Ernest Liu

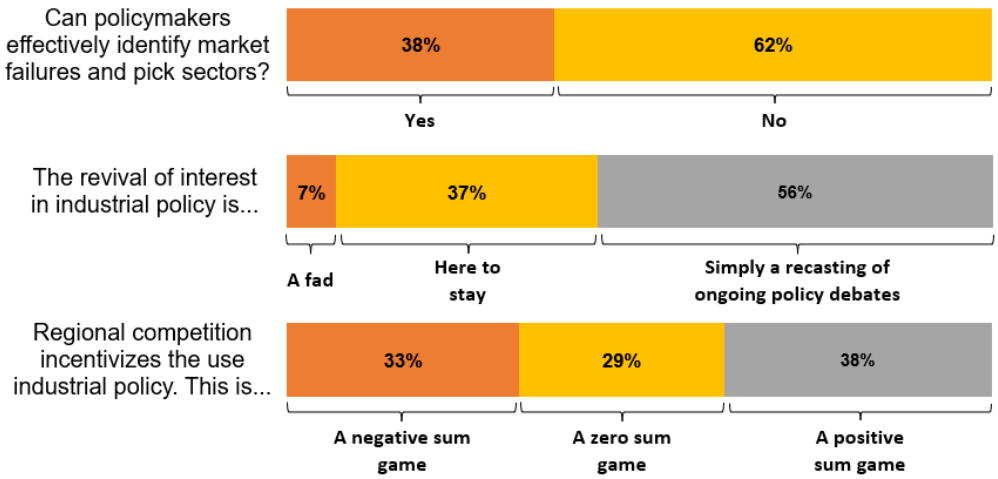
Industrial Policy

On Thursday, June 20, Ernest Liu joined Markus' Academy for a conversation on Industrial Policy. Ernest Liu is an Assistant Professor of Economics and the Class of 1936 Bicentennial Preceptor at Princeton University.

A few highlights from the discussion.

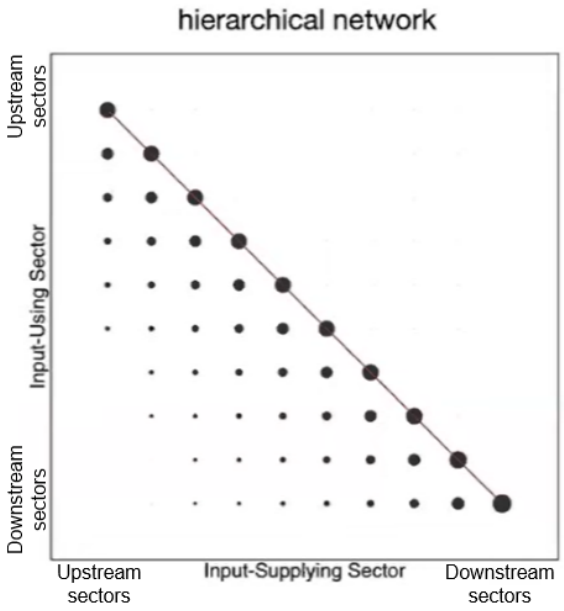
- **A summary in three bullets**
    - Industrial policy often aims at using selective interventions to improve aggregate efficiency. But it is hard to empirically measure the effectiveness of industrial policy in aggregate. We can use network theory to measure its aggregate effects and to identify key sectors and technologies
    - The talk covers four papers that highlight different economic mechanisms that can operate within networks, with varying policy recommendations
    - (1) Upstream sectors should be targeted when market imperfections accumulate along the supply chain; (2) cross-region externalities highlight the suboptimal incentives of local planners; (3) central sectors should be targeted to leverage knowledge spillovers; (4) in the presence of coordination problems, downstream sectors should be targeted to maximize incentives along the supply chain

- **[0:00] Markus' introduction and poll questions**
    - Industrial policy has been increasingly discussed in the media (Evenett et al., 2024) and implemented globally (Juhász et al., 2023)
    - There are several motives for it: (1) solving market failures, (2) solving coordination failures, (3) the provision of public goods, and (4) implementing regional policies
    - Good governance is required because industrial policies tend to invite cronyism. As Martin Wolf put it: "governments may fail to pick winners, while losers may succeed in picking governments"
    - Industrial policy can undermine globalization because it tends to lead to countermeasures within 6/12 months



- **[7:31] Industrial policy and networks**
  - Industrial policy has become an umbrella term to discuss government interventions that target the supply side. It can take many forms: state-owned enterprises, direct subsidies, subsidized credit...
  - Traditionally justified by the need to correct market failures, its recent revival has been motivated by technology competition, geopolitics, and achieving supply chain resilience
  - It is hard to assess the aggregate effectiveness of industrial policy. For example, a difference-in-differences approach comparing treated (subsidized) and untreated sectors will not be informative about aggregate effects
  - However, we can use network theory to think through general equilibrium effects and identify key sectors and technologies
  - Academics should ensure that their prescriptions from network theory are implementable based on observable data
  - The talk will cover four papers that highlight different economic mechanisms that can operate within networks, with varying policy recommendations

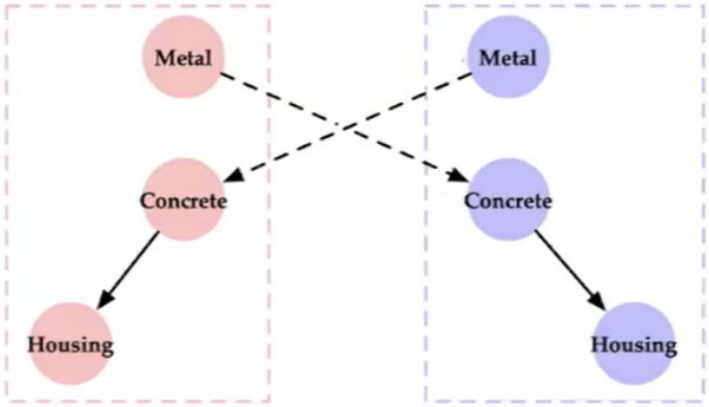
- **[14:36] Subsidizing upstream sectors to promote development (Liu, 2019)**
  - Input-output tables help us visualize how sectors of the economy provide inputs to each other. The chart below shows dots if a sector on the x-axis supplies inputs to a sector on the y-axis
  - It displays a hierarchical network of the kind we tend to see in the real world: upstream sectors tend to sell inputs to both upstream and downstream industries. Downstream sectors only supply inputs to other downstream sectors, yielding a lower triangular table



- When conducting industrial policy in the 1970s, South Korea targeted upstream sectors like steel, electronics, and petrochemicals. Similarly, in the last two decades, China transitioned from an economy with a homogeneous government presence to one where state-owned enterprises (SOEs) only have a larger presence in upstream sectors
- What is the intuition for the effectiveness of targeting the upstream? Consider a fully vertical supply chain with three firms: (1) an iron producer, (2) a machine manufacturer which buys iron, and (3) a textile company that buys machines.
- Suppose there are market imperfections like financial constraints or contracting frictions at each link. When textiles are constrained, the production of machines becomes inefficiently low; this distortion filters to the production of iron, and is further compounded by the distortion in the iron-machine link
- The textbook solution would be to provide taxes and subsidies to offset the market imperfections, but these may not be measurable and such an approach may backfire
- Consider instead an approach where, since the optimal is not achievable, the government seeks to maximize the general equilibrium benefits when choosing which sectors to support. The government will achieve a highest “bang for their buck” if it subsidizes the upstream to expand it (and taxes the downstream to reduce it). The effectiveness of this approach will depend on the size of the distortions in the economy
- To study the size of distortions one can derive a measure of “distortion centrality” for each sector. Distortion centrality is the concept of network centrality applied to distortions. *(MA note: discussed in our recent episode with Benjamin Golub)*
- The distortion centrality will effectively measure the ratio between how large a sector is and how large it should be. One can leverage methods from the industrial organization literature to estimate it (De Loecker and Warzynski,

2012). Crucially, it will capture the marginal social value of subsidizing a given sector, incorporating the general equilibrium effects
    - With this, we can evaluate the aggregate effect of a given industrial strategy by multiplying the government spending on each sector by its corresponding measure of distortion centrality, and aggregating this across sectors
    - When doing so, we can see that targeting upstream sectors is more effective at raising GDP (around 6.7% in China) than pursuing other strategies like targeting export-intense sectors or sectors with a high value-added
    - This is because, in hierarchical networks, the upstream sectors tend to be the sectors with a high distortion centrality measure. As in the textile example, distortions climb up the supply chain, so upstream sectors will tend to supply disproportionately to other sectors that are distorted
    - As a result, subsidizing upstream sectors will entail subsidizing sectors where the marginal social value of support is higher. Indeed, the sectors with the highest distortion centrality were the ones targeted by South Korea and China

- **[44:11] Local incentives in multi-region economies (Chen et al., 2024)**
    - The paper in the prior section covered a closed economy. Consider now an economy with several regions that are interconnected but industrial policy is implemented locally. For example, to build houses regions produce concrete, but to produce concrete each region imports metal



    - In this context there is a potential misalignment between local and national incentives. A national planner will want to subsidize upstream sectors, as before. However, local planners will want to target sectors that are upstream only to local production. In the example, the local planner will avoid subsidizing its metal sector, as this will only benefit the other (recipient) economy
    - Building on the framework of the prior paper, we can obtain both local and national measures of distortion centrality. The local measure of distortion centrality will capture only the local welfare gains from subsidizing a given sector, while the national distortion centrality measure will capture the national welfare impact of targeting that sector
    - When examining evidence from China, we see that, indeed, national industrial policy targeted sectors with high national distortion centrality, while local policy targeted sectors with high local distortion centrality

    - Interestingly, provinces that were more fiscally dependent on the national government targeted nationally distortion-central sectors. On the other hand, fiscally independent regions targeted sectors that are only beneficial to them
    - Since regions that rely more heavily on national government transfers tend to be less developed, less developed regions produce positive spillovers to the rest of China, while more developed ones create negative spillovers

- **[54:32] Innovation networks and R&D allocation (Lui and Ma, 2024)**
    - How should governments allocate R&D resources across technologies within an innovation network? How much should society invest in semiconductors vs pharmaceuticals?
    - The paper attempts to answer these questions. Rather than market distortions, which are arguably less important in developed economies, the network mechanism at work is the knowledge spillover across sectors
    - The baseline model is an endogenous growth model with a closed and multi-sector economy. A social planner must choose how to distribute production resources and, separately, R&D resources across sectors
    - Knowledge spillovers are modeled such that the productivity of R&D investments in a given sector depends on the level of knowledge of other sectors, along with the intellectual dependence between the given sector and the rest. The set of parameters determining how important knowledge in one sector is for R&D productivity in another sector defines the innovation network
    - The optimal allocation of production resources across goods is completely determined by consumers's preferences for each good
    - The allocation of R&D resources is more interesting: the social planner will consider both the direct effect of R&D investment on the recipient sector, but it will also internalize the fact that the R&D investment will benefit other sectors: the network effects
    - Because R&D investments take time to turn into knowledge stock, the network effects materialize in the future and so are discounted by the planner
    - As a result, the planner's optimal solution will be determined by the relationship between how impatient a society is (how high its discount rate) and how quickly the benefits of R&D investments materialize
    - If the society is very impatient, the planner will disregard the benefits of the network, and will allocate R&D resources in the same way as production resources. If the society is infinitely patient, the planner will prioritize the network benefits, and will allocate R&D resources according to how (eigenvector) central sectors are in the knowledge network; in this way targeting the sectors of the economy on which many others rely for knowledge
    - We can study the knowledge network in the data through citation relationships in filed patents. For example: how often do pharmaceutical patents cite patents in the semiconductor sector? In the data a few sectors tend to be much more central than the rest (e.g. the medical, computing or semiconductor sectors)
    - With our model we can arrive at the optimal distribution of R&D investment in any economy and compare it with the real world distribution

    - Japan, South Korea, Germany and the U.S. have the most efficiently allocated R&D. This is not in the paper, but there is some evidence that countries where innovation activity is more concentrated have a more efficient R&D allocation, since firms better internalize the benefits of their prior investments
    - In terms of specific technologies, the U.S. underinvests in semiconductors by 21%; this may explain the recent Chips for America Act and the Facilitating American-Built Semiconductors Act
    - The U.S. underinvests in green technologies by 25% (keep in mind this underinvestment only relates to the knowledge spillovers and does not include any environmental benefits)
    - China and South Korea overinvest in semiconductors by ~50% and ~40%
    - The model can be extended to include cross-country knowledge spillovers. Interestingly, countries with more self-sufficient knowledge networks, like the U.S. or Japan where 70% of citations are to domestic patents, suffer greater welfare losses from R&D misallocation. This is intuitive: Canada can free-ride on the R&D investment of the U.S., making their own misallocation less important

- **[1:16:12] Coordination failures in the green transition and Conclusion (Aghion et al., 2024)**
    - The green transition presents yet another mechanism for network theory to study: the coordination problem that arises when all technologies along the production chain need to transition simultaneously
    - For example, electric vehicles require batteries, and producing both is emission-intensive. Now, if there is no market for emission-reducing EVs, there will be no incentives to make green batteries. Conversely, if there is no market for green batteries there will be no incentive to produce emission-reducing EVs
    - The paper presents a dynamic model of technological transition along the supply chain. It arrives at four main conclusions:
    - 1. The social optimum requires both a carbon tax and targeted subsidies
    - 2. As opposed to Big-Push theories, which argue for intervening at scale across the supply chain, small and temporary subsidies to key sectors can have large long-run effects
    - 3. If subsidies are limited, they should primarily target downstream sectors. This is in contrast with the first paper of the talk, and is due the way that demand externalities and cost reductions travel (respectively, upward and downward) through the network
    - Since downstream sectors upstream their inputs 1-for-1, a 1% increase in EV demand will create a 1% increase in demand for batteries. However, because batteries use many inputs, a 1% reduction in battery costs will not lead to a 1% reduction in EV costs
    - 4. Misdirected or delayed industrial policy can permanently derail the green transition
    - The four papers overall show that the optimal industrial policy depends on the mechanism operating in the network. (1) Upstream sectors should be

targeted when market imperfections accumulate along the supply chain; (2) cross-region externalities highlighted the incentives of local planners; (3) central sectors should be targeted to leverage knowledge spillovers, but modulated by society's patience and its knowledge self-sufficiency; (4) in the presence of coordination problems, downstream sectors should be targeted to maximize incentives along the supply chain

- None of these fundamental mechanisms are new to economics, the question is just how they operate within a network. This calls for new economic models and theory, and new ways to measure the mechanisms in the data

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