GLOBALIZATION AND THE LADDER OF DEVELOPMENT

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THE LADDER OF DEVELOPMENT

- **Popular metaphor about development:**
  - Countries sit at different rungs of a ladder
  - Each rung associated with a ≠ set of economic activities
  - As countries develop, they become more capable, move up the ladder, produce and export more complex goods
- **This paper:**
  - Use ladder metaphor as a starting point to explore relationship between globalization and development

TRADE ⟷ DEVELOPMENT

- **Development → Trade:**
  - Countries with growing capability (because of domestic shocks) may acquire CA in more complex goods
- **Trade → Development:**
  - Countries specializing in more complex goods (because of foreigns shocks) may have faster capability growth

THIS PAPER

- **Theory:** *Does trade push countries up the development ladder or hold them at the bottom?*
  - Trade can move ***all*** countries up the ladder
  - This happens if ***(i)*** complex goods raise capability and ***(ii)*** fewer countries export complex goods
- **Empirics:** *Do complex goods raise capability?*
  - Supporting evidence using entry of other countries in WTO as IV for sectoral distribution of employment
- **Putting it together:** *Are the conditions necessary for trade to push all countries up the ladder satisfied in the data?* **No**
  - Robust to alternative measures of complexity and capability

RELATED LITERATURE

- **Theory**
  - **Comparative advantage:** Krugman (1979), Krugman (1986), Matsuyama (2005), Costinot (2009), Cunat Melitz (2012), Sutton Trefler (2016)
  - **Learning-by-Doing:** Krugman (1987), Boldrin Scheinkman (1988), Grossman Helpman (1990), Young (1991), Stokey (1991)
  - **Knowledge diffusion:** Perla, Tonetti and Waugh (2015), Sampson (2016), Buera Oberfield (2017)
- **Empirics**
  - **Complexity and capability:** Hausman Hidalgo (2009), Costinot, Donaldson, and Komunjer (2012), Hausman Hidalgo Bustos Coscia Chung Jimenez Simoes Yi. (2011), Levchenko and Zhang (2016), Hanson Lind Muendler (2016)
  - **Trade patterns and growth:** Hausman Hwang Rodrik (2007), Lederman Mahoney (2012), Bartelme Lan Levchenko (2019)

ROADMAP

- Theory
- Measurement
- Estimation
- Counterfactuals
- Robustness

THEORY

ENVIRONMENT

- Many countries indexed by i
- Continuum of goods indexed by k
  - Total measure of goods normalized to one
- Time is continuous and indexed by t

- Labor is the only factor for production
  - $L_{i,t}$ = labor endowment in country i at date t

PREFERENCES

- **Nested CES utility:**

$$U_i = \int_0^\infty e^{-\rho_i t} u_i(C_{i,t}) dt$$

$$C_{i,t} = \left(\int (C_{i,t}^k)^{(\epsilon-1)/\epsilon} dk \right)^{\epsilon/(\epsilon-1)}$$

$$C_{i,t}^k = \left(\sum_j (c_{ji,t}^k)^{(\sigma-1)/\sigma} \right)^{\sigma/(\sigma-1)}$$

- Elasticities of substitution such that:
  - $\epsilon > 0, \sigma > 1, \sigma > \epsilon$
  - Foreign competition in a sector ➡ less employment

TECHNOLOGY

- Goods differ in complexity n_t^k, countries differ in capability $N_{i,t}$:
  - F_t= cdf of complexity across goods
  - $N_t = \{N_{i,t}\}$= state of world technology
- **Linear technology:**

FROM DEVELOPMENT TO TRADE

$$q_{ij,t}^k = A_{ij,t}^k \ell_{ij,t}^k$$

$$\text{Prob}(A_{i,t}^k \leq a) = G_{i,t}(a \mid n_t^k = n, N_{i,t})$$

TECHNOLOGY

- Future capabilities depend on present capabilities and their endogenous patterns of specialization

FROM TRADE TO DEVELOPMENT

$$\dot{N}_{i,t} = H_{i,t}(N_{i,t}, F^{\ell}_{i,t})$$

$$F^{\ell}_{i,t}(n) = \frac{\int_{0 \leq n^k \leq n} \sum_j \ell^k_{ij,t} dk}{\int \sum_j \ell^k_{ij,t} dk}$$

- **Dynamic spillovers:**
  - $H_{i,t}$ is increasing in $F^{\ell}_{i,t}$ (in M.L.R.P sense)
  - More employment in complex sectors → more growth

COMPETITIVE EQUILIBRIUM

- Competitive equilibrium with free trade + financial autarky
- At each date t, conditional on state of world technology N_t:
  - profit maximization, utility maximization, market clearing

$$\Rightarrow \quad \{w_{i,t}\}, \{p^k_{ij,t}, P^k_{j,t}, P_{j,t}\}, \{c^k_{ij,t}, C^k_{j,t}, C_{j,t}\}, \{\ell^k_{ij,t}\}$$

- From t to $t + dt$, employment distribution $F^{\ell}_{i,t} \Rightarrow N_{t+dt}$

PUSHED TO THE TOP OR HELD AT THE BOTTOM? A BENCHMARK

- **Pure ladder economy** (Generalization of Krugman 1979)**:**

$$A^k_{ij,t} = \begin{cases} A_{ij,t} & \text{if } n^t_k \leq N^t_i, \\ 0 & \text{otherwise.} \end{cases}$$

- **Key features:**
  - More capable countries ➡ more likely to export
  - More complex goods ➡ less likely to be exported
  - More capable countries ➡ CA in more complex goods
- **Question:** *What is the difference between time paths of capability* $N_{i,t}$ *and consumption* $C_{i,t}$ *with & without trade?*

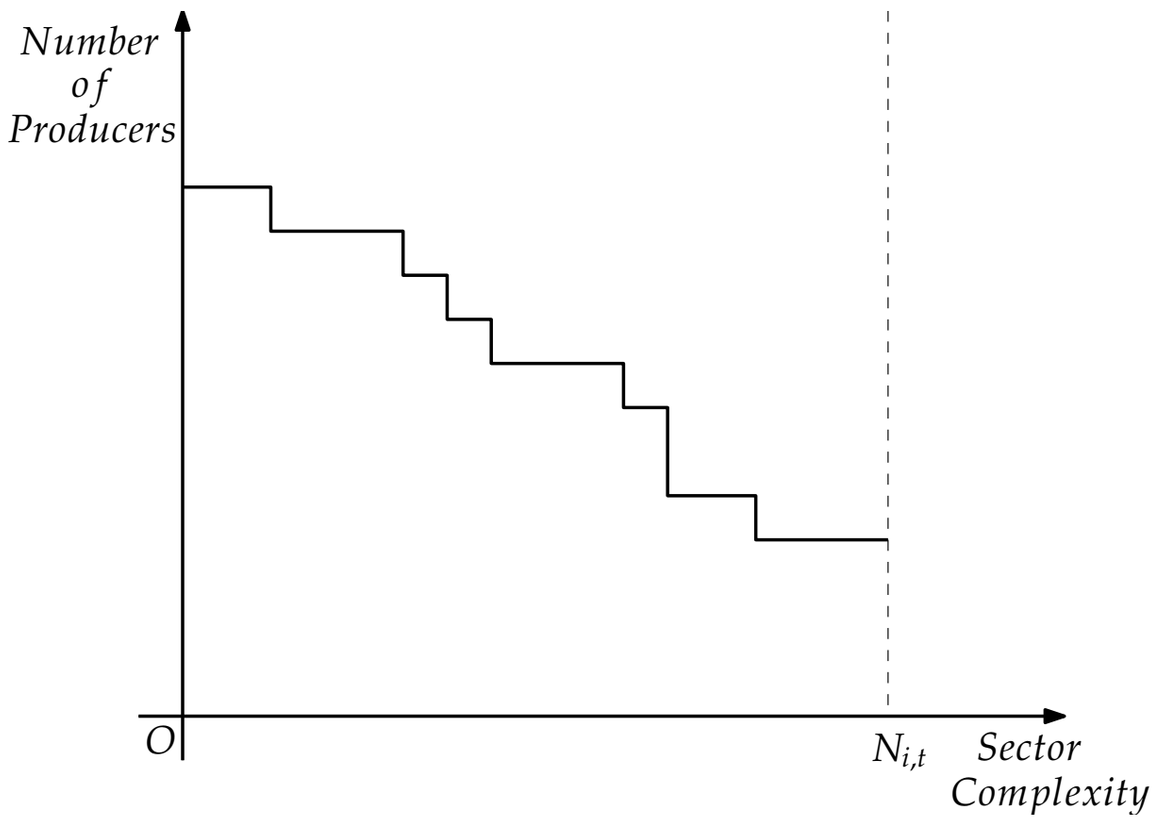
THE CASE FOR DYNAMIC GAINS FROM TRADE IN ALL COUNTRIES

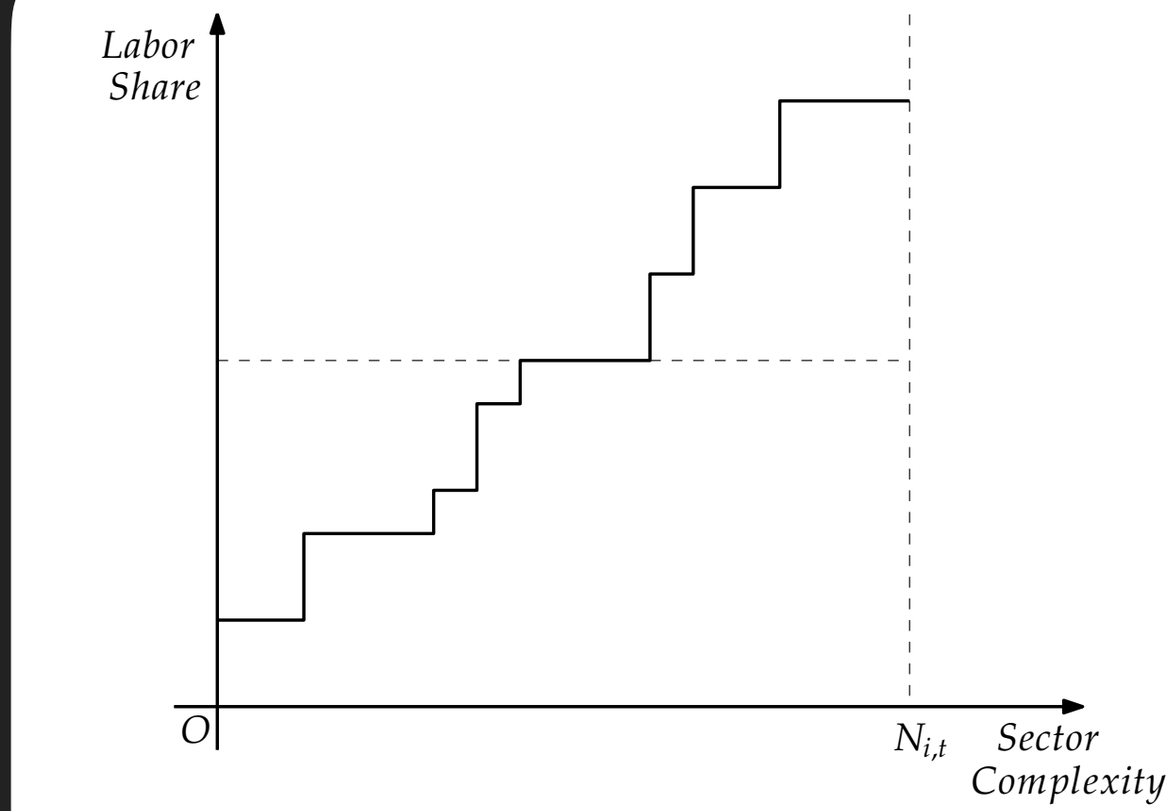
PROPOSITION 1.

IN A PURE LADDER ECONOMY, OPENING UP TO TRADE RAISES TECHNOLOGICAL CAPABILITY $\{N_{i,t}\}$ AND AGGREGATE CONSUMPTION $\{C_{i,t}\}$ AT ALL DATES IN ALL COUNTRIES

- **Sketch of Proof:**
  - More foreign competition in less complex sectors in ***all*** countries
    → more employment in more complex sectors in ***all*** countries
  - At any date t, $(N_{i,t})_{trade} = (N_{i,t})_{autarky}$ → $(\dot{N}_{i,t})_{trade} > (\dot{N}_{i,t})_{autarky}$
  - $(N_{i,t})_{trade} > (N_{i,t})_{autarky}$ → $(C_{i,t})_{trade} > (C_{i,t})_{autarky}$

MORE COMPLEX, LESS FOREIGN COMPETITION!





HOW LARGE ARE THE STATIC AND DYNAMIC GAINS FROM TRADE?

PROPOSITION 2.

IN A PURE LADDER ECONOMY, GAINS FROM TRADE ARE BOUNDED FROM BELOW AND ABOVE BY

$$\underline{GT}_i = 1 - \underbrace{\left[\int e_i(n)(\lambda_{ii}(n))^{\frac{\epsilon-1}{\sigma-1}} dF(n)\right]^{\frac{1}{\epsilon-1}}}_{\text{Static Gains}}$$

$$\bar{GT}_i = 1 - \underbrace{\left[\int e_i(n)(\lambda_{ii}(n))^{\frac{\epsilon-1}{\sigma-1}} dF(n)\right]^{\frac{1}{\epsilon-1}}}_{\text{Static Gains}} \cdot \underbrace{\left[H_i^{-1}(0,F_i^{\ell})/H_i^{-1}(0,F)\right]^{\frac{1}{(1-\epsilon)}}}_{\text{Dynamic Gains}}$$

MEASURING CAPABILITY AND COMPLEXITY

TWO APPROACHES

- **General idea =** Use trade data to reveal productivity distribution and, in turn, capability and complexity
- **Approach 1 (next, closer to HHR and HH):**
  - Assumption: more capable countries more likely to export more complex goods + more complex goods more likely to be exported by more capable countries
- **Approach 2 (later, closer to pure ladder benchmark):**
  - Assumption: more capable countries more likely to export + more complex goods less likely to be exported

BASELINE MEASURES OF CAPABILITY AND COMPLEXITY

- Productivity distribution $G_{i,t}$ such that:

$$\text{Prob}(A^k_{ij,t} > 0) = \delta_{ij,t} + \gamma^k_{j,t} + N_{i,t} n^k_t$$

- **Linear probability model:**

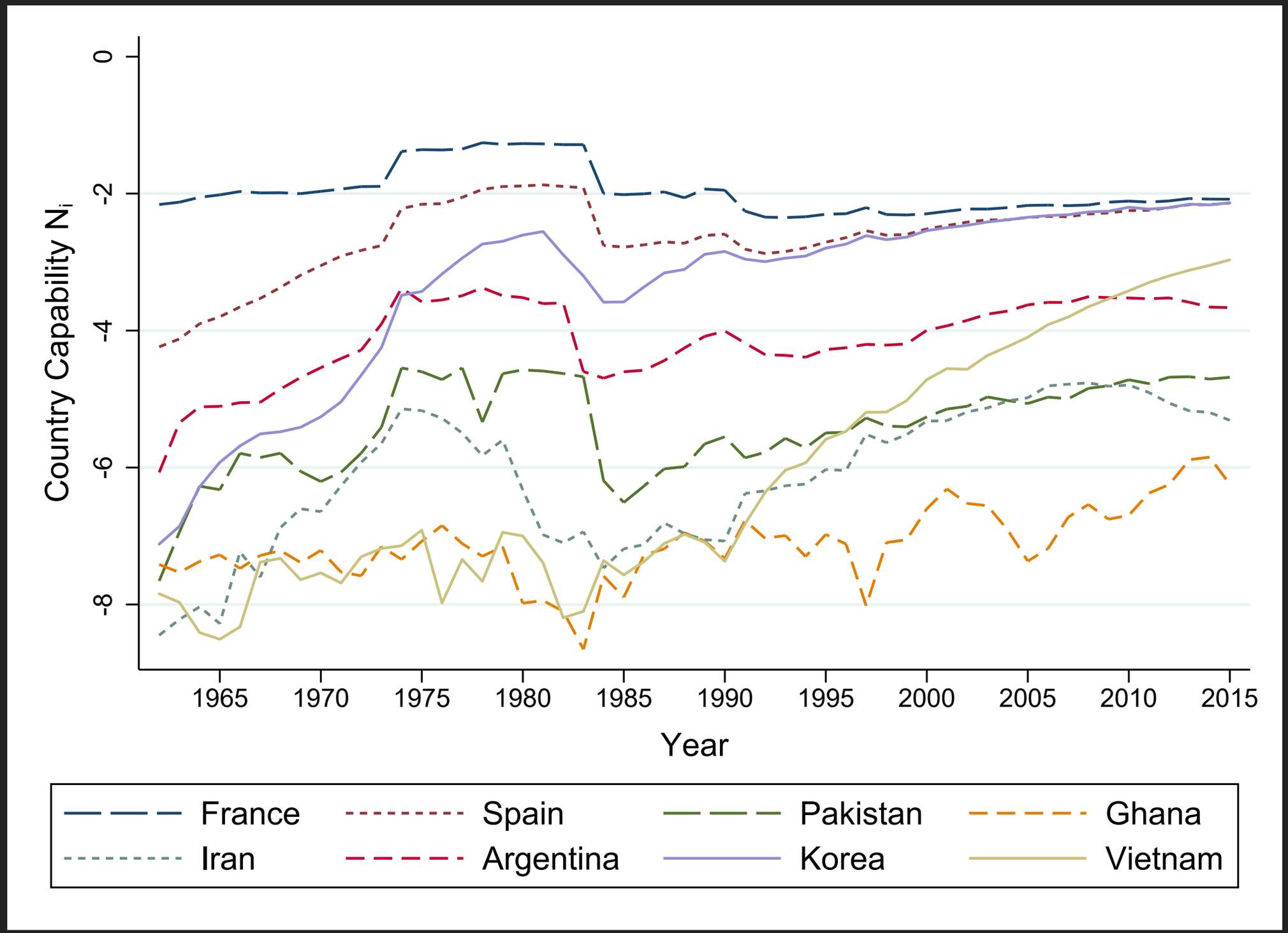
$$\text{Dummy}\{x^k_{ij,t} > 0\} = \delta_{ij,t} + \gamma^k_{j,t} + N_{i,t} n^k_t + u^k_{ij,t}$$

- RCA (CDK, LZ, HLM), but at extensive margin (HHR, HH)

DATA

- Use COMTRADE SITC (Rev2) 4-digit bilateral trade data 1962-2015
- Replicate Feenstra et al. (2005) to clean data
  - But use all flows, bottom coding trade flows ≤ $100,000

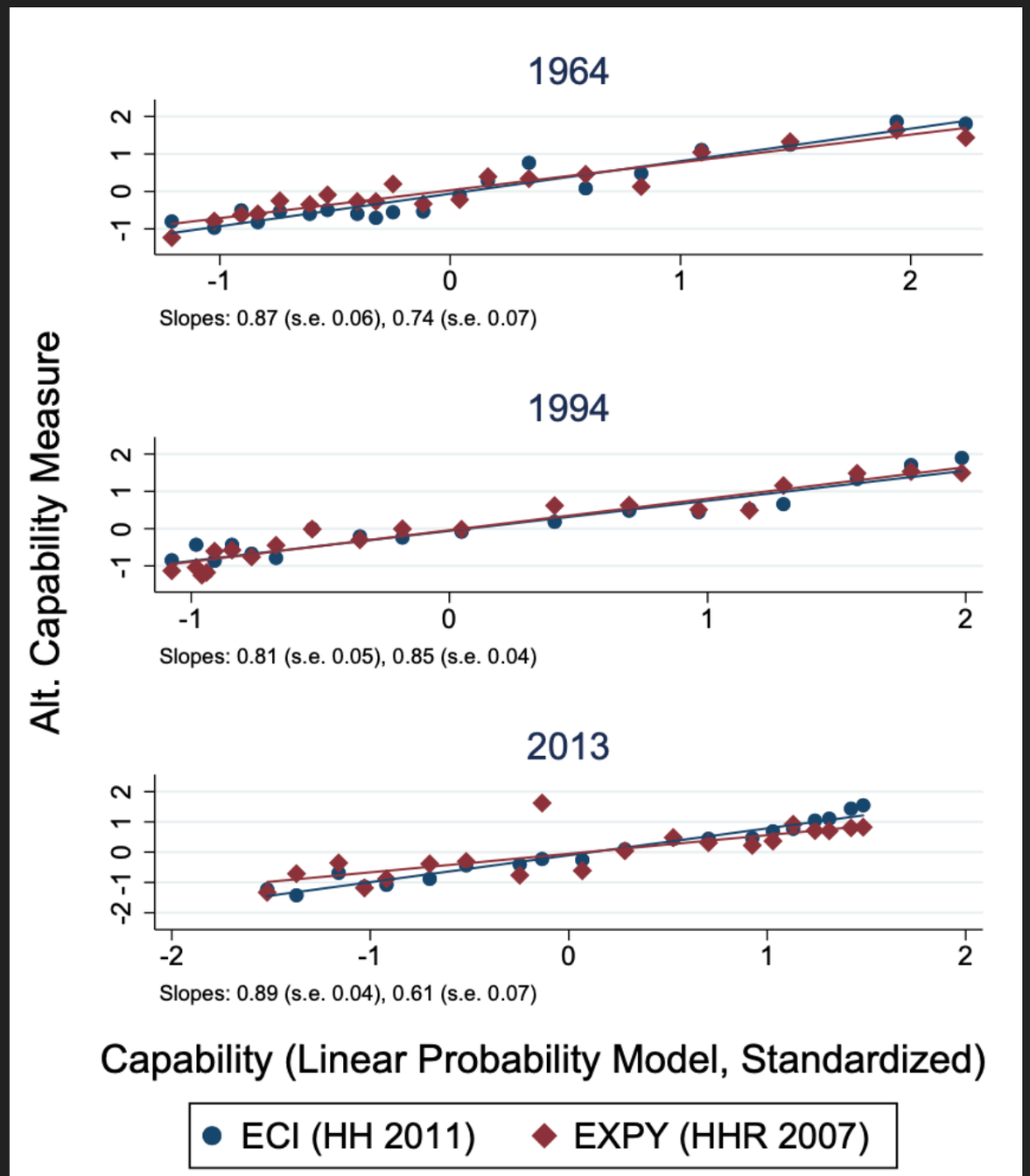
BASELINE CAPABILITY (1962–2015)

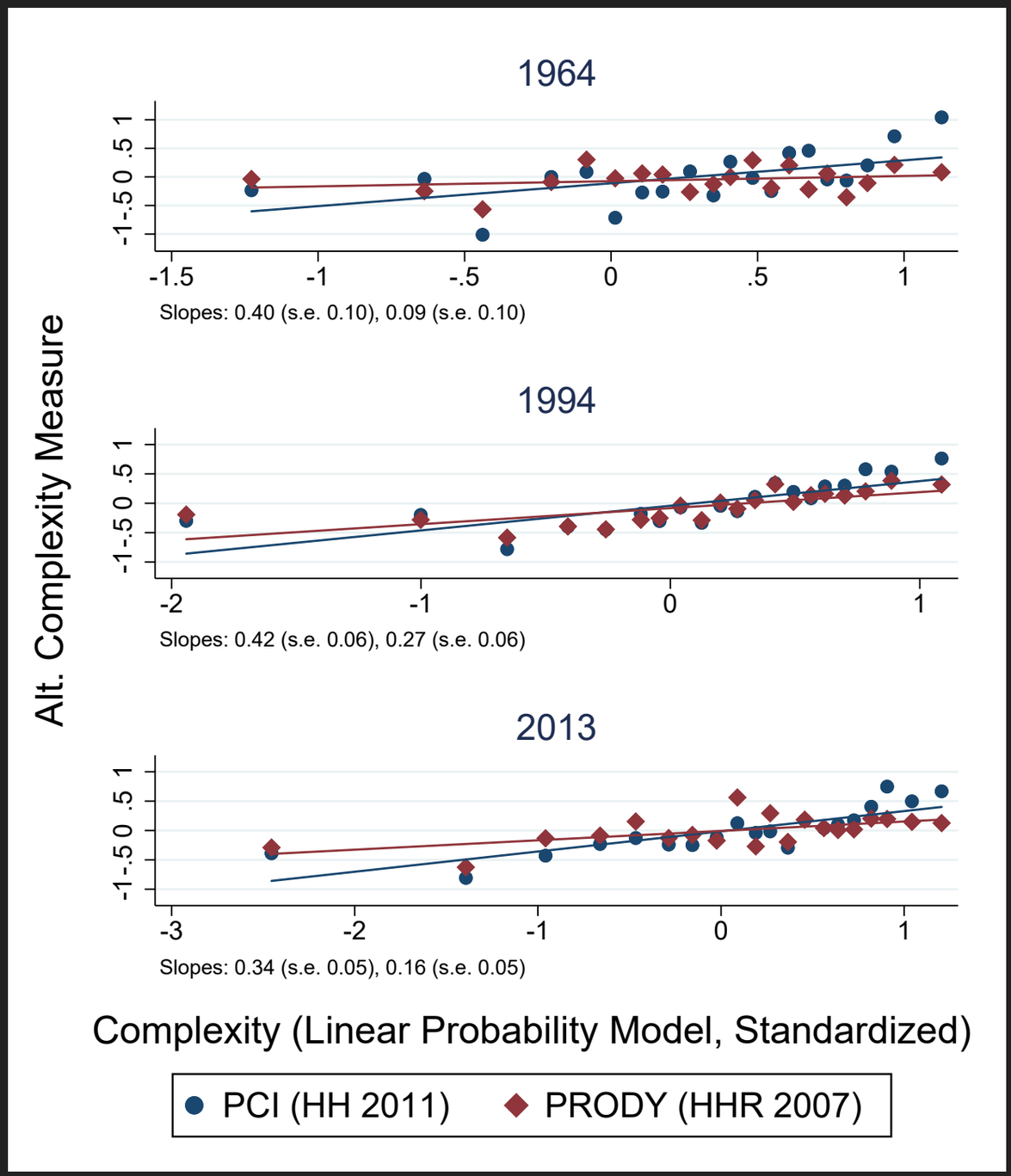


BASELINE COMPLEXITY (1962–2015)

	Sectors with highest n^k (Average Rank, 1962-2015)	
1	Medicaments	4.926
2	Chemical Products	10.778
3	Miscellaneous Non-Electrical Machines	12.130
4	Cars	12.685
5	Miscellaneous Electrical Machinery	14.167
6	Miscellaneous Non-Electrical Machinery Parts	14.667
7	Medical Instruments	21.870
8	Electric Wire	25.056
9	Miscellaneous Hand Tools	25.167
10	Trucks and Vans	34.352
	Sectors with lowest n^k (Average Rank, 1962-2015)	
1	Yarn of Regenerated Fibres	522.559
2	Wood Panels	503.756
3	Hand Woven Rugs	503.576
4	Wool Undergarments	502.071
5	Undergarments of Other Fibres	501.177
6	Lime, cement, and fabricated construction materials	493.292
7	Elastic Knitted Fibres	488.607
8	Aircraft Tires	487.095
9	Rotary Converters	484.381
10	Men's Underwear	483.250

COMPARISON TO EARLIER WORK (HHR 2007 + HH 2011)





ESTIMATING DYNAMIC SPILLOVERS

BASELINE SPECIFICATION

- **Dynamic spillovers:**

$$N_{i,t+1} = \beta \int n dF^{\ell}_{i,t}(n) + \phi N_{i,t} + \gamma_i + \delta_t + \varepsilon_{i,t+1}$$

- **Key endogeneity issue:**

$$S_{i,t} \equiv \int n dF^{\ell}_{i,t}(n) \not\perp \varepsilon_{i,t+1}$$

IV STRATEGY

- **General idea:**
  - Reductions in other countries tariffs affect domestic production mix, exogenous to domestic policies
  - Construct IV from FO approx. of impact of others' WTO entry

$\Rightarrow$

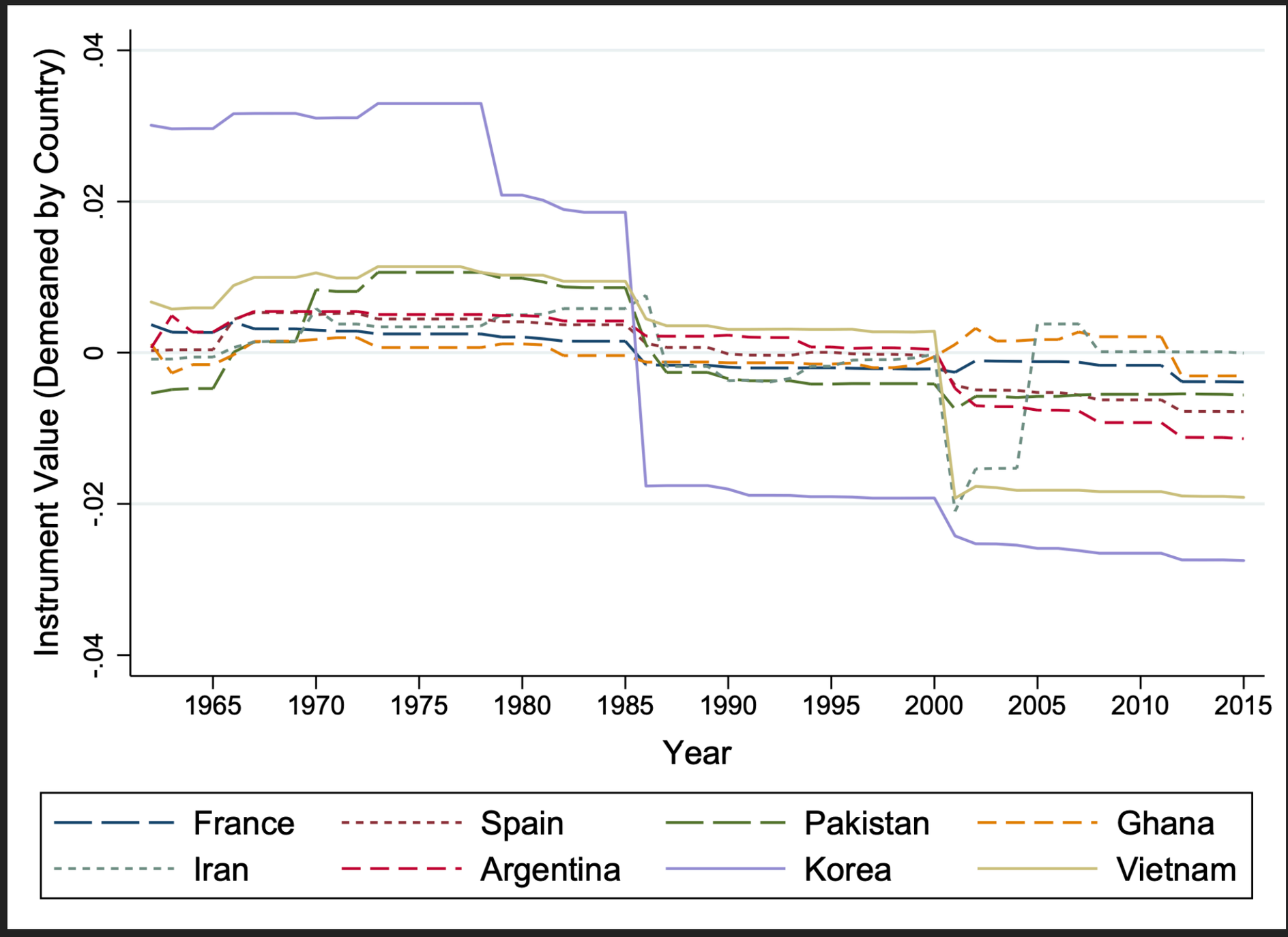
- **IV (I):** *Product-destination-level labor demand shifter*

$$Z^{I}_{i,t} = \sum_{t_c \leq t} \sum_{k} n^{k}_{t_c-1} \underbrace{\omega^{k}_{i,t_c-1} \left(\sum_{j \neq c} \rho^{k}_{ij,t_c-1} \lambda^{k}_{cj,t_c-1} - \sum_{k'} \omega^{k'}_{i,t} \sum_{j \neq c} \rho^{k'}_{ij,t_c-1} \lambda^{k'}_{cj,t_c-1} \right)}_{\text{shift in } k\text{'s employment share predicted by sector-level price changes}}$$

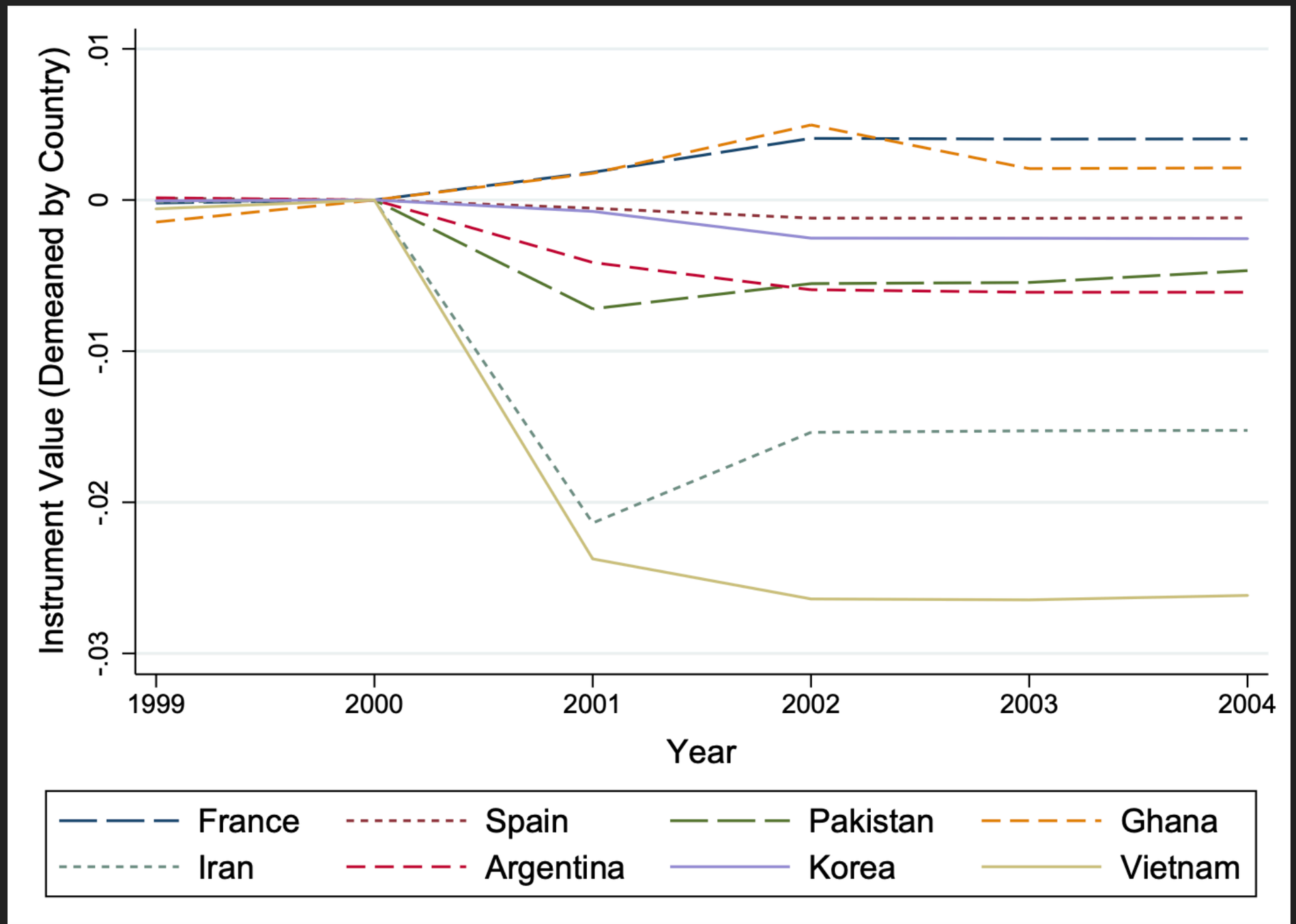
- **IV (II):** *Destination-level labor demand shifter*

$$Z^{II}_{i,t} = \sum_{t_c \leq t} \sum_{k} n^{k}_{t_c-1} \times \underbrace{\omega^{k}_{i,t_c-1} \left(\sum_{j \neq c} \rho^{k}_{ij,t_c-1} \lambda_{cj,t_c-1} - \sum_{k'} \omega^{k'}_{i,t} \sum_{j \neq c} \rho^{k'}_{ij,t_c-1} \lambda_{cj,t_c-1} \right)}_{\text{shift in } k\text{'s employment share predicted by aggregate-level price changes}}$$

TIMEPATH OF IV



TIMEPATH OF IV (ZOOMING AROUND CHINA'S WTO ENTRY)



FIRST STAGE RESULTS

	Average Complexity $S_{i,t}$	
	(1)	(2)
WTO Entrant Shock $Z^{I}_{i,t}$	-2.717***	-0.988*
(Product-Destination Level)	(0.511)	(0.593)
WTO Entrant Shock $Z^{II}_{i,t}$		-13.19***
(Destination Level)		(1.931)
Country and year FEs	Yes	Yes
Observations	7,071	7,071
R-squared	0.514	0.529
Clusters	1592	1592

IV RESULTS: POSITIVE DYNAMIC SPILLOVERS

	Country Capability $N_{i,t+1}$		
	(1) OLS	(2) IV ($Z^I_{i,t}$)	(3) IV ($Z^I_{i,t}$ and $Z^{II}_{i,t}$)
Average Complexity $S_{i,t}$	0.0978*	1.373***	0.739***
	(0.0532)	(0.426)	(0.229)
Initial Capability $N_{i,t}$	0.473***	0.356***	0.414***
	(0.0285)	(0.0476)	(0.0346)
Country and year FEs	Yes	Yes	Yes
Observations	6,331	6,331	6,331
R-squared	0.938	-0.041	0.184
Clusters	1442	1442	1442
CD F-Stat		112	154.4
KP F-Stat		21.66	33.11

DOES TRADE PUSH ALL COUNTRIES TO THE TOP?

COUNTERFACTUAL QUESTION

- **Question:**
  - *What would happen to path of capability and aggregate consumption from 1962 to 2014 if, from 1962 onwards, a country were to move to autarky?*

- **Decomposition of welfare changes into:**
  - **Static gains:**

$$GT_{i,t}^{static} = 1 - \frac{C_{i,t}^{autarky}}{C_{i,t}} \Big|_{N_{i,t}=N_{i,t}^{data}}$$

  - **Dynamic gains:**

$$GT_{i,t}^{dynamic} = GT_{i,t} - GT_{i,t}^{static}$$

BASELINE ECONOMY

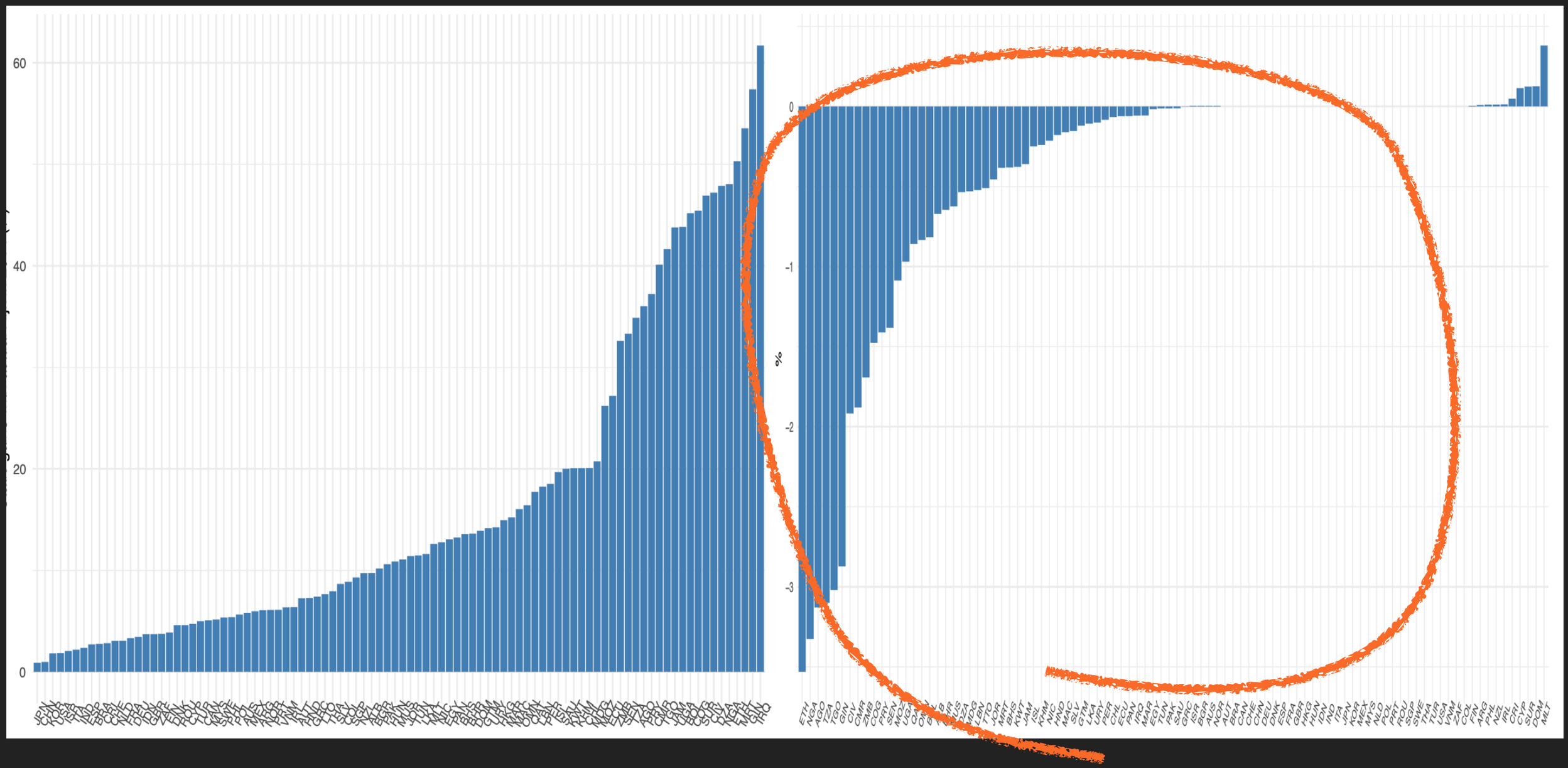
Parameter	Value	Choice Calibration
Panel A: Nested CES Preferences		
σ	2.7	Broda and Weinstein (2006)
ϵ	1.36	Redding and Weinstein (2018)
Panel B: Dynamic Spillovers		
β	0.739	Baseline estimate
ϕ	0.838	Baseline estimate

- Under trade equilibrium, $\{A_{ij,t}^k\}$ = match all trade flows
- Under autarky equilibrium, Prob$(A_{ij,t}^k > 0)$ = linear probability model

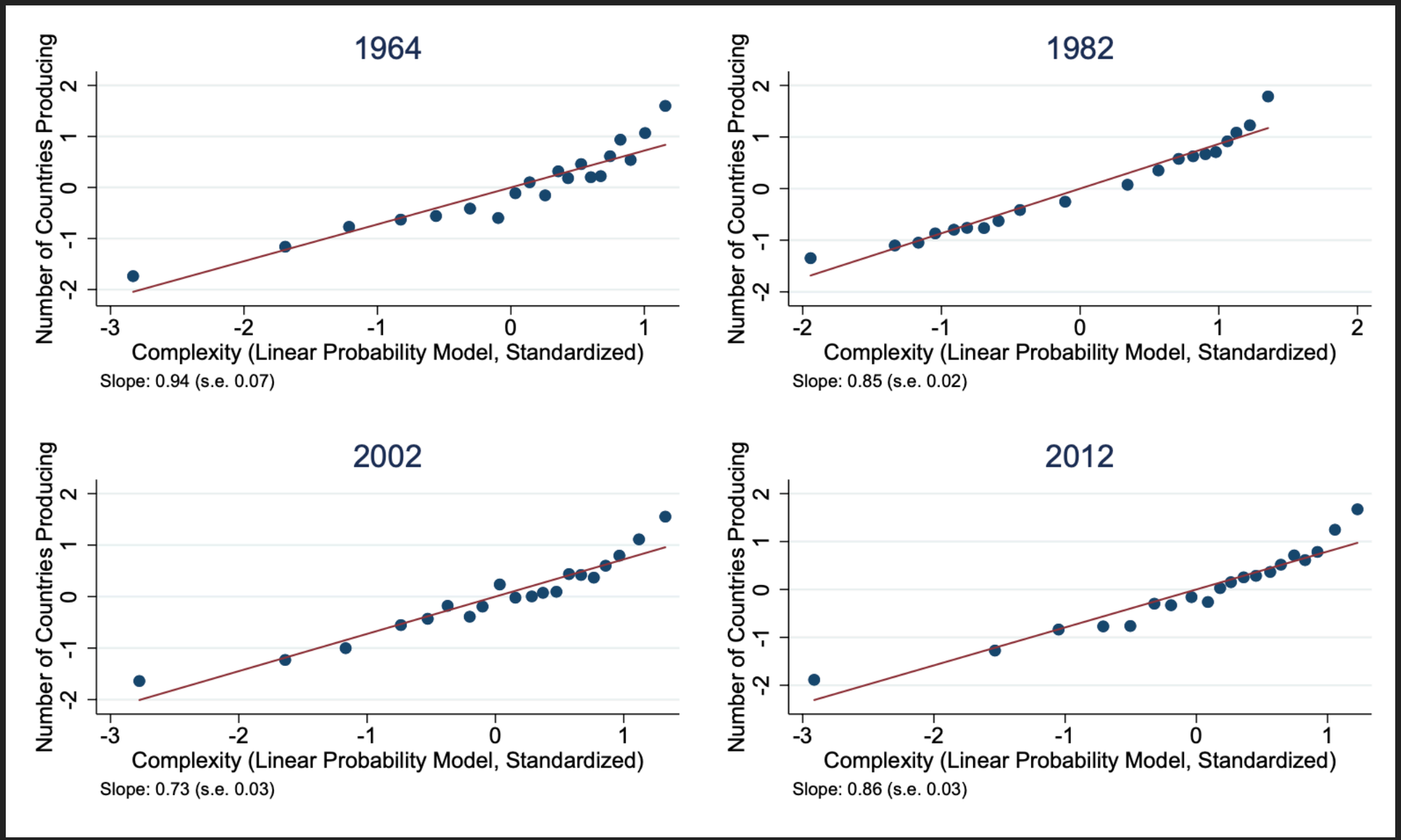
STATIC AND DYNAMIC GAINS FROM TRADE

STATIC GAINS

DYNAMIC LOSSES



MORE COMPLEX, MORE FOREIGN COMPETITION!



HOW ROBUST ARE DYNAMIC LOSSES?

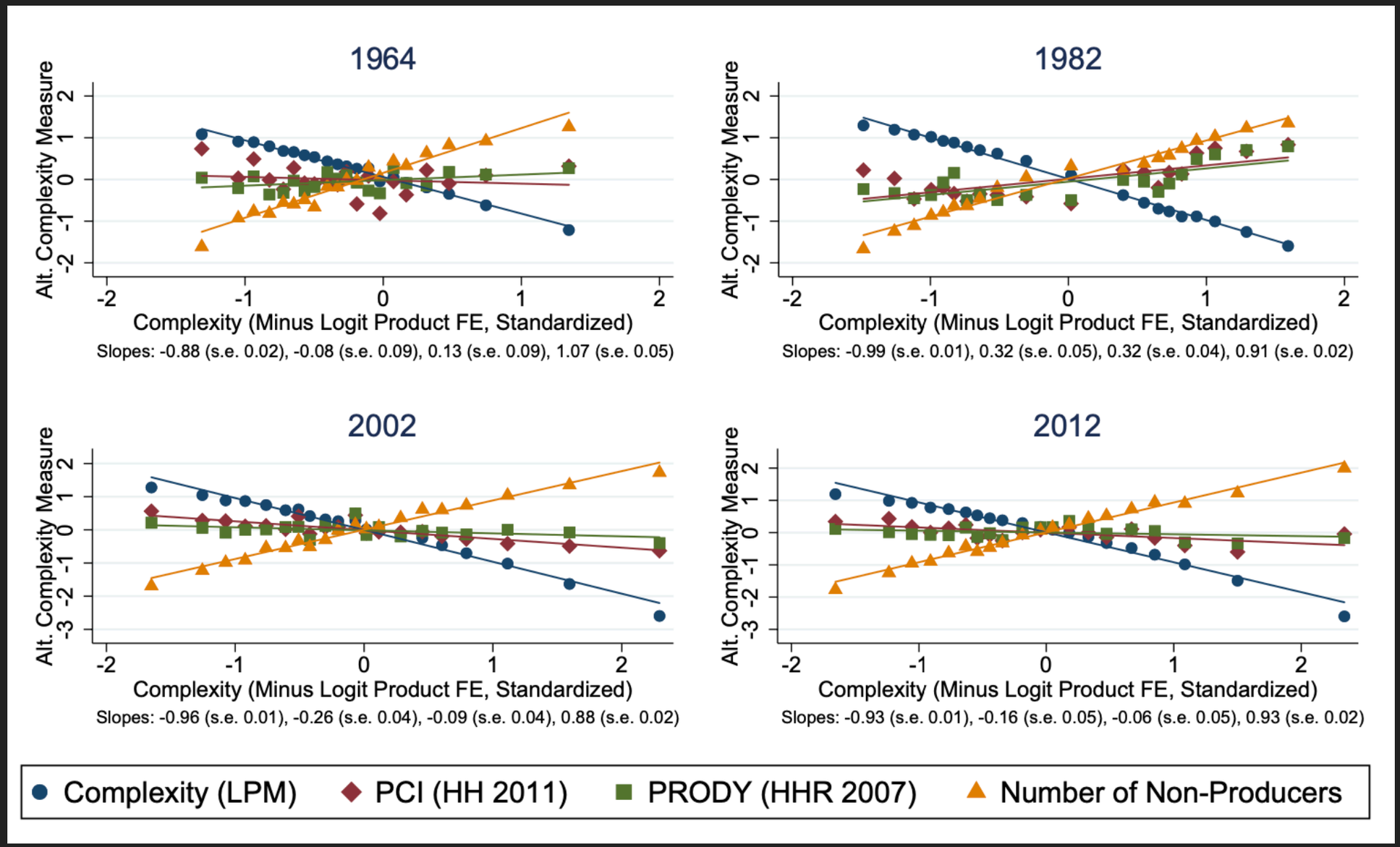
ALTERNATIVE MEASURES OF CAPABILITY AND COMPLEXITY

- Productivity distribution $G_{i,t}$ such that:
  - More capable countries export more goods
  - More complex goods exported by fewer countries

- **Logit model:**

$$\text{Prob}(A^k_{ij,t} > 0) = \frac{e^{(N_{i,t} - n^k_t)}}{1 + e^{(N_{i,t} - n^k_t)}}$$

MORE COMPLEX GOODS, LESS FOREIGN COMPETITION



by construction!

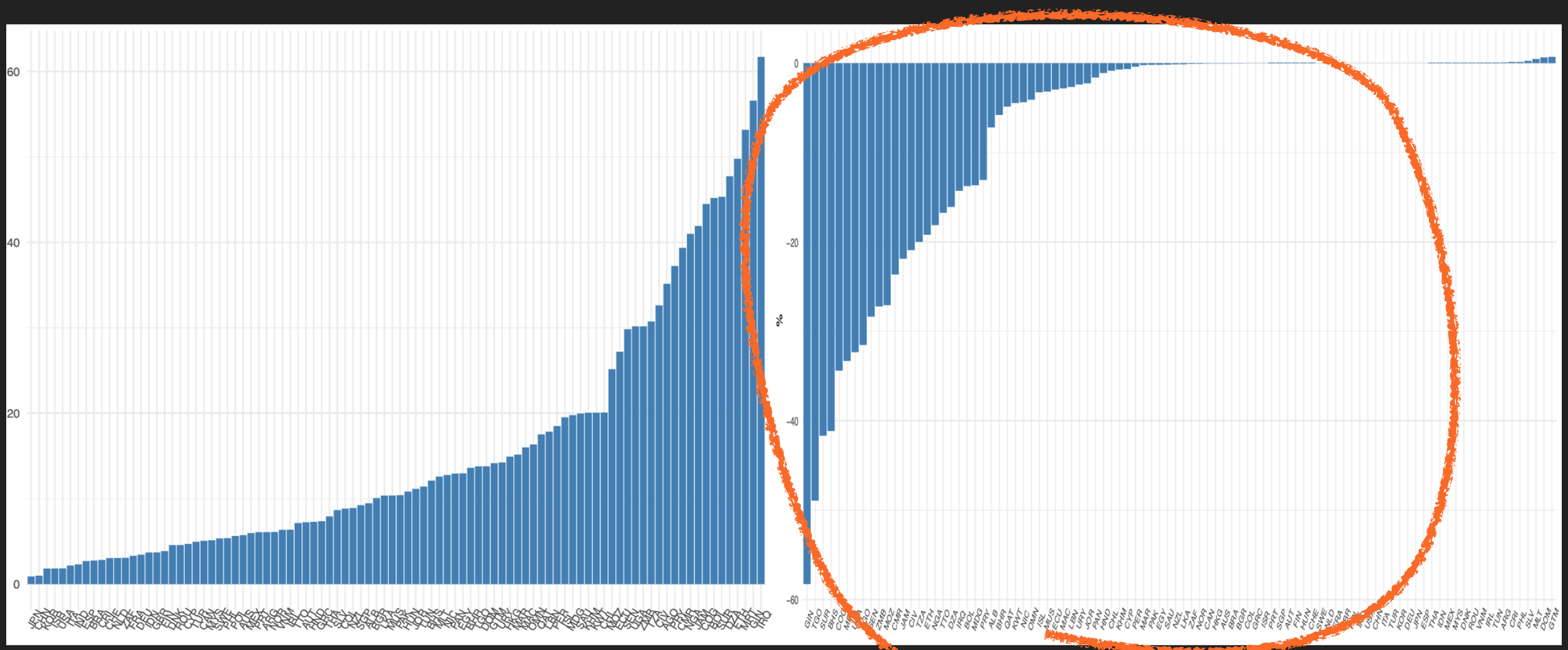
BUT DYNAMIC SPILLOVERS ARE NOW NEGATIVE...

	Country Capability $N_{i,t+1}$		
	(1) OLS	(2) IV ($Z^I_{i,t}$)	(3) IV ($Z^I_{i,t}$ and $Z^{II}_{i,t}$)
Average Complexity $S_{i,t}$	-0.0799*	-0.567**	-0.512***
	(0.0412)	(0.275)	(0.189)
Initial Capability $N_{i,t}$	0.539***	0.489***	0.494***
	(0.0323)	(0.0405)	(0.0363)
Country and year FEs	Yes	Yes	Yes
Observations	6,331	6,331	6,331
R-squared	0.967	0.328	0.343
Clusters	1442	1442	1442
CD F-Stat		151	142.5
KP F-Stat		36.32	34.19

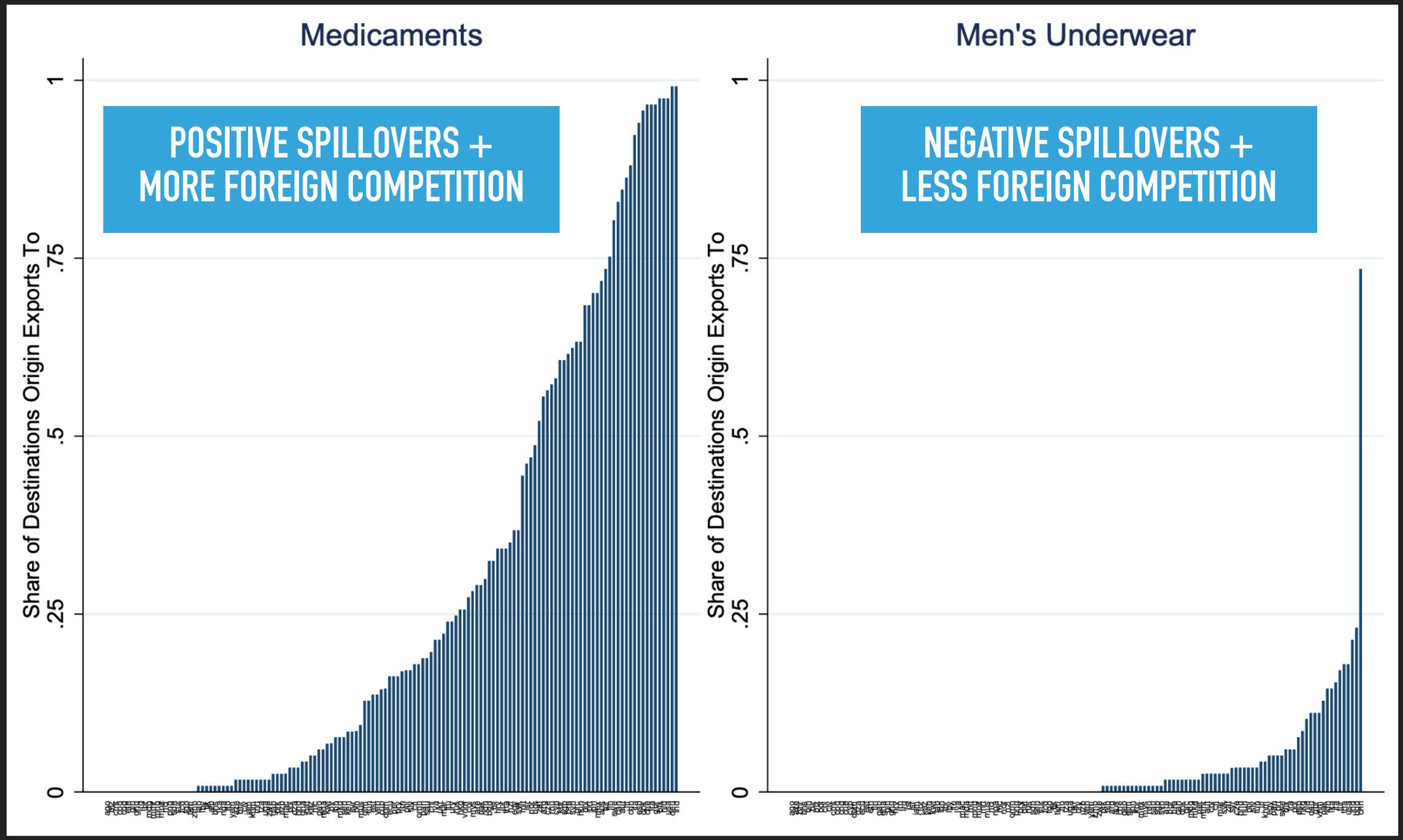
. . . AND SO DYNAMIC LOSSES REMAIN PERVASIVE

STATIC GAINS

DYNAMIC LOSSES



A TALE OF TWO SECTORS



WHAT HAVE WE LEARNT?

MAIN TAKEAWAYS

1. ***Theory:***

   - Trade can move ***all*** countries up the ladder
   - This happens if (i) complex goods raise capability and (ii) fewer countries export complex goods

2. ***Empirics:***

   - Evidence of plausibly exogenous employment shifts towards some sectors raising technological capability
   - However, more countries export in those sectors

1 + 2 → pervasive dynamic welfare losses from trade