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 $\xi$: the ratio between undistorted and distorted sectoral size

$$\xi' \propto \beta' \frac{I-D}{\Theta}$$

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

- $\xi$ captures the social value of policy interventions, incorporating general equilibrium effects
  - $\xi_i > 1 \iff$ subsidizing sector $i$ raises aggregate output

- $\xi$ averages to one across sectors ($\mathbb{E}[\xi] = 1$): uniformly promoting all sectors is ineffective

- useful for quantitative policy evaluation: $\Delta \ln GDP \approx \text{Cov} (\xi_i, \text{GovtSpending}_i)$

- high $\xi$ sectors supply disproportionally more to distorted sectors, direct or indirectly
  - tends to be higher in upstream sectors
Measuring distortion centrality $\xi$

- Empirical challenge: computing $\xi$ requires knowledge of distortions $D$

\[ \xi' \propto \beta' (I - D \circ \Theta)^{-1} \]

- 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

This area is dense: HCl sectors supply strongly to non-targeted sectors

This area is sparse: HCl sectors demand few inputs from non-targeted sectors

The input-using industry was targeted by HCl drive

All others
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:
### Which Chinese industries have high / low distortion centralities?

<table>
<thead>
<tr>
<th>Top 10</th>
<th>Bottom 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coke making</td>
<td>Canned food products</td>
</tr>
<tr>
<td>Nonferrous metals and alloys</td>
<td>Dairy products</td>
</tr>
<tr>
<td>Ironmaking</td>
<td>Other miscellaneous food products</td>
</tr>
<tr>
<td>Ferrous alloy</td>
<td>Condiments</td>
</tr>
<tr>
<td>Steelmaking</td>
<td>Drugs</td>
</tr>
<tr>
<td>Metal cutting machinery</td>
<td>Meat products</td>
</tr>
<tr>
<td>Chemical fibers</td>
<td>Grain mill products</td>
</tr>
<tr>
<td>Electronic components</td>
<td>Liquor and alcoholic drinks</td>
</tr>
<tr>
<td>Specialized industrial equipments</td>
<td>Vegetable oil products</td>
</tr>
<tr>
<td>Basic chemicals</td>
<td>Tobacco</td>
</tr>
</tbody>
</table>
In China, $\alpha_i$ predicts sectoral credit, taxes, and SOE subsidies

<table>
<thead>
<tr>
<th></th>
<th>Int. Rate</th>
<th>Debt Ratio</th>
<th>Tax Break</th>
<th>Tax Rate</th>
<th>SOE Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha_i$</td>
<td>$-0.987^{***}$</td>
<td>$2.726^{***}$</td>
<td>$2.911^{**}$</td>
<td>$-1.589^{***}$</td>
<td>$7.808^{**}$</td>
</tr>
<tr>
<td></td>
<td>$(0.223)$</td>
<td>$(0.622)$</td>
<td>$(1.412)$</td>
<td>$(0.431)$</td>
<td>$(2.833)$</td>
</tr>
<tr>
<td>adj. $R^2$</td>
<td>0.301</td>
<td>0.231</td>
<td>0.097</td>
<td>0.176</td>
<td>0.290</td>
</tr>
<tr>
<td>Controls</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td># Obs.</td>
<td>79</td>
<td>79</td>
<td>79</td>
<td>79</td>
<td>79</td>
</tr>
</tbody>
</table>

- 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
Industrial policies in China account for 6.7% gains in GDP

- The covariance formula \( \Delta \ln GDP \approx \text{Cov} (\xi_i, \text{GovtSpending}_i) \) 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