Uneven Firm Growth in a Globalized World

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Uneven firm growth in recent decades in OECD:

- Industry leaders grow faster in productivity and sales than followers within a country

  Andrews et al. (2016), Autor et al. (2020)...

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- Limited empirical or quantitative evidence
- Gutierrez and Philippon (2020): U.S. leaders grow faster in foreign sales compared to domestic sales

Research Question

1. Does globalization play a role in generating uneven firm growth in OECD?
   - If so, in what ways?

2. Effect on industrial concentration and aggregate productivity growth?

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1. Develop a two-country endogenous growth model with **two new features**

   based on Akcigit-Ates-Impullitti (2018), Liu-Mian-Sufi (2022), etc

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- effects of globalization depend on innovation process
  - *disadvantage*: **leaders** innovates **more** than followers → concentration ↑, TFPg could ↓
  - *advantage*: **followers** innovates **more** than leaders → concentration ↓, TFPg ↑

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2. Provide suggestive evidence for innovation *disadvantage* of backwardness
   - fewer patents/citations if more left behind

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   - an OECD country V.S. ROW
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   - explain concentration $\uparrow$ ($\approx$70%) and TFPg $\downarrow$ ($\approx$40%) in the OECD data

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   - front-loaded welfare gains, ROW benefits more
   - keys to my findings: two new model features
     - ⋆ strategic domestic competition in an open economy
     - ⋆ innovation disadvantage of backwardness

Model Mechanism

Globalization brings larger foreign market size

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Globalization brings harsher foreign competition

- leader innovation ↓ by more

Contribution to the Literature

The rise in industrial concentration and productivity growth slowdown in OECD

- Olmstead-Rumsey (2022), Liu et al. (2022), Peters and Walsh (2022), Aghion et al. (2021), Cavenaile et al. (2019); Akcigit and Ates (2019, 2021), Gutiérrez and Philippon (2020)...
- new perspective: globalization plays a (unique) role

Trade, innovation, knowledge spillover, and heterogeneous firms

- Akcigit-Ates-Impullitti (2018), Cavenaile et al. (2022), Perla et al. (2021), Aghion et al. (2018), Atkeson and Burstein (2010), Akcigit and Melitz (2021); Hsieh-Klenow-Nath (2021), Rivera-Batiz and Romer (1991), Berkes et al. (2022)...
- new model features: market size effect decreases productivity growth

Schumpeterian growth and *advantage* of backwardness

- Peters (2020), Peters and Zilibotti (2021), Perla et al. (2021), Akcigit et al. (2018), Aghion et al. (2005)...
- new facts: innovation disadvantage of backwardness in domestic and int'l markets

Innovation, misallocation, and firm dynamics

- Hsieh and Klenow (2009), Acemoglu et al. (2018), König et al. (2020)...
- resource reallocation to more productive firms could generate long-run growth losses

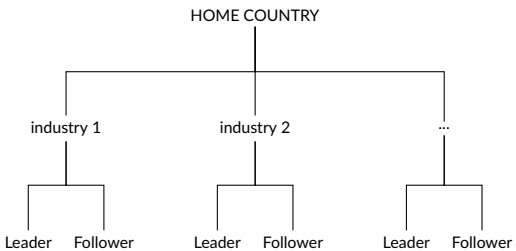
Contents

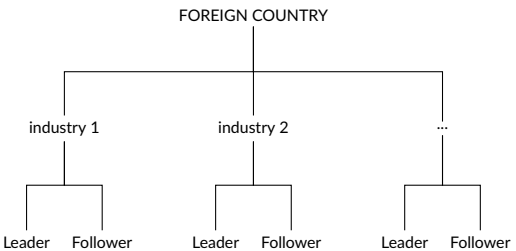
Key Model Element

- oligopolistic competition within and across countries
  - à la Atkeson and Burstein (2008)
- innovation investment
- domestic and int'l knowledge spillovers

Model Setup

- continuous time, infinite horizon, country $c \in \{H, F\}$, industry $j \in [0, 1]$
- in each c : representative consumer, perfect competition in final good market
  ▸ HH ▸ Final good
- two intermediate firms per c-j: leader ($i = 1$) VS follower ($i = 2$)
  - ▸ static production + dynamic innovation





Intermediate Good Production

For firm i in industry j, country c, and time t,

- $y^T_{ijct} = q_{ijct} l_{ijct}, \quad q_{1jct} \geq q_{2jct}$
- $y^T_{ijct} = y^{\text{domestic sales}}_{ijct} + y^{\text{exports}}_{ijct}, \quad$ iceberg cost $\tau_c > 1$
- imperfectly substitutable varieties within j, with $\epsilon > 1$
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Model property:

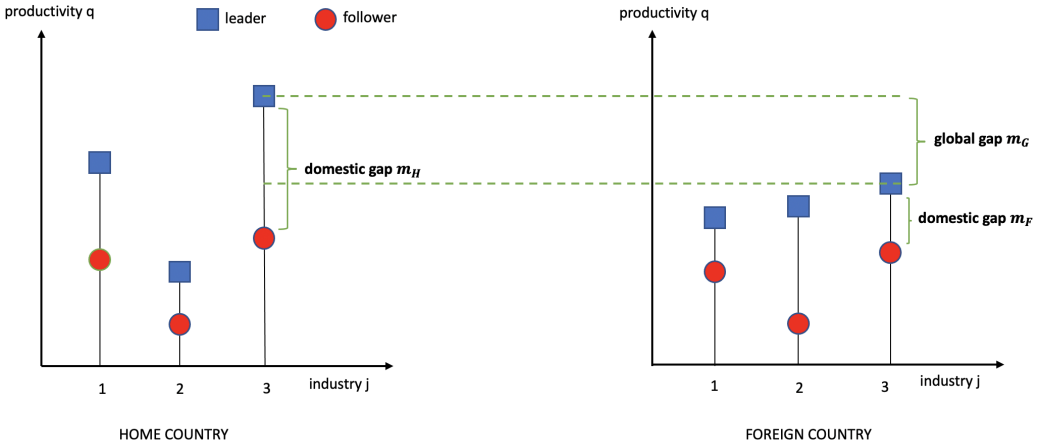
- strategic interactions take place **within** j, depend on **relative productivity**

Lemma A.1, Proposition A.1 | Proposition 1, 2

Technology Gap (Relative Productivity)

3 technology gaps $\boldsymbol{m} \equiv (m_H, m_F, m_G)$

- $\frac{q_{1jH}}{q_{2jH}} = \lambda^{m_H}$
- $\boldsymbol{m}$ represents industry j, state variables



Endogenous Innovation: Cost

- pay innovation cost $R_{ict}(\boldsymbol{m})$ to choose prob. $x_{ict}(\boldsymbol{m})$ s.t. innovate successfully

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  - $f_{ic}(\boldsymbol{m}) \equiv \exp(m_H)^{\bar{\varphi}_{ic}} \exp(m_F)^{\bar{\psi}_{ic}} \exp(m_G)^{\bar{\chi}_{ic}}$
    - $\bar{\varphi}_{2H}(\bar{\chi}_{iH}) < 0$: pay higher R when more left behind $\rightarrow$ **lower x when more left-behind**
    - $\bar{\varphi}_{2H}(\bar{\chi}_{iH}) > 0$: pay lower R when more left behind $\rightarrow$ **higher x when more left-behind**

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- successful innovation increases relative productivity by **one step or more**

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    - ★ ϕ_H^{Dgap} (ϕ_H^{Ggap}) > 0: more likely to jump one step → **lower** x **when more left-behind**
      e.g., Liu et al. (2022), Aghion et al. (2005)...
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- lower x when more left-behind: “innovation *disadvantage* of backwardness"
  - counterpart of innovation *advantage* of backwardness in the literature see, e.g., Akcigit et al. (2018)

Exogeneous Knowledge Spillovers

Spillovers from competitors

- followers get domestic knowledge spillover with prob. κ
- leaders and followers get international knowledge spillover with prob. ι
  - if productivity lower than foreign leaders

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Knowledge spillovers lead to higher relative productivity

- same as endogenous innovation

Balanced Growth Path (BGP) Equilibrium

Definition 1. A balanced growth path equilibrium of the two-country open economy consists of an allocation $\{y_{ict}, y^*_{ict}, l_{ict}, l^*_{ict}, x_{ict}, Y_{ct}, C_{ct}, L_c, R_{ct}, \{\mu_t(\boldsymbol{m}), Q_{ct}(\boldsymbol{m})\}_{\boldsymbol{m}\equiv(m_c,m_{c'},m_G)}\}^{c,c'\in\{H,F\},t\in[0,\infty)}_{i\in\{1,2\},j\in[0,1]}$, and prices $\{r_{ct}, w_{ct}, P_{ct}, p_{ict}, p^*_{ict}\}^{c\in\{H,F\},t\in[0,\infty)}_{i\in\{1,2\},j\in[0,1]}$ such that for any $m_c \in \{0, ..., \bar{m}_c\}$, $m_G \in \{-\bar{m}_G, ..., 0, ..., \bar{m}_G\}$ and all t,

(i) all agents' decisions optimize;
(ii) asset market clears, pinning down r_{ct} via the household's Euler equation;
(iii) labor market clears, pinning down the wage rate w_{ct};
(iv) final good market clears;
(v) trade is balanced in intermediate good sector; and
(vi) $\mu_t(\boldsymbol{m})$ and $Q_{ct}(\boldsymbol{m})$ evolve as specified and are consistent with firms' choices of x_{ict}.

▸ evolution of distribution $\mu(\boldsymbol{m})$ ▸ growth ▸ market clearing

Contents

Data

Define industry leaders and followers: cf. Kroen-Liu-Mian-Sufi (2021)...

- leaders: top 5% firms by sales in 2-digit industry in each country-year
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- innovation incentive $\propto$ patent value $\propto$ patent citations Kogan et al. (2017)...

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Measure tech gaps by sales difference:

- domestic gap: log difference in sales between leaders and followers (leader premium)
- foreign gap: log difference in sales in other countries
- global gap: global output share of OECD

▸ sample

Firm Innovation Incentive Over Tech Gaps

For firm i in industry j, country c, and year t,

$$\text{measured innovation}_{ijct} = \beta_0 + \beta_1 \text{leader premium}_{jct} + \beta_2 \text{global output share}_{jct} + \beta_3 \text{leader premium}_{jc't}$$
$$+\beta_4 \text{leader premium}^2_{jct} + \beta_5 \text{global output share}^2_{jct} + \beta_6 \text{leader premium}^2_{jc't} + \gamma_{c,t} + \delta_i + \epsilon_{ijct}$$

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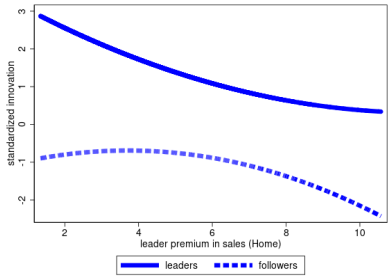
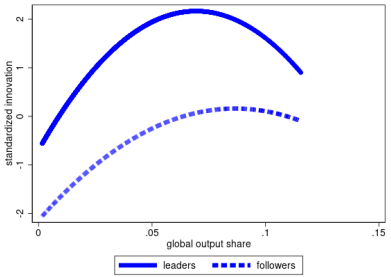


c fitted value over domestic gap



d fitted value over global gap

- **Lower innovation incentive when more left behind the domestic or global technology frontier**

regression table | compare with literature | m_F | patent firms

Robustness

- Alternative definition of leaders
  - top 10%, top 25%
- Alternative data sample
  - drop firms that never have patents
- Alternative measure of innovation
  - number of patents, citations per patent
  - TFPR growth, sales growth
- Alternative measure of technology gaps
  - lagged leader sales premium
  - leader market share among domestic firms, HHI; OECD global export share
  - TFPR, number of patents
- Alternative empirical specification
  - higher order terms, interaction terms
  - additional firm-level controls (leverage, sales)

▸ extensive margin raw data

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Parameterization

initial BGP + new BGP

Parameterization: Overview

- Foreign has larger market size L_c and lower innovation efficiency than Home
  - Home: an advanced OECD country; Foreign: ROW

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  1. **aggregate variables:** mean export intensity, TFPg, OECD's relative TFP, R&D/GDP...
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Parameter	Initial BGP	New BGP	Targeted Moments		
				Data	Model
Trade iceberg cost τ	1.91	1.83	ΔMean export intensity	0.07	0.07
Int'l knowledge spillover ι	0.01	0.05	ΔOECD's relative TFP	-12.4	-12.7

▸ external ▸ internal ▸ industry TFP data ▸ new BGP ▸ Validation 1: industry distribution ▸ Validation 2: int'l spillover ι

Standard Parameterization in Initial BGP

External Parameter	Notation	Value	Identification
Fraction of leaders in a country	ω_{1c}	0.05	Empirical facts
Labor force in Home country	L_H	1	Normalization
Innovation cost elasticity	γ_{ic}	2	Common estimates
Discount factor	ρ	0.05	Real interest rate

Internal Parameter	Notation	Value	Targeted Moments	Data	Model
Panel A. Aggregate variables					
Labor force in Foreign	L_F	30	Mean global output share	0.06	0.06
Elasticity of substitution	ϵ	5	Aggregate markup	1.20 - 1.30	1.30
Trade iceberg cost	τ_c	1.91	Mean export intensity	0.17	0.17
Productivity step size	λ	1.08	TFP growth rate,%	1.05	1.05
Innovation cost scale	α_{1H}	18.73	R&D/GDP in OECD	2.27	2.30
	α_{1F}	109.56	R&D/GDP in ROW	1.91	1.87
	α_{2H}	2.97	Mean leader inno. premium	0.25	0.32
	α_{2F}	7.83	Std leader inno. premium	0.48	0.56

Parameterization in Initial BGP: Innovation Cost

- directly discipline by the data

Parameter	Notation	Value	Targeted Moments	Data	Model
Panel B. State-dependent Innovation Cost					
	$\bar{\varphi}_{1H}, \bar{\psi}_{1F}$	1.51	β_1^{leader}(R&D, OECD leader sales premium)	3.453***	3.322
	$\bar{\varphi}_{2H}, \bar{\psi}_{2F}$	1.33	$\beta_1^{\text{follower}}$(R&D, OECD leader sales premium)	3.188***	3.127
	$\bar{\psi}_{1H}, \bar{\psi}_{2H}$	0.0	β_3^{leader}(R&D, ROW leader sales premium)	0.000***	0.000
	$\bar{\varphi}_{1F}, \bar{\varphi}_{2F}$	0.0	$\beta_3^{\text{follower}}$ (R&D, ROW leader sales premium)	0.000***	0.000
	$\bar{\chi}_{1H}, \lvert\bar{\chi}_{1F}\rvert$	0.01	β_2^{leader}(R&D, OECD global output share)	0.054***	0.033
	$\bar{\chi}_{2H}, \lvert\bar{\chi}_{2F}\rvert$	0.02	$\beta_2^{\text{follower}}$(R&D, OECD global output share)	0.372***	0.149

Parameterization in Initial BGP: Innovation Step Size

- infer from patent data

Parameter	Notation	Value	Targeted Moments		
				Data	Model
Panel C. Innovation Step Size					
Domestic	$\phi_H^{\text{Dgap}}, \phi_F^{\text{Dgap}}$	5.61	β_1(inno., OECD leader sales premium)	-0.495***	-0.442
Int'l	$\phi_H^{\text{Ggap}}, \phi_F^{\text{Ggap}}$	5.93	β_2(inno., OECD global output share)	72.973**	68.822
			β_4(inno., OECD leader sales premium^2)	0.021	0.024
			β_5(inno., OECD global output share^2)	-525.275**	-436.145
			β_3(inno., ROW leader sales premium)	-1.803***	-1.291
			β_6(inno., ROW leader sales premium^2)	0.096	0.083

Parameterization in Initial BGP: Knowledge Spillover

- follow the literature: spillovers explain “what cannot explained by innovation"
- spillovers are closely related to relative productivity across countries/firms
- measure relative productivity by relative sales/TFP in the data
  - control confounding effects

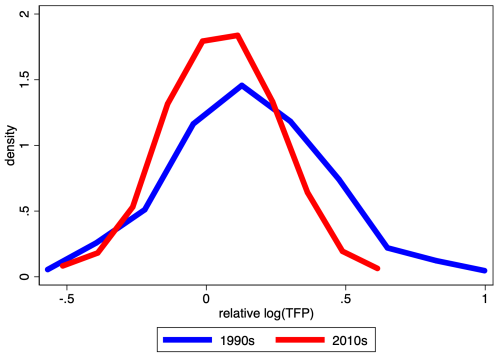
Internal Parameter	Notation	Value	Targeted Moments	Data	Model
Panel D. Knowledge spillovers					
Domestic spillover	κ	0.09	Mean leader sales premium	3.10	3.09
Int’l spillover	ι	0.01	Mean OECD’s relative TFP	1.29	1.29

Infer Int'l Knowledge Spillover Parameter ι

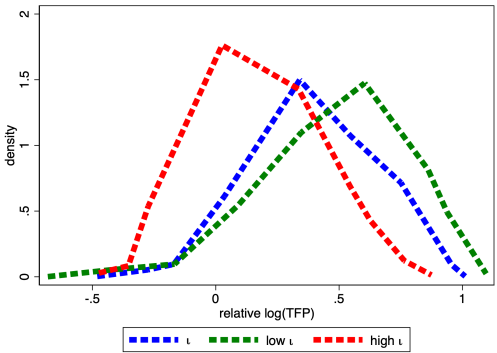
- estimate ι indirectly to match relative TFP across countries
  - à la Prato (2021), etc
- other factors affecting relative TFP contaminates ι estimation
  - reduced misallocation from reforms; R&D subsidy; price diff via exchange rate changes...
- construct new industry TFP level data set to control other factors
  - construct the multilateral TFP index suggested by Caves et al. (1982)
  - data from EU KLEMS, OECD, WB, IMF, FRED
    - ⋆ compensation of employees, capital stock, value-added, financial development index, labor quality improvement index, R&D-GDP ratio...

Validate Int'l Knowledge Spillover Parameter ι

- ι nicely targets the industry density distribution over OECD relative TFP



e Data



f Model

Effects of Globalization on OECD

BGP Analysis

Effects of Globalization on OECD

	Data	Model	globalization ($\iota\uparrow, \tau\downarrow$)	$\iota\uparrow$	$\tau\downarrow$
Uneven Firm Growth					
ΔLeader premium in sales	0.52	0.52	0.40		
ΔLeader premium in exports	0.91	0.92	0.76		

- leaders grow faster in exports than domestic sales
  - $\Rightarrow$ **foreign market vital to uneven firm growth**

Effects of Globalization on OECD

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Uneven Firm Growth					
ΔLeader premium in sales	0.52	0.52	0.40		
ΔLeader premium in exports	0.91	0.92	0.76		
Aggregates					
ΔTFP growth rate,%	-0.78	-0.79	-0.33		
ΔIndustrial concentration	0.08	0.08	0.06		

- leaders grow faster in exports than domestic sales
  - $\Rightarrow$ **foreign market vital to uneven firm growth**
- globalization explains around 70% industrial concentration $\uparrow$, 40% TFP growth $\downarrow$

Effects of Globalization on OECD

	Data	Model	globalization ($\iota \uparrow, \tau \downarrow$)	$\iota \uparrow$	$\tau \downarrow$
Uneven Firm Growth					
ΔLeader premium in sales	0.52	0.52	0.40	0.38	0.02
ΔLeader premium in exports	0.91	0.92	0.76	0.75	0.002
Aggregates					
ΔTFP growth rate,%	-0.78	-0.79	-0.33	-0.33	0.00
ΔIndustrial concentration	0.08	0.08	0.06	0.05	0.01

- leaders grow faster in exports than domestic sales
  - $\Rightarrow$ **foreign market vital to uneven firm growth**
- globalization explains around 70% industrial concentration $\uparrow$, 40% TFP growth $\downarrow$
- **international knowledge spillover force ($\iota \uparrow$) dominates** trade cost force ($\tau \downarrow$)
  - larger market size effect

▸ Effects on ROW ▸ Other trends ▸ Identify τ and ι ▸ Globalization effects decomposition ▸ Role of $f_{ic}(\boldsymbol{m})$

Effects of Globalization on OECD: Mechanism Decomposition

- market size effect (MS): leaders increase innovation by more
  - MS: change of τ, $\frac{w_F}{w_H}$, or $\frac{PY_F}{PY_H}$ increases profits
- int'l business stealing effect (IS) + import competition effect (IC): opposite
  - IS: change of ι directly affects x
  - IC: change of τ, $\frac{w_F}{w_H}$, or $\frac{PY_F}{PY_H}$ decreases profits

	$\iota\uparrow, \tau\downarrow$	$\iota\uparrow$		$\tau\downarrow$		
		all effects(MS,IS)	IS	all effects(MS,IC)	MS	IC
Uneven Firm Growth						
ΔLeader premium in TFPg, %	0.10	0.10	-0.03	0.002	0.005	-0.002
Aggregates						
ΔTFP growth rate,%	-0.33	-0.33	-0.25	0.00		
ΔIndustrial concentration	0.06	0.05	-0.05	0.01		

Role of the Key Model Elements

The Role of the Two Key Model Elements

- **oligopolistic domestic competition + innovation disadvantage of backwardness**

The Role of the Two Key Model Elements

- **oligopolistic domestic competition + innovation disadvantage of backwardness**

	Globalization	No domestic competition (1 firm per j, c)	Domestic innovation advantage of backwardness ($\phi_H^{\text{Dgap}} < 0$)
Uneven Firm Growth			
ΔLeader prem. in sales	0.40		-0.08
ΔLeader prem. in exports	0.76		-0.20
Aggregates			
ΔProductivity growth rate,%	-0.33	-0.08	0.46
ΔIndustrial concentration	0.06		-0.05

- **weaker domestic competition:** growth ↓ more than harsher foreign competition
- **innovation advantage of backwardness:** growth ↑, concentration ↓

▸ Compare to Akcigit-Ates-Impullitti (2018) ▸ More counterfactuals ▸ Non-linear g over m_H ▸ Non-linear g over m_G

Additional Discussion

1. Policy implications
2. Other secular trends
   - declining interest rate/research productivity/domestic knowledge spillover
3. Transition dynamics
4. Welfare implications
5. Additional empirical evidence
6. Model assumptions and extensions
   - not all firms export
   - endogenous entry and exit
   - alternative way of modelling spillovers
     - ⋆ lower innovation costs of firms w/o tech advantage
     - ⋆ int'l knowledge spillovers endogenously vary with trade

Contents

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Two new model features:

- strategic domestic competition in open economy
- innovation disadvantage of backwardness

Conclusion

A new perspective:

- globalization leads to concentration increase & productivity growth slowdown
  - mainly via *weaker domestic competition* instead of *harsher foreign competition*

Two new model features:

- strategic domestic competition in open economy
- innovation disadvantage of backwardness

New facts for innovation disadvantage of backwardness:

- in both domestic and global market