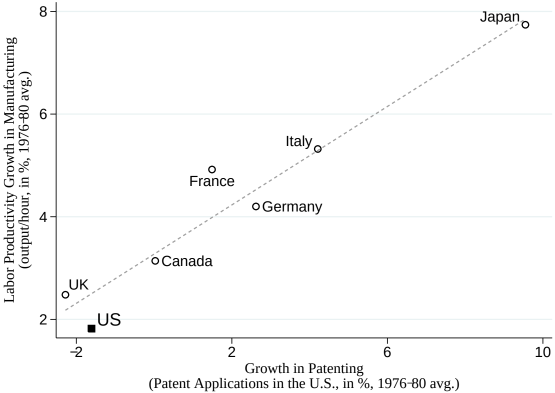
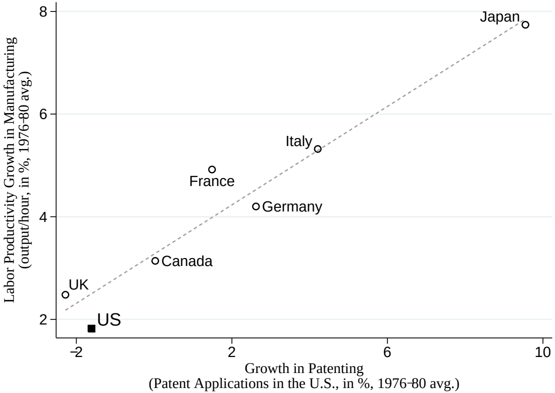


"Foreign competition in the technology intensive industries poses a more serious threat to our country's position in the international marketplace than ever before in our history."

John P. McTague (1985)[a]

[a] Associate Director of the Office of Science and Technology Policy of the Reagan Administration.

Motivation - United States in the Late 1970s

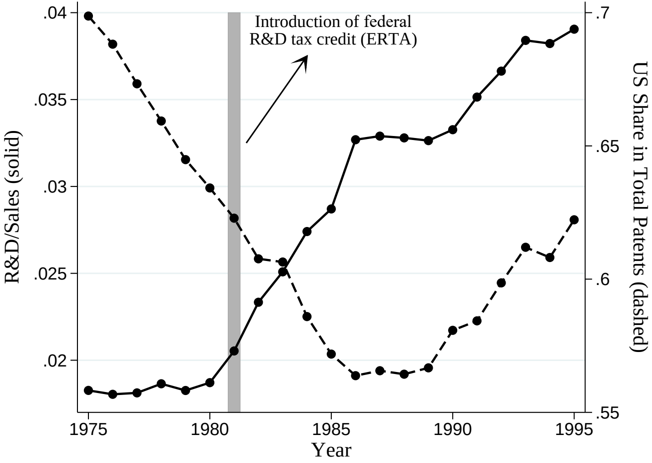


" ... these industries are dominated by a few nations and firms so that competitive advantage brings significant economic profits and political influence. Thus, if the United States becomes a net importer and a technically inferior producer, it would also become a less independent, less influential and less secure nation."

U.S. Council of National Security (1986)

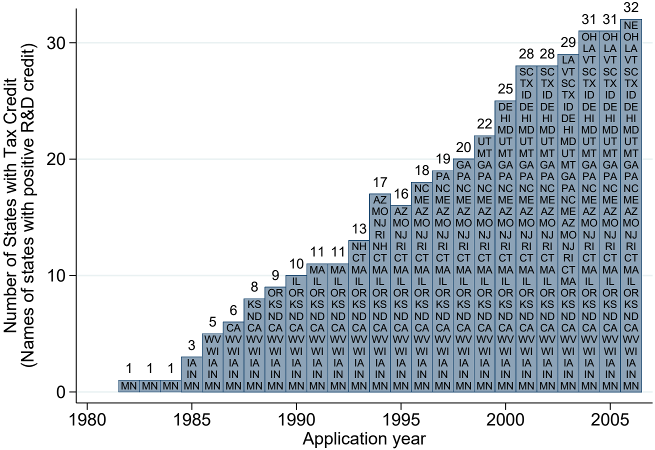
Akcigit, Ates, Impullitti (2017)

Make America Great Again!



— R&D Intensity - - - Patenting Share of the U.S.

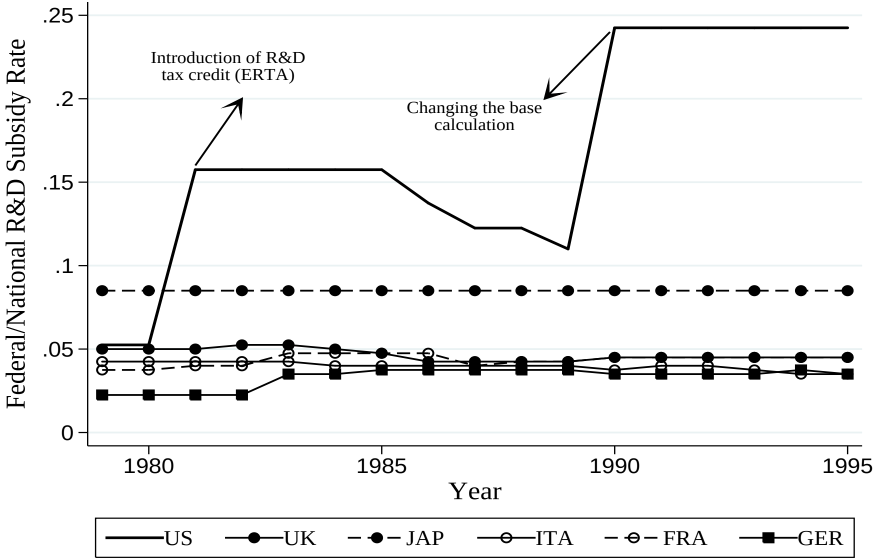
...And Again: State-level R&D Tax Credit



Source: Authors' calculations, Wilson (2009)

State-level R&D tax credit policies were also enacted.

R&D Policies in Other Countries



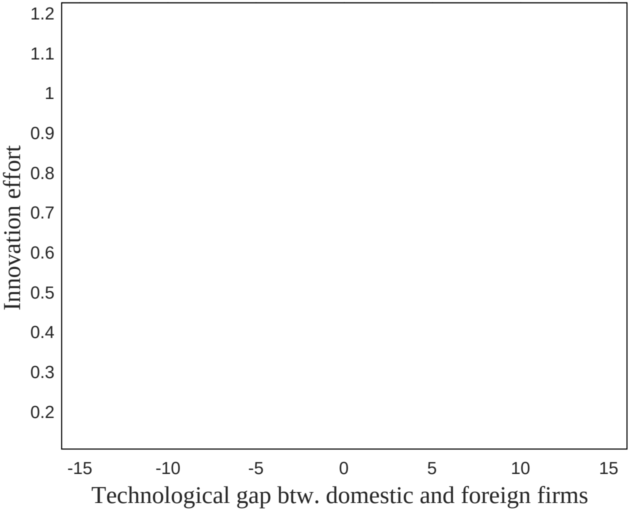
Motivating Questions

- What are the welfare effects of industrial policies in an open economy with foreign technological competition?
- Managing international competition:
  - **Protectionism** as a response to foreign technological catching up
  - **R&D subsidies** as an alternative response to foreign catching up
- How do the answers depend on the policymaker's horizon?

To Answer These Questions...

- **Model:**
  - Open economy DGE model with endogenous technological progress
  - Two large economies subject to trade frictions
  - Step-by-step innovation with strategic interaction
  - Endogenous entry-exit
  - Transitional dynamics: important for policy horizon
- **Quantitative analysis**

Main Mechanism in the Model



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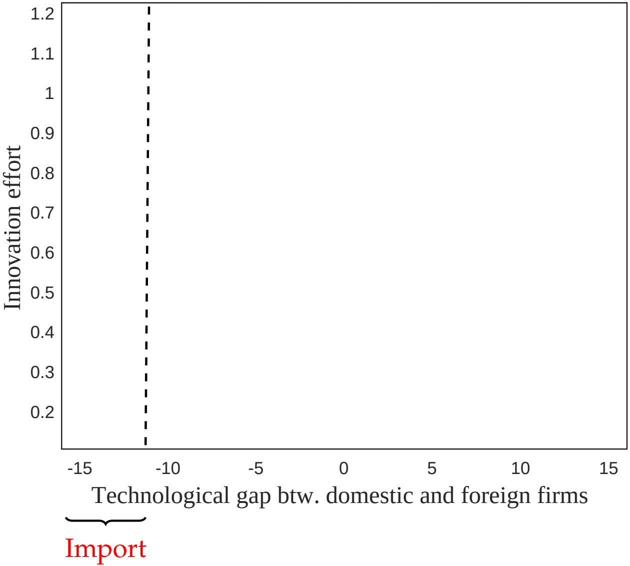
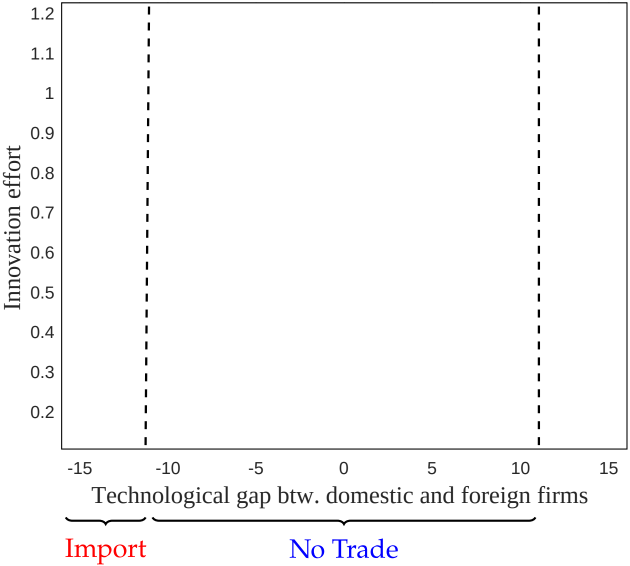


Main Mechanism in the Model



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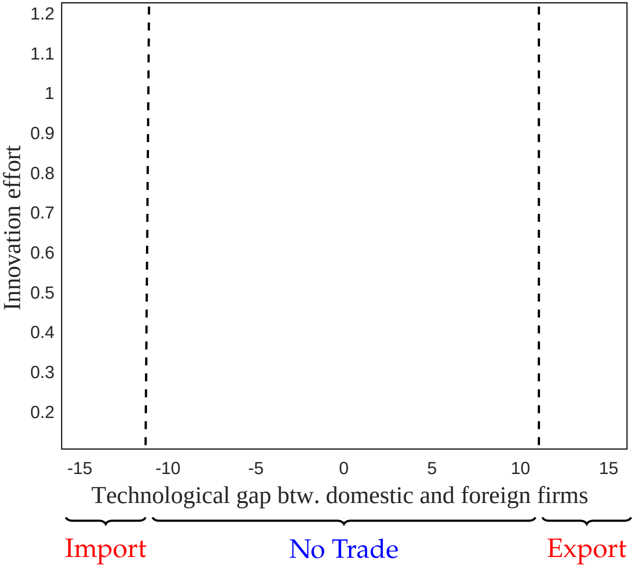

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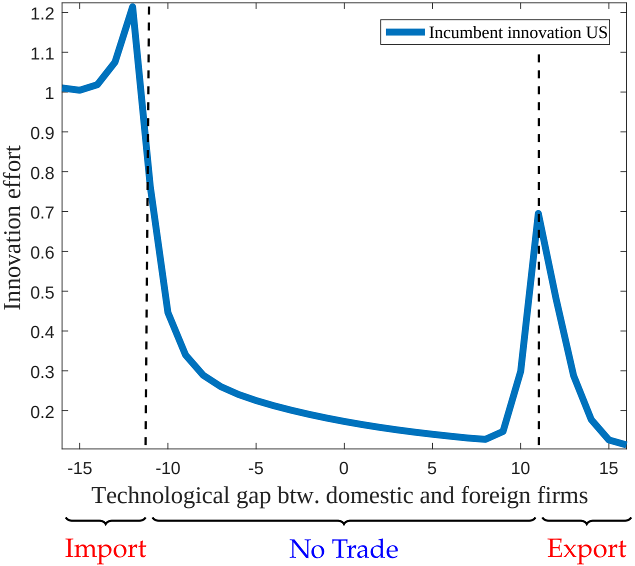

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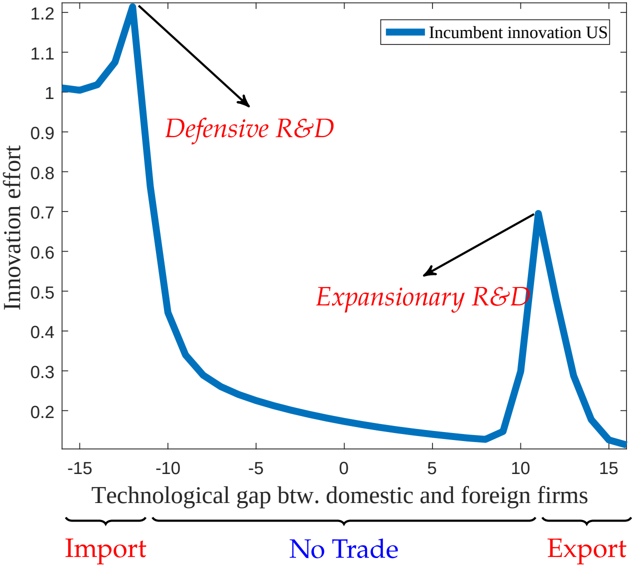

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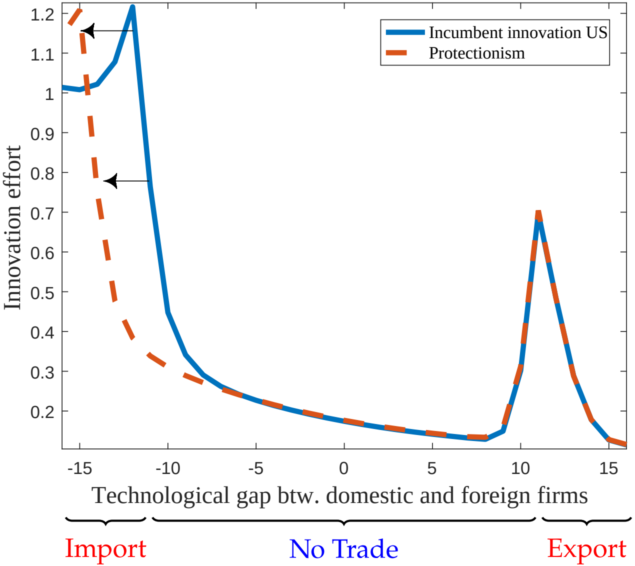

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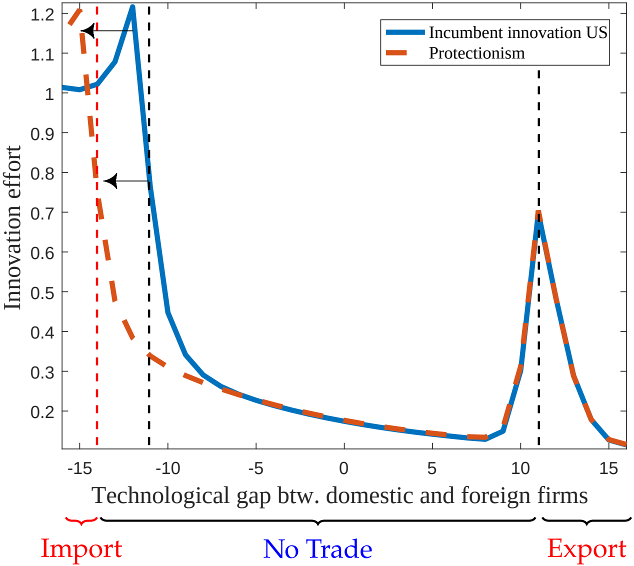
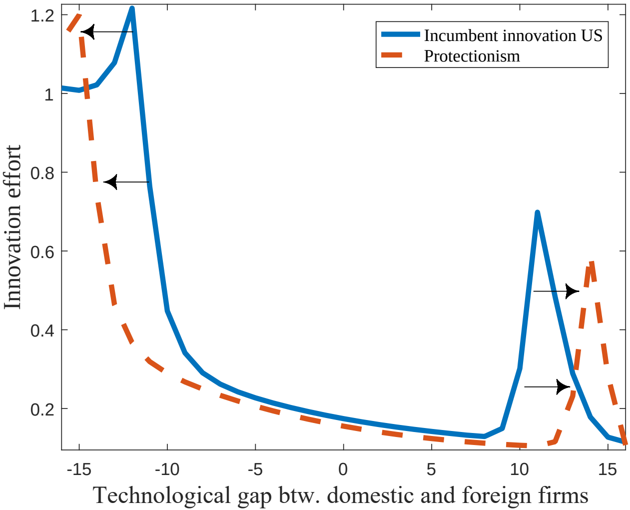


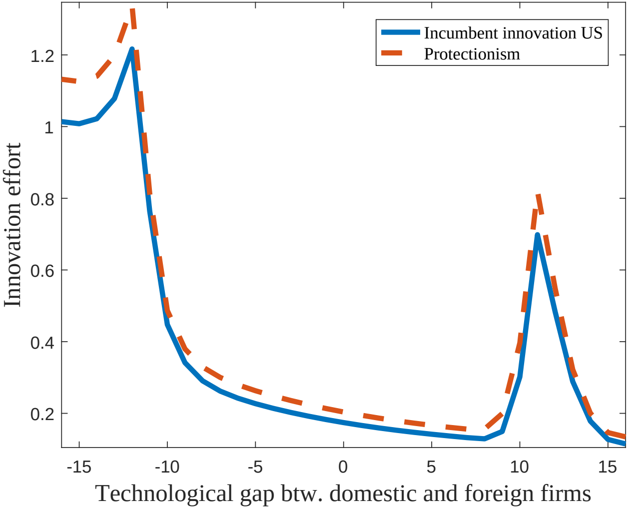
Main Mechanism in the Model

RETALIATION:



Main Mechanism in the Model

R&D Subsidy:



Preview of the Results

1. **Static effects:**
   - Protectionism could benefit firms (and the overall welfare) by keeping the profits in the country.

2. **Dynamic effects:**
   - Catching up: more innovation through escape competition and through technology transfer
   - Protectionism: less innovation less technology sourcing

3. Protectionism yields welfare gains in the short run (10 yrs.) but large long-run losses

4. R&D subsidies is the dominant policy for long-sighted policy makers

5. Policy complementarity: lower trade barriers imply lower optimal subsidy

MODEL

Part 1. Static Environment

Preferences

- There is a representative household in each country:

$$U_c(t) = \int_t^{\infty} \exp(-\rho\,(s-t))\frac{C_c^{1-\varepsilon}(s)-1}{1-\varepsilon}\,ds. \tag{3}$$

- Household owns: fixed factor ($L_c = 1$) and assets of domestic firms (A_c)
- Budget constraint

$$r_c(t)A_c(t) + L_c\omega_c(t) = C_c(t) + \dot{A}_c(t) + T_c(t), \tag{4}$$

- Asset markets

$$A_c(t) = \int_0^1 (V_{cj}(t) + \tilde{V}_{cj}(t))dj.$$

Preferences

- There is a representative household in each country:

$$U_c(t) = \int_t^\infty \exp(-\rho\,(s-t))\frac{C_c^{1-\varepsilon}(s)-1}{1-\varepsilon}\,ds. \tag{1}$$

- Household owns: fixed factor ($L_c = 1$) and assets of domestic firms (A_c)
- Budget constraint

$$r_c \quad A_c \quad + L_c\omega_c \quad = C_c \quad + \dot{A}_c \quad + T_c \quad , \tag{2}$$

- Asset markets

$$A_c \quad = \int_0^1 (V_{cj} \quad + \tilde{V}_{cj} \quad)dj.$$

Final Good

- Final good in country c produced with technology

$$Y_c = \frac{L_c^{\beta}}{1-\beta} \int_0^1 q_{c'j}^{\beta} k_{c'j}^{1-\beta} dj, \text{ where } c' \in A, B \tag{5}$$

- L_c: Labor, fixed factor, immobile, normalized to 1.
- $j \in [0, 1]$: intermediate variety.
- q_{cj}: quality of variety j in country c
- k_{cj}: amount of variety j used.
- Highest quality good (adjusted for trade cost) is purchased.

Intermediate Goods

- In each j, one firm per country competing for leadership à la Bertrand.

$$\text{Tech. Leadership in } j = \begin{cases} A \text{ is leader,} & \text{if} \quad q_{Aj} > q_{Bj} \\ B \text{ is leader,} & \text{if} \quad q_{Aj} < q_{Bj} \\ \text{Neck\&Neck,} & \text{if} \quad q_{Aj} = q_{Bj} \end{cases}$$

- Qualities evolve through **innovation** and **spillovers** (to be explained later).

- Intermediate goods are produced at the marginal cost of η in terms of final good.

- Selling abroad has export cost κ.

Intermediate Good Decisions I

- Final Good producer's maximization gives

$$p_j = q_j^{\beta} k_j^{-\beta}.$$

- Intermediate good producer's maximization problem when selling to domestic market

$$\Pi\left(q_j\right) = \max_{k_j \geq 0} \left\{ q_j^{\beta} k_j^{1-\beta} - \eta k_j \right\}.$$

Intermediate Good Decisions I

- Final Good producer's maximization gives

$$p_j = q_j^{\beta} k_j^{-\beta}.$$

- Intermediate good producer's maximization problem when exporting

$$\hat{\Pi}\left(q_j\right) = \max_{k_j \geq 0} \left\{ q_j^{\beta} k_j^{1-\beta} - (1+\kappa)\eta k_j \right\}.$$

Intermediate Good Decisions II

- Equilibrium domestic profit is:

$$\Pi\left(q_j\right) = \pi q_j,$$

where $\pi \equiv \left(\frac{1-\beta}{\eta}\right)^{\frac{1-\beta}{\beta}} \beta.$

- Equilibrium profit from selling abroad is:

$$\hat{\Pi}\left(q_j\right) = \hat{\pi} q_j,$$

where $\hat{\pi} \equiv \left(\frac{1-\beta}{(1+\kappa)\eta}\right)^{\frac{1-\beta}{\beta}} \beta.$

Export vs Import Decisions

- Country A exports in sector j iff

$$\frac{q_{Aj}}{q_{Bj}} > 1 + \kappa$$

- Country A imports in sector j iff

$$\frac{q_{Bj}}{q_{Aj}} > 1 + \kappa$$

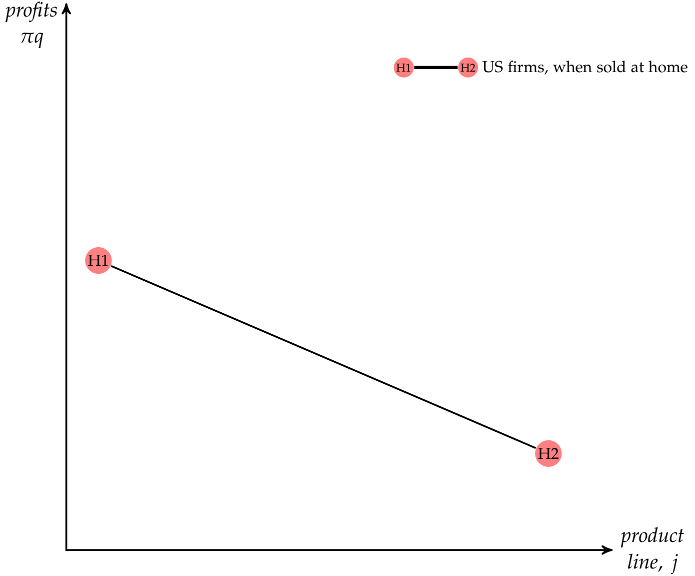
Static Implications of the Model

Proposition 1. *Consider the static environment described above. The static change in income in the open economy relative to autarky is determined by the following forces:*

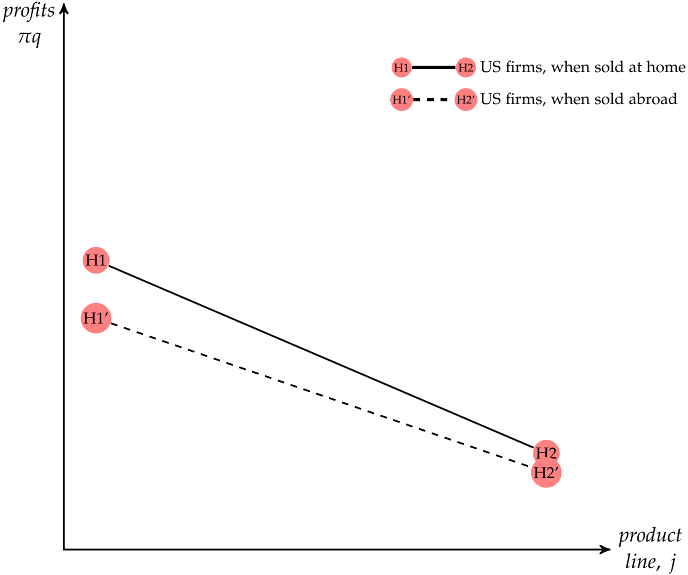
1. *an increase in profits from generating additional profits from exports due to higher market size;*
2. *a decline in profits from destruction of profits of laggard firms;*
3. *an increase in wages from higher labor productivity through transfer of technology.*

The combined impact of these forces is ambiguous.

Decision to Trade



Decision to Trade



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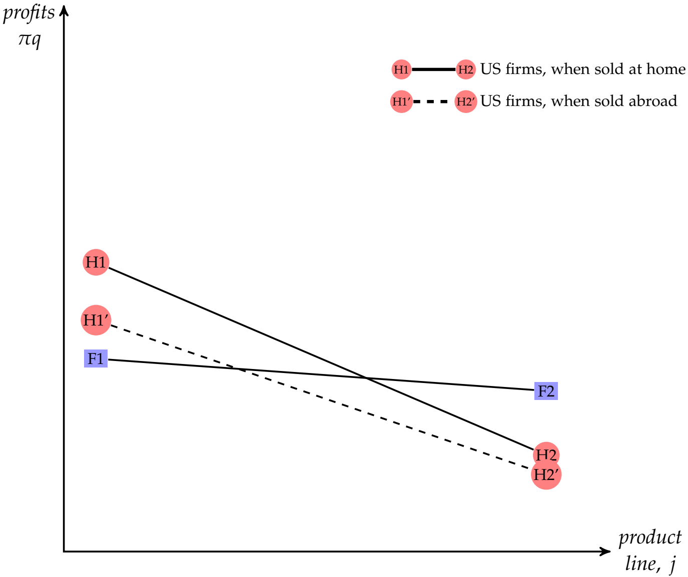

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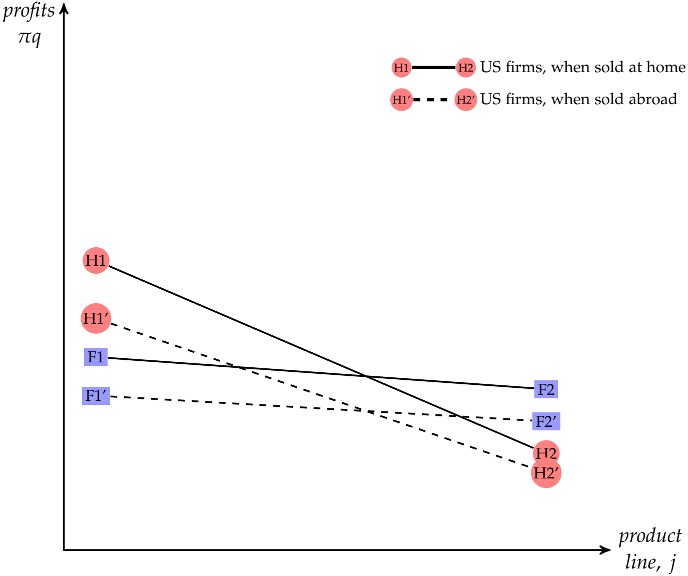

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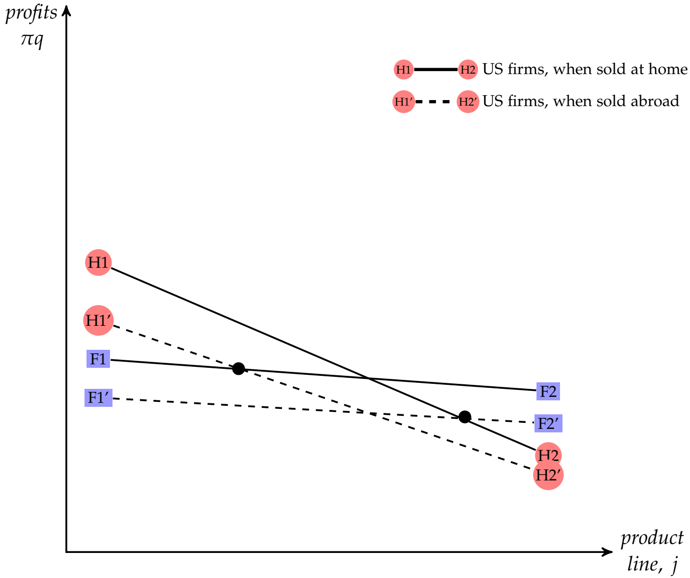

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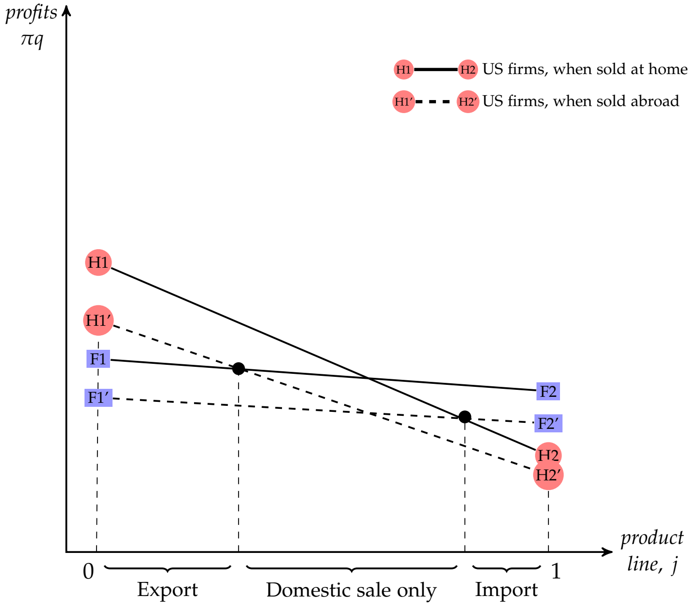


Impact of Openness on Profits and Wages

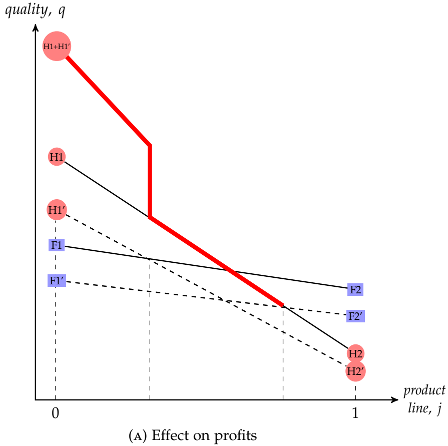


Figure 9: Static effects of openness

MODEL

Part 2. Dynamic Environment

Intermediate Goods

- Qualities evolve through **innovation** and **spillovers**.
- Successful innovation generates quality jumps btw. t and $t + \Delta t$:

$$q_{cj}\left(t + \Delta t\right) = \lambda^{k} q_{cj}\left(t\right)$$

  where $\lambda > 1,\ c \in \{A, B\}$.

- $k \in \mathbb{N}^{+}$ is a random variable

Quality Dynamics

- If $n_c(t) = \int_0^t k(s)ds$ is the number of quality jumps up to time t

$$q_{cj}(t) = \lambda^{n_c(t)}.$$

- Technology gap between A and B in j

$$\frac{q_{Aj}}{q_{Bj}} = \frac{\lambda^{n_{Aj}}}{\lambda^{n_{Bj}}} = \lambda^{n_{Aj}-n_{Bj}} \equiv \lambda^{m_{Aj}}$$

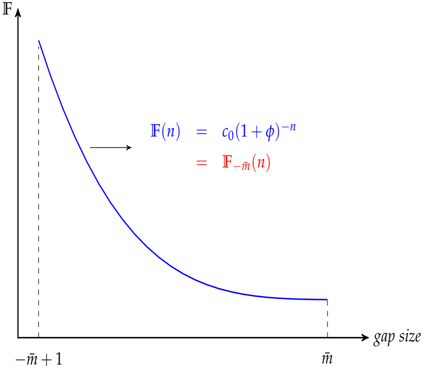
- **Assumption.** Max gap is $\bar{m} \implies$

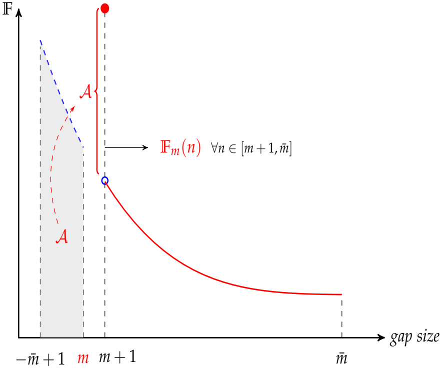
$$m_c \in \{-\bar{m}, -\bar{m}+1, ..., 0, ..., \bar{m}-1, \bar{m}\}, \text{where } c \in \{A, B\}$$

- $\mathbb{F}(k)$ is a distribution such that:
  - multiple step jumps are less likely: increasing difficulty
  - Backward firms more likely to multiple jumps: advantage of backwardness [à la Gerschenkron (1951)]

▸ details

Step Jump Distribution, $F(k)$





Innovation by incumbents and entrants

- **Incumbents**:

$$C\left(x_j^c; q_j\right) = q_j \alpha_c \left(x_j^c\right)^{\gamma_c}.$$

  - z_j^c: R&D investment
  - x_j^c: Poisson arrival rate:

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  - z_j^c: R&D investment
  - x_j^c: Poisson arrival rate:
- **Entrants**:
$$C\left(\tilde{x}_j^c; q_j\right) = q_j \alpha_c \left(\tilde{x}_j^c\right)^{\gamma_c}.$$
  - Directed entry
  - Drawing from same step-size distribution of domestic incumbent

Illustration of the Innovation Dynamics

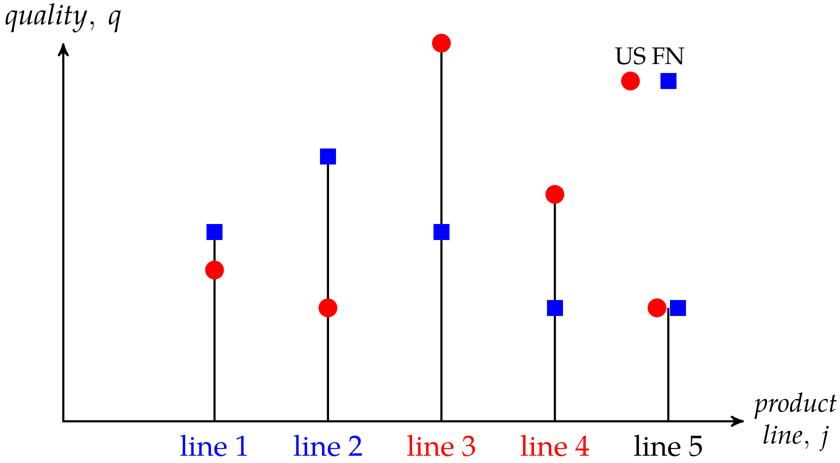

Illustration of the Innovation Dynamics

Suppose the follower in line 2 innovates.

- Scenario 1: It closes the gap, but remains follower.

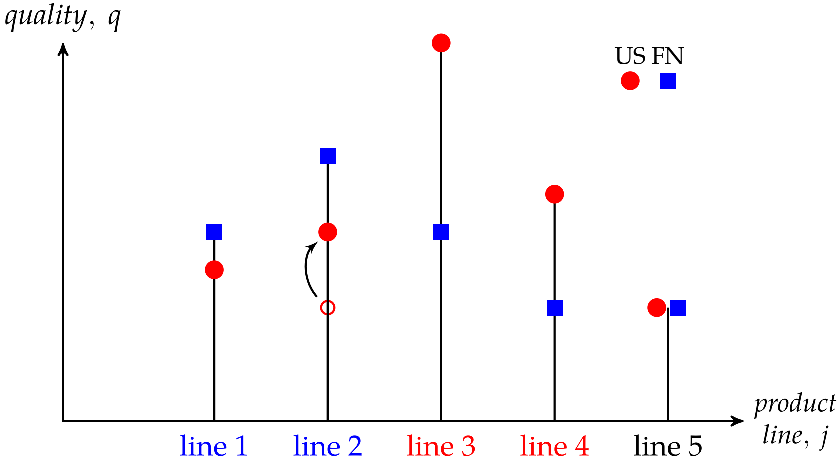

Illustration of the Innovation Dynamics

Suppose the follower in line 2 innovates.

- Scenario 2: It catches up.

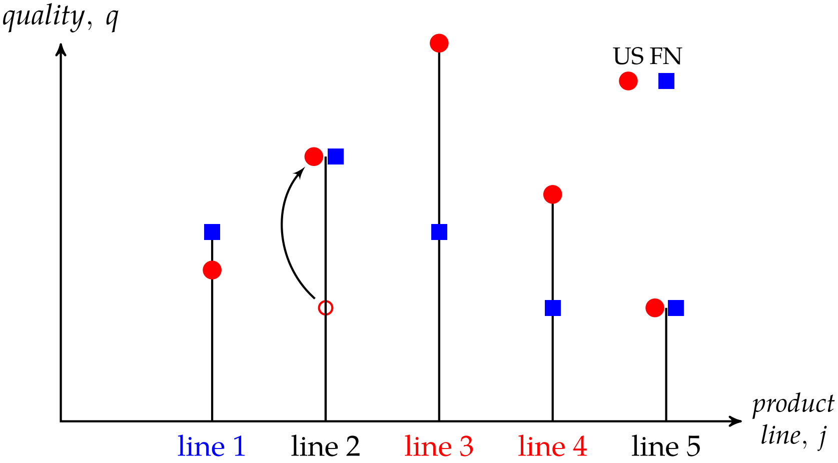

Illustration of the Innovation Dynamics

Suppose the follower in line 2 innovates.

- Scenario 3: It leapfrogs.

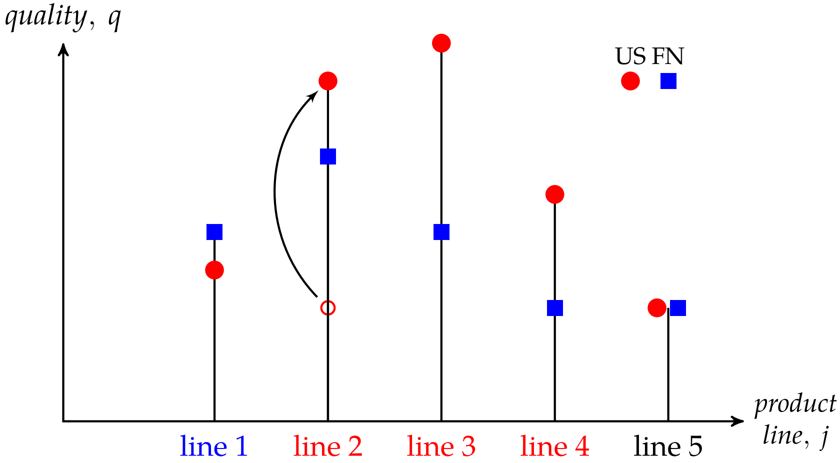

Illustration of the Innovation Dynamics

Entry leads to similar dynamics ...

- ... but forces the domestic incumbent to exit.

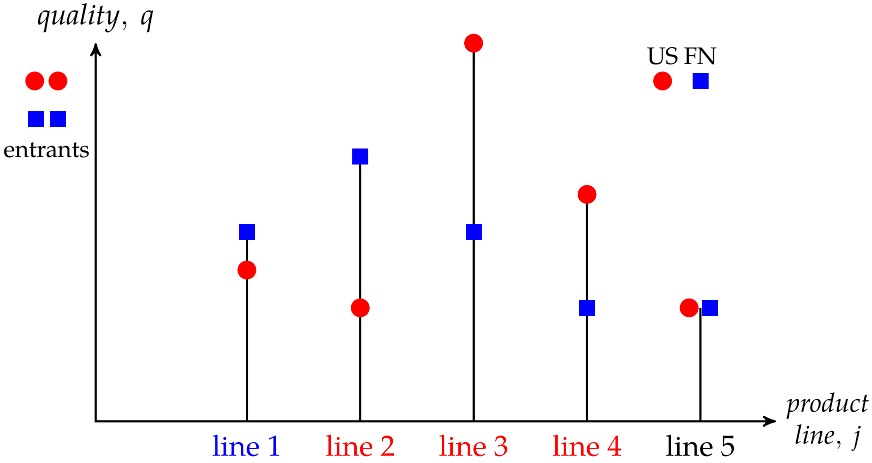

Illustration of the Innovation Dynamics

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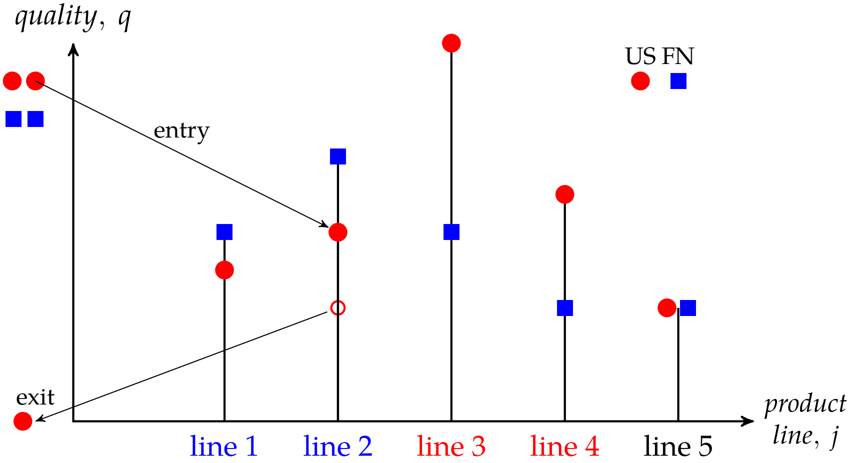

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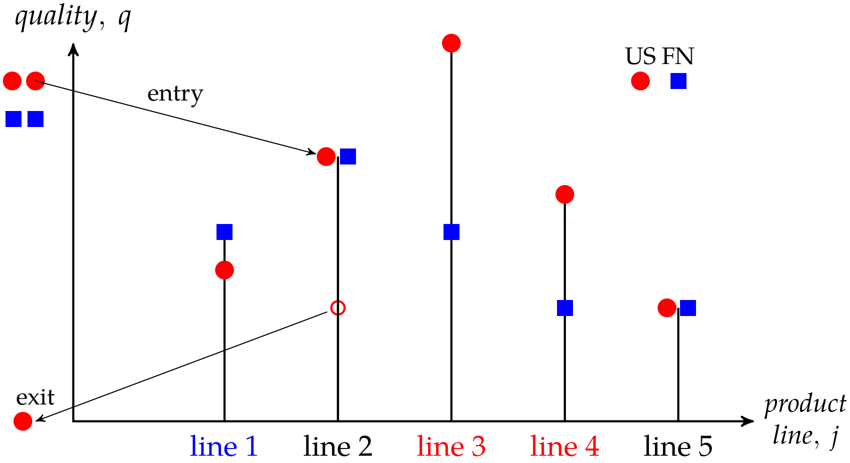

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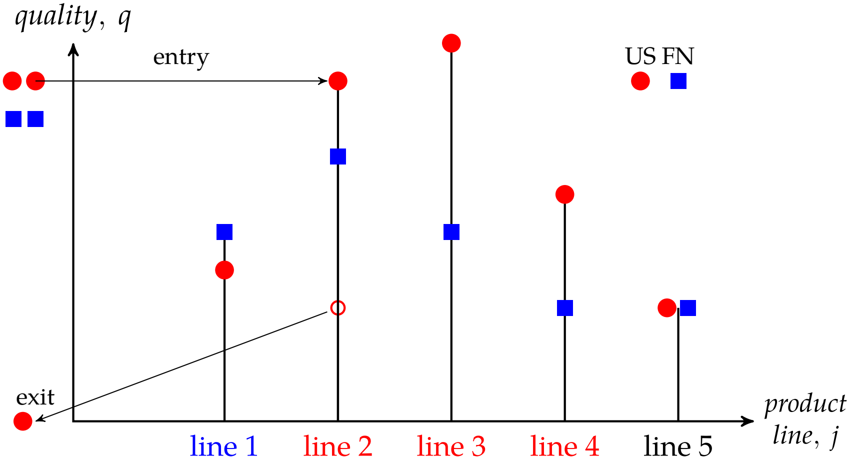
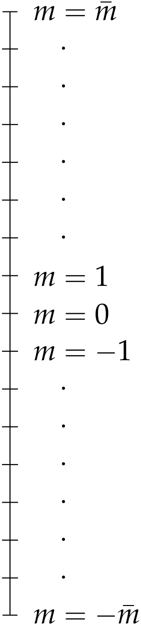


Free Entry



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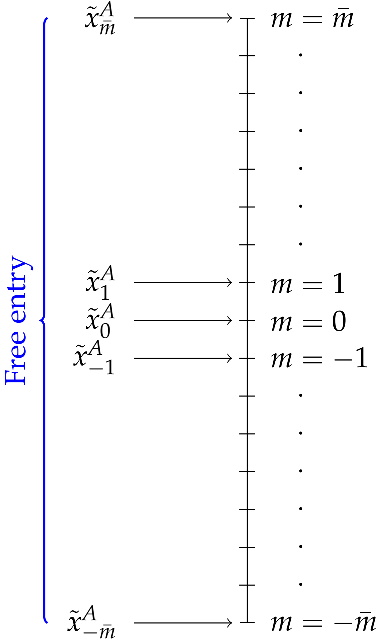

Free entry
$\tilde{x}^A_{\bar{m}}$
$m = \bar{m}$
$\tilde{x}^A_{1}$
$m = 1$
$\tilde{x}^A_{0}$
$m = 0$
$\tilde{x}^A_{-1}$
$m = -1$
$\tilde{x}^A_{-\bar{m}}$
$m = -\bar{m}$

Value Functions

$$
\begin{aligned}
r_{At} V_{Amt}\left(q_t\right) - \dot{V}_{Amt}\left(q_t\right) = \max_{x_{Amt}} \Bigg\{ & \Pi\left(m\right) q_t - \left(1 - \tau^A\right) \alpha_A \frac{\left(x_{Amt}\right)^{\gamma_A}}{\gamma_A} q_t \\
& + x_{Amt} \sum_{n_t = m+1}^{\bar{m}} \mathbb{F}_m\left(n_t\right) \left[V_{Ant}\left(\lambda^{\left(n_t - m\right)} q_t\right) - V_{Amt}\left(q_t\right) \right] \\
& + \tilde{x}_{Amt} \left[0 - V_{Amt}\left(q_t\right)\right] \\
& + \left(x_{B(-m)t} + \tilde{x}_{B(-m)t}\right) \sum_{n_t = -m+1}^{\bar{m}} \mathbb{F}_{-m}\left(n_t\right) \left[V_{A(-nt)}\left(q_t\right) - V_{Amt}\left(q_t\right) \right] \Bigg\}
\end{aligned}
$$

Quantitative Analysis

Part 1. Estimation

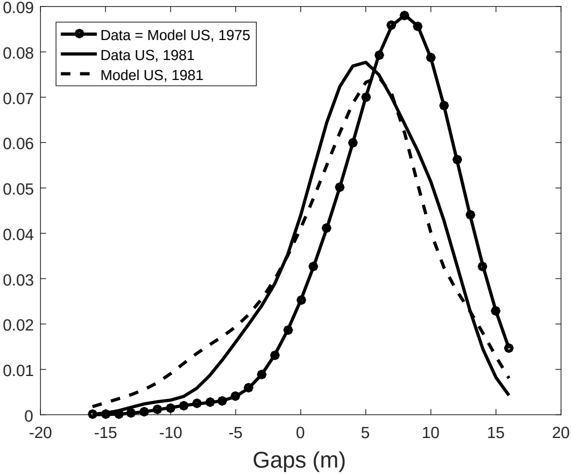
Calibration strategy

- 17 parameters to be determined, 7 are estimated
  - 6 statistics on trade, growth, and innovation over 1975-81 ...
  - and the leadership distribution in 1981.
- Initiate the model in 1975 feeding in the leadership distribution and simulate until 1981

Table: Model fit

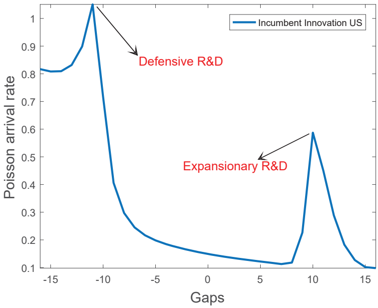
Moment	Estimate	Target	Source
1. TFP Growth U.S.	0.45%	0.55%	Coe et al. (2009) 1975-81
2. TFP Growth FN	2.13%	1.82%	Coe et al. (2009) 1975-81
3. R&D/GDP U.S.	1.65%	1.75%	OECD 1981
4. R&D/GDP FN	1.85%	1.96%	OECD 1981
5. Entry Rate U.S.	10%	10%	BDS 1977-81
6. Export Share U.S.	7.11%	7%	WB 1975-81
7. Patenting Distribution	n/a	n/a	See next slide.

Identification: Evolution of Sector Shares



Model replicates adverse shift of leadership distribution toward smaller gaps over 1975-85.

Validation I: Steady-state Innovation Distribution



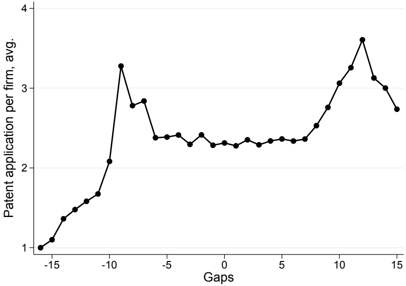


Figure. Data (left) vs Model Simulation (right)

In our simulation, $m^* \approx 10$.

Validation II: Implications on Entrant Innovation

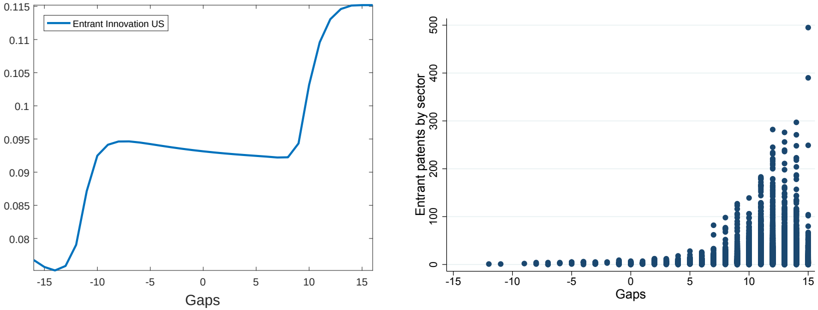


Figure. Entrant Innovation. Model (left) vs data (right).

Quantitative Analysis

Part 2. Welfare Implications and Optimal Policy

Welfare Effects of Catching-Up

Table 8: Observed and optimal U.S. R&D subsidy: 1981-2016

	Subsidy rate	Welfare gains 1981-2016
Observed R&D subsidy	19.2%	0.77%
Optimal R&D subsidy	69%	5.8%

Welfare Effects of Protectionist Policies

Question:

- What is the impact of a 40% increase in tariffs on welfare and innovation?

Welfare Effects of Protectionist Policies

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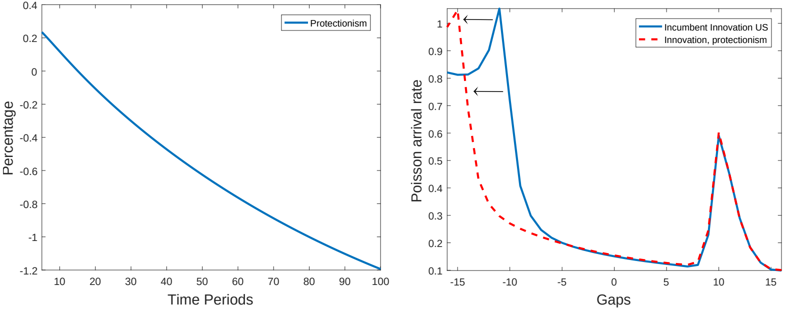


Welfare (left) and innovation response (right) after 40% tariff rate.

Welfare Effects of Protectionist Policies

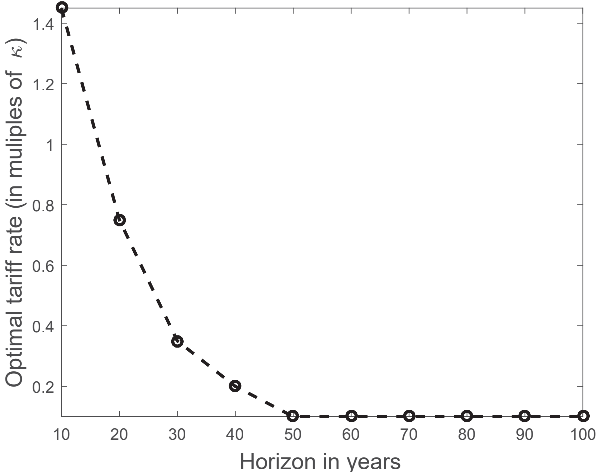
Question:

- What is the optimal tariff rate for different policy horizons?

Welfare Effects of Protectionist Policies

Question:

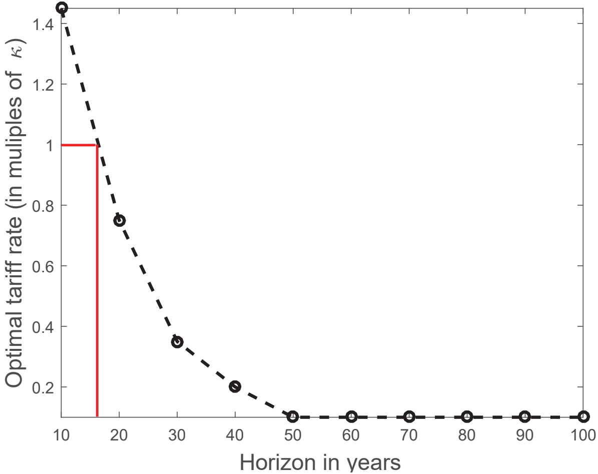
- What is the optimal tariff rate for different policy horizons?



Welfare Effects of Protectionist Policies

Question:

- What is the optimal tariff rate for different policy horizons?



Optimal Subsidy Policy

Questions:

1. What is the optimal subsidy rate for different time horizons?
2. How does it depend on openness?

Optimal Subsidy Policy

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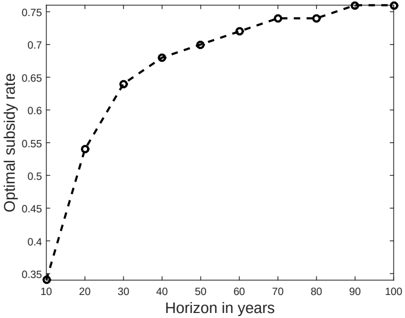

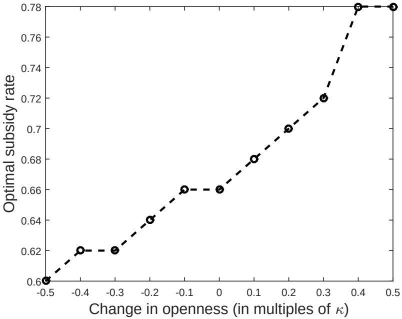

Conclusion

- Built a new dynamic general equilibrium model with endogenous productivity growth, international trade and strategic interaction between competing firms.
- Strategic interaction (competition) channel is quantitatively very important.
- Policies have different implications in different horizons:
  - Protectionist response, short-run gains, long-run losses
  - R&D subsidy leads to notable welfare gains in longer horizons
- Governing globalization? Yes but with innovation policy, not protectionism!
- To do: Brexit simulation?