Industrial Policies in Production Networks

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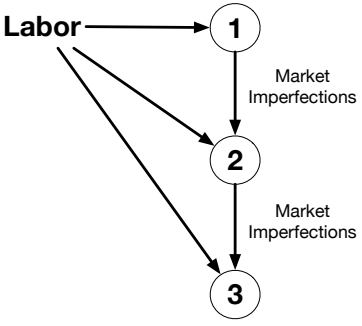
Introduction

- Industrial policies: *selective* intervention into key economic sectors
- How to conduct industrial policies?
  - important to consider linkages across sectors (Hirschman 1958)
- I build a framework to analyze policy interventions in networks
  - a simple measure, "distortion centrality", should guide policies
  - sectors with high distortion centrality tends to be *upstream*
  - suitable for quantitative evaluations

Economic intuition

- Example: a vertical production chain
  - upstream sector 1: iron
  - midstream sector 2: machine
  - downstream sector 3: textile
  - market imperfections (e.g. financial constraints) in sourcing intermediate inputs



- Which sector should the government promote?
- Market imperfections distort the use of inputs:
  - too little resources are allocated to the input-producing sector
  - effects compound: upstream is the smallest relative to optimal size
- Subsidizing upstream generates welfare gains
  - Effectiveness depends on size of distortions in the economy

Distortion centrality ξ: the ratio between undistorted and distorted sectoral size

$$\xi' \propto \underbrace{\beta'}_{\substack{\text{fraction of output} \\ \text{to consumers}}} \left(I - \underbrace{\mathbf{D}}_{\substack{\text{market} \\ \text{imperfections}}} \circ \underbrace{\Theta}_{\substack{\text{input-output} \\ \text{table}}} \right)^{-1}$$

For general network structures and a large class of economic environments:

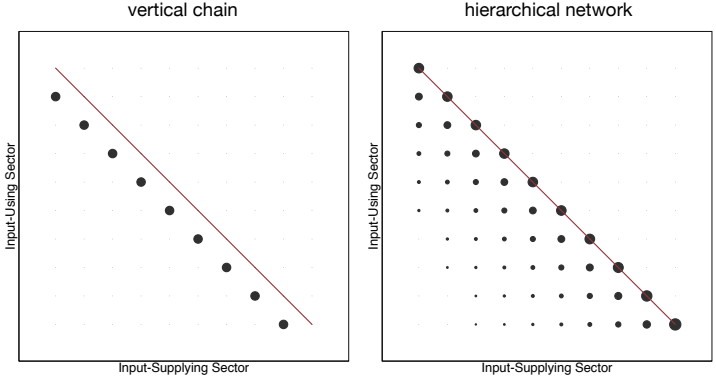
- ξ captures the *social value* of policy interventions, incorporating general equilibrium effects
  - $\xi_i > 1 \iff$ subsidizing sector i raises aggregate output
- ξ averages to one across sectors ($\mathbb{E}[\xi] = 1$): uniformly promoting all sectors is ineffective
- useful for quantitative policy evaluation: $\Delta \ln GDP \approx Cov(\xi_i, GovtSpending_i)$
- high ξ sectors supply disproportionately more to distorted sectors, direct or indirectly
  - tends to be higher in upstream sectors

Measuring distortion centrality ξ

- Empirical challenge: computing ξ requires knowledge of distortions **D**

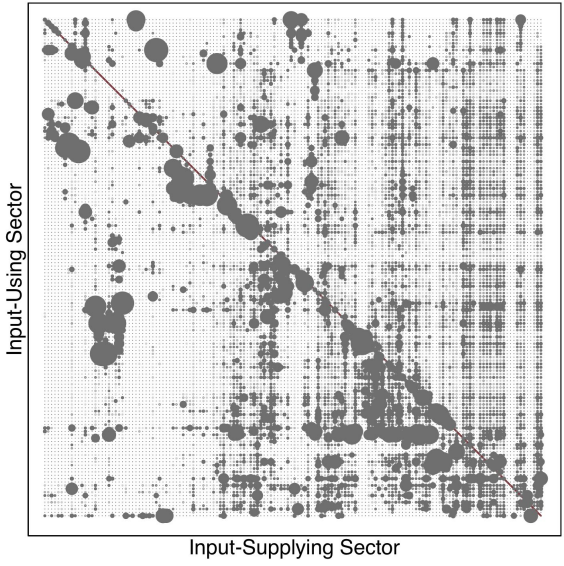
$$\xi' \propto \beta' \left(I - \mathbf{D} \circ \Theta \right)^{-1}$$

- Hierarchical networks: a generalization of vertical chains
  - relatively upstream sectors supply disproportionately to other relatively upstream sectors
- Distortion centrality tends to correlate with upstreamness and can thus be measured



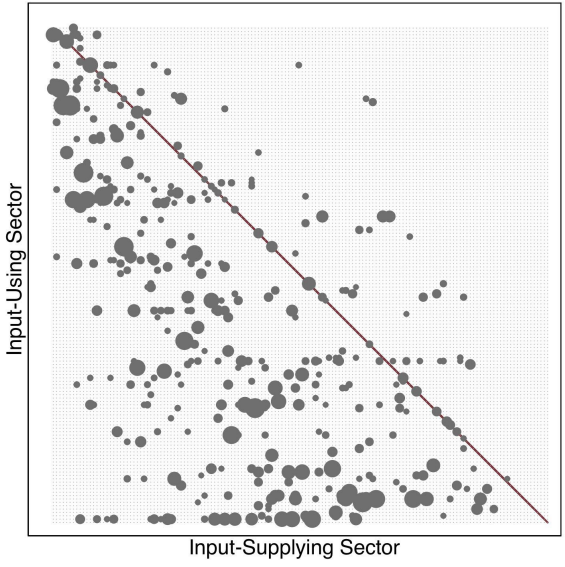
Real-world input-output matrices are hierarchical: South Korea in 1970

Ordering industries by standard industrial codes:

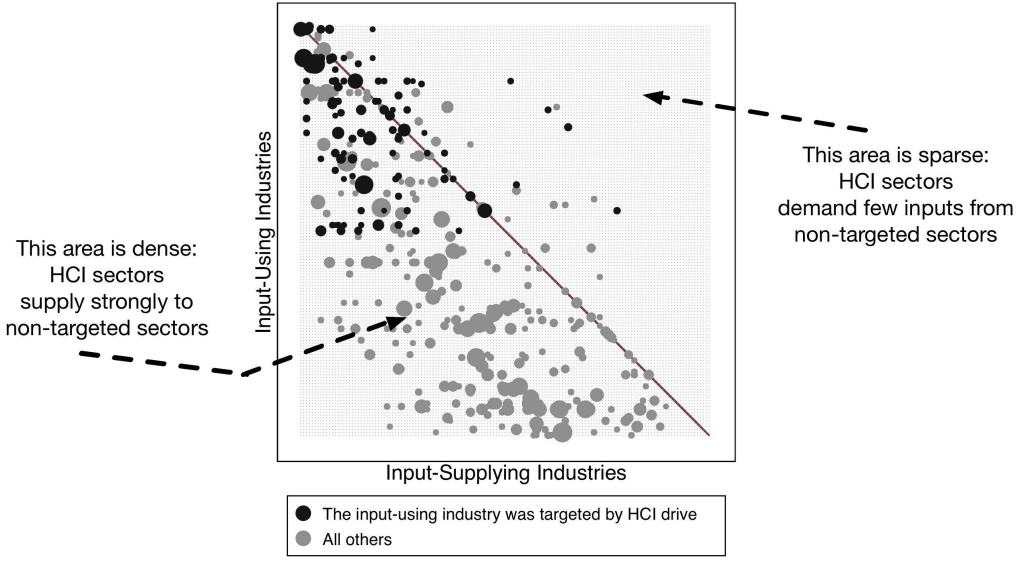


Real-world input-output matrices are hierarchical: South Korea in 1970

Re-order industries by distortion centrality, then remove small entries:

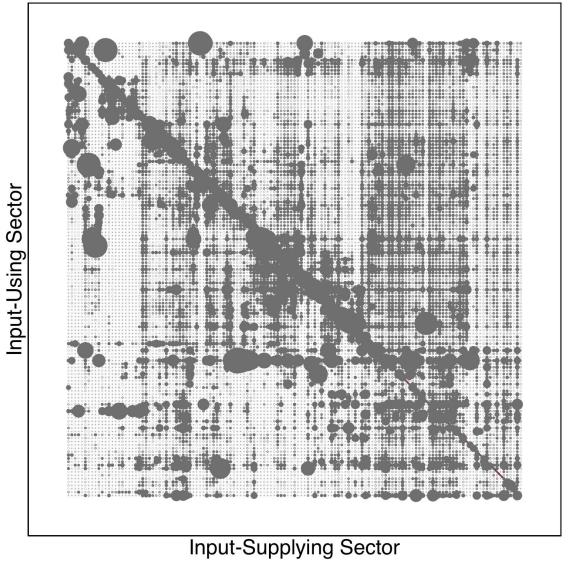


South Korea's "Heavy Chemical Industry Drive" targeted high-ξ sectors



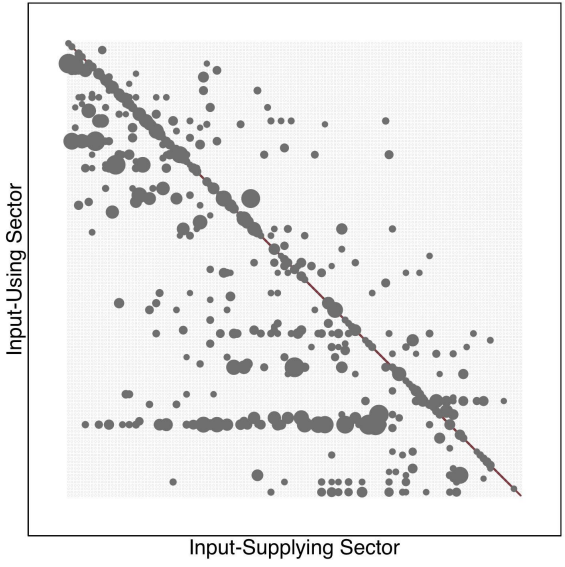
Input-output table of China in 2007

Ordering industries by standard industrial codes:



Input-output table of China in 2007 is also hierarchical

Re-order industries by distortion centrality, then remove small entries:



$\xi_i^{10\%}$: distortion centrality with constant distortion $\chi_{ij} = 0.1$

	Average correlation with benchmark $\xi_i^{10\%}$			
	South Korea in 1970		China in 2007	
Panel A: Simulated χ_{ij}'s	**Pearson's r**	**Spearman's ρ**	**Pearson's r**	**Spearman's ρ**
$N(0.1, 0.1)$	0.95	0.93	0.99	0.99
$U[0, 0.1]$	0.98	0.97	1	1
$Exp(0.1)$	0.95	0.94	0.98	0.99
Panel B: Estimated χ_{ij}'s				
De Loecker and Warzynski	-	-	0.99	0.99
Foreign firms as controls	-	-	0.98	0.98
Rajan and Zingales	0.98	0.97	0.98	0.98
Self-reported financial costs	-	-	0.92	0.92
Sectoral profit share	0.91	0.91	0.99	0.98
"Upstreamness" by Antras et al. (2012)	0.96	0.96	0.98	0.97

Which Chinese industries have high / low distortion centralities?

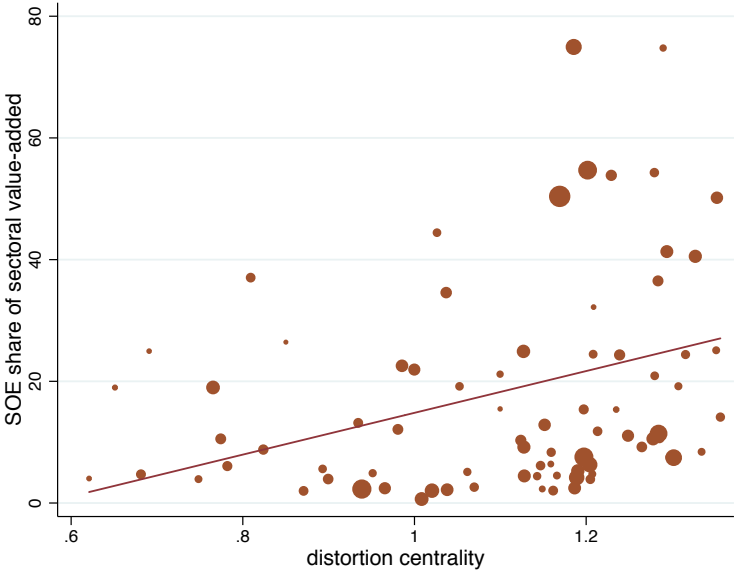
Top 10	Bottom 10
Coke making	Canned food products
Nonferrous metals and alloys	Dairy products
Ironmaking	Other miscellaneous food products
Ferrous alloy	Condiments
Steelmaking	Drugs
Metal cutting machinery	Meat products
Chemical fibers	Grain mill products
Electronic components	Liquor and alcoholic drinks
Specialized industrial equipments	Vegetable oil products
Basic chemicals	Tobacco

In China, ξ_i predicts sectoral credit, taxes, and SOE subsidies

	Int. Rate	Debt Ratio	Tax Break	Tax Rate	SOE Share
	(1)	(2)	(3)	(4)	(5)
ξ_i	-0.987^{***}	2.726^{***}	2.911^{**}	-1.589^{***}	7.577^{**}
	(0.223)	(0.622)	(1.412)	(0.431)	(2.963)
adj. R^2	0.301	0.231	0.097	0.176	0.066
Controls	Yes	Yes	Yes	Yes	Yes
# Obs.	79	79	79	79	79

- In sectors with high distortion centrality,
  - firms pay lower interest rates and have more external debt
  - firms pay lower taxes
  - more state-owned enterprises
- Pattern survives after controlling for other potential reasons for intervention
  - capital intensity, profit share, scale of industry, export intensity

More SOEs in high-ξ sectors



To first-order, industrial policies in China account for 5.7% gain in GDP

- Chinese sectoral policies in credit, taxes, and government subsidies to SOEs have all contributed to aggregate efficiency gains

		% GDP gains			
Distortion centrality specification	$sd(\xi)$	Credit	Taxes	SOEs	Total
Benchmark ($\xi^{10\%}$)	0.22	1.69	0.64	1.27	3.60
De Loecker and Warzynski	0.42	3.07	1.19	2.39	6.65
Foreign firms as controls	0.25	1.69	0.67	1.16	3.51
Rajan and Zingales	0.11	1.01	0.36	0.65	2.02
Sectoral profit share	0.17	1.20	0.47	0.95	2.62

Counterfactuals

- Targeting sectors by capital intensity, size, or value-added is unlikely to be effective

	% GDP gains				
Specification for ξ	$\xi^{10\%}$	**DLW**	Foreign	RZ	ProfitShr
Real-world interventions	3.60	6.65	3.51	2.02	2.62
Counterfactual policy target					
Sales γ	-1.42	-2.57	-1.18	-0.83	-1.14
Consumption share	-2.56	-4.62	-2.43	-1.44	-1.90
Export intensity	1.13	1.98	0.99	0.79	0.80
Sectoral value-added	-1.30	-2.41	-1.11	-0.75	-0.95
Interm. exp. share	1.34	2.39	1.11	0.83	0.87
Optimal Assignment	5.33	10.18	5.85	2.97	3.97

Industrial policies in China account for 6.7% gains in GDP

- The covariance formula ($\Delta \ln GDP \approx Cov\left(\xi_i, GovtSpending_i\right)$) reveals:
  - Chinese sectoral policies in credit, taxes, and government subsidies to SOEs have all contributed to aggregate efficiency gains
  - altogether account for about 6.7% gains
- Counterfactuals analysis
  - targeting sectors by capital intensity, size, or value-added is unlikely to be effective