Decentralized Industrial Policy

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Abstract

Many industrial policies were enacted by local governments. Decentralizing government intervention can undermine industrial policies if the local and aggregate welfares are misaligned. In this paper, we extend the closed-economy analysis in Liu (2019) to a multi-region setting with inter-regional trade and input-output linkages. We derive sufficient statistics for the regional and aggregate welfare impacts of industrial policy. Using China's cross-province input-output table, we show there is significant divergence between the incentives of the central and a provincial government: while the nation may benefit from promoting upstream sectors, regional economies benefit from "import substitution" policies that improve terms-of-trade but may harm the nation. Our central and local sufficient statistics predict policies enacted by the respective governments. The predictive power for local industrial policies improves in the regions with more fiscal autonomy. Adopting industrial policies aligned with central sufficient statistics can double the aggregate welfare gain by industrial policies aligned with local sufficient statistics.

1 Introduction

Many economies adopt industrial policy to promote certain sectors. Political authority is often viewed a prerequisite for successful industrial polices that correct market failures and generate positive externality (see, e.g., Rodrik, 2004). In practice, many industrial policies were enacted by local government. A decentralized policy decision making process can undermine industrial policies if the local and aggregate welfares are misaligned. When the misalignment is sufficiently strong, well-meaning industrial policies from a local perspective may become counterproductive at the aggregate level due to negative, beggar-thy-neighbor spillover effects on other regions. In this paper, we first analyze the local and aggregate welfare impacts of industrial policy in a model that provides an economic rationale for government interventions. We then provide empirical evidence for the consistency between model predictions and real-world industrial policies.

On the theoretical front, Liu (2019) shows that a central planner may improve aggregate productive efficiency by promoting upstream sectors because distortionary effects of market imperfections are compounded through input-output linkages. This paper extends his closed-economy analysis to a multi-region setting with inter-regional trade and input-output linkages. We introduce market imperfections to the transaction of intermediate inputs, and we derive sufficient statistics that capture the local and cross-region spillover effects of industrial policies. We derive two measures—what we call *"local"* and *"central"* intervention indices—that should guide industrial policies. Both measures vary by region and industry; the local intervention index captures the local welfare impact per fiscal dollar on policy subsidies towards a domestic industry—the "bang-for-the-buck" to a local planner—whereas the central intervention index captures the impact on the aggregate welfare across all regions per fiscal dollar. Both our measures account for the fact that industrial policies have general equilibrium effects, as subsidies to one sector in one region may potentially affect allocations and productions in all other regions and sectors.

Intuitively, the central and local intervention indices may differ for two reasons. First, while subsidies to upstream industries in a region may benefit the nation as whole by reducing misallocations due to market imperfections, the region itself only captures a fraction of the aggregate benefits and therefore a local planner's incentive is mitigated. The second force is terms-of-trade (ToT) considerations. While tariffs cannot be levied on inter-regional trade within the nation, local planners can exploit industrial policies to manipulate the ToT to their advantage, by taxing the production of goods that are disproportionately sold to outside buyers and subsidizing the domestic production of goods that competes with regional imports (i.e., "import substitution").

We apply the model to China, where industrial policies are pervasive. The best-known industrial policy is perhaps the central and provincial Five-Year plans adopted by the respective government. Various preferential policies such as Special Economic Zones (SEZs), subsidies, tax credits are arranged to promote the growth of the industries identified by the Five-Year plans (see, e.g., Wu et al., 2019). China's large state sector also faciliates the implementation of industrial policies, since subsidies are often directed to state-owned enterprises in the selected industries. More importantly, China is a large economy with substantial cross-region heterogeneity. The local governments are granted considerable autonomy for industrial policies. The decentralized nature of local industrial policies are further strengthened by the career concerns of local government officials (Xiong, 2018) and strong local state capacity (Bai et al., 2020a). These features make China an ideal laboratory for our model.

We empirically measure our sufficient statistics for all the 42 industries in 31 provinces based China's cross-region input-output table. We find that, while upstreamness correlates strongly with the central intervention index—corroborating the findings of Liu (2019)—it only weakly correlates with the local intervention indices. The correlation between central and local intervention indices is weak, suggesting substantial misalignments between the aggregate and local welfares. The dispersion of the two intervention indices is also different. The wider dispersion of local intervention index implies higher sensitivity of local welfare to industrial policy, primarily because of the much more important role of regional trade linkages for local welfare. Decentralized local industrial policies aligned with local invention index should therefore be distinctively different from central industrial policies following central intervention index.

We next examine the consistency between our intervention indices and industrial policies implemented in China. The empirical challenge is that many industrial policies are not observable. Distinguishing central and local industrial policies is even harder. Instead of directly estimating industrial policies, we infer them indirectly from central and local "policy platforms". We consider two specific types of policy platforms: Special Economic Zone (SEZ) and state-owned enterprise (SOE). On the former platform, the frequency of an industry selected by central and local SEZs are used to measure the intensity of central and local industrial policy for the industry, respectively. On the latter platform, we measure the intensity of central and local industrial policy by the share of central and local SOEs in the industry. We argue that local state sector is a more decentralized policy platform than local SEZ. The selection of industries by local SEZs is heavily influenced by central industrial policies such as the Five-Year plans issued by the central government. Any major deviation from the central plan is easy to detect and has to be well justified. In contrast, local governments have greater autonomy to support local SOEs for their own industrial policies since such local industrial policies mainly depend on local resources.

We find the intensity of both central and local industrial policies through SEZs to be aligned with central intervention index but uncorrelated with local intervention index. The intensity of central industrial policy through SOEs is aligned with central intervention index but uncorrelated with local intervention index. However, the intensity of local industrial policy through SOEs is aligned with local intervention index but uncorrelated with central intervention index. We also find the intensity of local industrial policy through SOEs to be more aligned with local intervention index in the provinces receiving less fiscal transfers from the central government. These findings suggest that (i) central intervention index have a better predictive power for the intensity of both central and local industrial policies on a more centralized policy platform; (ii) local intervention index have a better predictive power for the intensity of local industrial policies on a more decentralized policy platform; (iii) the predictive power for the intensity of local industrial policies improves in the regions with more fiscal autonomy.

An interesting question is how the central and local industrial policies are implemented through SOEs. We use a large-scale firm survey data from China's State Administration of Taxation (SAT henceforth). The SAT data covers both manufacturing and service industries and, hence, has a much better sectoral composition than the Annual Survey of Industrial Firms widely used in the literature. Three province-industry-ownership-specific wedges are constructed: capita, labor and land wedge. Following Hsieh and Klenow (2009), we interpret lower wedge as lower tax or higher subsidy. We find all the three wedges to be negatively correlated with local intervention index but uncorrelated with central intervention index across local SOEs. This suggests local SOEs receive more subsidies in the industries that are more important for local welfare, a specific channel for the alignment between local state share and local intervention index. In contrast, none of the wedges correlates significantly to central or local intervention index across central SOEs or private firms. The alignment between central state share and central intervention index has to be explained by other channels than subsidizing central SOEs.

Finally, we conduct some simple counterfactual exercises to assess the magnitude of welfare losses caused by decentralized industrial policies. We first estimate total subsidies for local industrial policies through local SOEs, which amount to about 2.9 percent of GDP in the model. Adopting such local industrial policy would increase the aggregate welfare by 0.2 percentage points. If we instead allocate the same amount of subsidies across industries by central intervention index, keeping the sensitivity of the policy intensity to central invention index the same as that to local invention index, the aggregate welfare gain would be doubled.

Our work contributes to the literature of inefficient production networks (Jones, 2011, 2013; Baqaee, 2018; Acemoglu and Azar, 2020; Baqaee and Farhi, 2020; Bigio and La'o, 2020). Most related is Liu (2019), who derives sufficient statistics for industrial policy in a production network with a single region. Our paper differs from Liu (2019) by studying deriving distinct sufficient statistics for regional and aggregate welfare response to industrial policy in a multi-region production network with inter-regional trade, à la Caliendo and Parro (2015). Our theoretical results highlight the divergence in incentives between a local planner and a central planner, thereby enabling us to understand and evaluate the industrial policy platforms that belong to different levels of governments in China.

We also contribute to a fast-growing literature on distortions, their politico-economic foundations and macroeconomic consequences in China. It has been widely documented that Chinese SOEs are associated with lower capital productivity than their private counterparts (Dollar and Wei, 2007; Song et al., 2011; Hsieh and Song, 2015). Our findings suggest that local industrial policies implemented through local SOEs be an explanation for the average product revenue gap. Wang (2019) justifies policies in favor of the state sector from a politico-economic perspective. Our model provides a different rational: SOEs served as a policy platform for industrial policies. Brandt et al. (2013) estimate aggregate TFP losses by between- and within-province distortions. We find the cross-province distortions to be related to industrial policies.

The rest of the paper is structured as follows. Section 2 presents a multi-region model with inter-regional trade and input-output linkages and derives our central and local intervention index. The empirical analysis is conducted in Section 3. Section 4 concludes.

2 Model

2.1 Model Setup

We introduce market imperfections and industrial policies à la Liu (2019) into the multi-region production network model of Caliendo and Parro (2015) with inter-region trade.

Technology. There are N regions and K industries. Each region $n = 1, \ldots, N$ has a representative consumer who supplies labor $\bar{\ell}_n$ inelastically and has preferences

$$u_n = \prod_{i=1}^{K} c_{ni}^{\beta_{ni}}, \qquad c_{ni} \equiv \left(\sum_{m=1}^{N} (c_n^{mi})^{\frac{\theta}{\theta+1}} \right)^{\frac{\theta+1}{\theta}}. \tag{1}$$

That is, consumer n has Cobb-Douglas preferences over bundles of goods from industries $i = 1, \ldots, K$ with Cobb-Douglas weights $\beta_{ni} \geq 0, \sum_{i=1}^{K} \beta_{ni} = 1$. c_{ni} is the bundle of goods from industry i consumed in n and is itself a CES aggregator over varieties produced from all regions $m = 1, \ldots, N$: where $\theta + 1 > 1$ is the elasticity of substitution across varieties within industry i

produced from different regions, and c_n^{mi} is the quantity of good i produced from region m sold to final consumer in region n. In what follows, whenever a variable indicates cross-region trade flows, we use superscripts to denote origin and subscripts to denote destination for the flow of goods.

Each region n produces a region-specific variety for each industry k—we refer to each variety simply as "good nk"—with constant returns to scale production function

$$q_{nk} = \zeta_{nk} z_{nk} \left(\ell_{nk}\right)^{\eta_{nk}} \prod_{i=1}^{K} \left(g_{nk}^{i}\right)^{\sigma_{nk}^{i}}, \qquad g_{nk}^{i} \equiv \left(\sum_{m=1}^{N} \left(g_{nk}^{mi}\right)^{\frac{\theta}{\theta+1}}\right)^{\frac{\theta+1}{\theta}}. \tag{2}$$

That is, production function of good nk is a Cobb-Douglas aggregator over labor ℓ_{nk} and intermediate inputs bundles g_{nk}^{i}, $i = 1, \ldots, K$. Each intermediate bundle is itself a CES aggregator over varieties produced from all other regions $m = 1, \ldots, N$. Note z_{nk} is the productivity, g_{nk}^{mi} is the quantity of good mi used as intermediate input for producing of good nk, ℓ_{nk} is the units of labor inputs, η_{nk} is the labor elasticity, and σ_{nk}^{i} is the intermediate elasticity for input i used in the production of good nk. We assume $\eta_{nk}, \sigma_{nk}^{i} \geq 0$ and $\eta_{nk} + \sum_{i=1}^{K} \sigma_{nk}^{i} = 1$. $\zeta_{nk} \equiv \eta_{nk}^{-\eta_{nk}} \prod_{i=1}^{K} \left(\sigma_{nk}^{i}\right)^{-\sigma_{nk}^{i}}$ is a normalizing constant.

Iceberg Costs, Market Imperfections, and Industrial Policies.

Following Caliendo and Parro (2015), we assume there are iceberg trade costs across region-industry pairs: for every unit of good mi to reach producer nk, $d_{nk}^{mi} \geq 1$ units must leave region m. With slight abuse of notation we use d_{nc}^{mi} to denote the iceberg costs of sending good mi to consumer in region n. These iceberg costs represent transportation technology and are not signs of inefficiency.

In addition, following Liu (2019), we introduce market imperfections and policy subsidies into the transaction of intermediate goods between buyers and sellers. Our goal is to study how policy interventions can affect regional and aggregate welfare, taking market imperfections and iceberg trade costs as given.

Market imperfections represent *inefficient* and *non-policy* features that affect the market allocation. We model imperfections as reduced-form "wedges" χ_{nk}^{mi} and have two properties. First, market imperfections raise input prices: for every dollar of good mi that producer nk buys, the buyer must make an additional payment that is $\chi_{nk}^{mi} \geq 0$ fraction of the transaction value. Second, these payments represent "quasi-rents," meaning they are deadweight losses that leave the economy.

Importantly, market imperfections do not represent government interventions. As we show, the aforementioned features of market imperfections imply that the decentralized equilibrium is Pareto-inefficient, and a central planner could improve welfare by redistributing resources across production sectors and regions. We introduce policy intervention as production subsidies τ_{nk}^{mi} and τ_{nk}^{ℓ}, respectively targeting the use of intermediate inputs and labor. We interpret these production subsidies as industrial policies, i.e., government intervention that directs resources towards specific sectors and regions.

Liu (2019) introduces the same notion of market imperfections into a single-region, closed-economy production network and derives sufficient statistics for the aggregate impact of industrial policies. In this paper, we introduce market imperfections into a multi-region production network with inter-region trade, and our key theoretical contribution is to analyze regional and cross-region spillover effects of industrial policies in this framework. We derive separate sufficient statistics for industrial policies financed by a central government and by a local government.

In what follows, we use financial frictions as a running narrative for market imperfections, motivated by financial frictions' well-documented importance in developing countries.

Production Costs. We assume all producers are cost-minimizers. Given the factor price (w_n), cost of production input (p_{mi}), iceberg trade costs (d_{nk}^{mi}), market imperfections (χ_{nk}^{mi}), and production subsidies (τ_{nk}^{ℓ} and τ_{nk}^{mi}), the production cost of good nk is

$$p_{nk} = z_{nk}^{-1} \left(w_n \left(1 - \tau_{nk}^{\ell} \right) \right)^{\eta_{nk}} \prod_{i=1}^{K} \left(\sum_{m=1}^{N} \left(p_{mi} d_{nk}^{mi} \left(1 + \chi_{nk}^{mi} \right) \left(1 - \tau_{nk}^{mi} \right) \right)^{-\theta} \right)^{-\sigma_{nk}^{i}/\theta} . \tag{3}$$

That is, the cost of producing good nk is the Cobb-Douglas price index over labor and intermediate inputs from each industry; the price of intermediate inputs i used by producer nk is in turn a CES aggregator over varieties sourced from different regions with trade elasticity θ. The price producer nk pays for input mi is $p_{mi} d_{nk}^{mi} \left(1 + \chi_{nk}^{mi} \right) \left(1 - \tau_{nk}^{mi} \right)$, i.e., the production cost of good mi multiplied by the iceberg trade costs and market imperfections and then subtracting policy subsidies. For expositional clarity, we assume market imperfections apply only to intermediate transactions and not to labor; this is without loss of generality as additional imperfection wedges can always be modeled by adding fictitious producers to the economy.

Market Clearing. Labor markets clear within each region:

$$\sum_{k=1}^{K} \ell_{nk} = \bar{\ell}_n \qquad \text{for all } n. \tag{4}$$

Goods market clear across regions:

$$\sum_{n=1}^{N}\left[c_n^{mi}d_{nc}^{mi}+\sum_{k=1}^{K}g_{nk}^{mi}d_{nk}^{mi}\right]=q_{mi}\qquad \text{for all } m,i. \tag{5}$$

That is, the total output of good mi is equal to the total quantity sold to all regions, including producers and consumers, taking into account the iceberg costs involved in shipping goods across regions.

Consumer Budget. The consumer in each region n spends post-tax labor income on consumption:

$$\sum_{m=1}^{N}\sum_{i=1}^{K}c_n^{mi}p_{mi}d_{nc}^{mi}=w_n\bar{\ell}_n-x_n \tag{6}$$

where x_n is the lump-sum taxes levied by governments on consumer n.

Government Budget. Policy interventions are modeled as region-sector-input-specific production subsidies paid by the government, financed by lump-sum taxes. The government's budget constraint is

$$\sum_n x_n=\sum_n\sum_k\left(\sum_m\sum_i p_{mi}g_{nk}^{mi}d_{nk}^{mi}\tau_{nk}^{mi}+w_n\ell_{nk}\tau_{nk}^{\ell}\right). \tag{7}$$

The parenthesis on the right-hand side captures the total value of subsidies given to producer nk. The entire right-hand side is thus total subsidies provided by the government and has to equal to the total lump-sum taxes collected on the left-hand side.

The government budget constraint can be satisfied in many ways; for instance, one may impose the additional constraint that lump-sum taxes levied from each region n have to be equal to the total subsidies given to producers in that region:

$$x_n=\sum_k\left(\sum_m\sum_i p_{mi}g_{nk}^{mi}d_{nk}^{mi}\tau_{nk}^{mi}+w_n\ell_{nk}\tau_{nk}^{\ell}\right).$$

The degree of flexibility in satisfying the government budget constraint is key to our subsequent analysis in contrasting the incentive of a central planner and that of a local planner.

Price Normalization. We normalize the total factor income across all regions to one:

$$\sum_{n=1}^{N}w_n\bar{\ell}_n\equiv 1. \tag{8}$$

2.2 Equilibrium

Definition 1. Equilibrium. Given productivities z_{nk}, iceberg trade costs d_{nk}^{mi} and d_{nc}^{mi}, market imperfections χ_{nk}^{mi}, industrial policies $\{\tau_{nk}^{mi}, \tau_{nk}^{\ell}\}$, an equilibrium is the collection of prices $\{p_{nk}, w_n\}$, allocations $\{q_{nk}, \ell_{nk}, g_{nk}^{mi}, c_n^{mi}\}$, lump-sum taxes x_n, such that: a) the consumer in each region chooses consumption to maximize utility (1) subject to budget constraint (6); b) producers choose allocations to solve cost-minimization problems (3), setting prices to production costs; c) given inputs, production outputs satisfy the production functions (2); d) markets for the factor and intermediate goods clear according to (4) and (5); e) government budget constraint (7) is satisfied; f) total labor income across all regions sums to one according to the normalization (8).

Definition 2. A **Market Equilibrium** is an equilibrium in which there are no subsidies or lump-sum taxes: $\tau_{nk}^{mi} = \tau_{nk}^{\ell} = x_n = 0$ for all n, k, m, i.

Absent market imperfections or industrial policies, our model coincides with the international trade model of Caliendo and Parro (2015) without tariffs. The first welfare theorem holds despite the presence of iceberg trade costs, and the economy is *Pareto efficient.*

In the presence of market imperfections ($\chi_{nk}^{mi} > 0$ for some n, k, m, i), the market equilibrium is *Pareto inefficient*, and, as we show, industrial policies may improve welfare for consumers in all regions.

Our theoretical results derive sufficient statistics for the first-order changes in regional welfare u_n in response to industrial policies introduced to the market economy. Because of inter-regional trade, industrial policy targeting any region-industry may have general equilibrium effects and affect consumer welfare in all other regions. The impact of industrial policy also depends on how it is financed, i.e., who is being taxed.

We later apply these sufficient statistics to empirical study industrial policies in China. A central theme of our empirical application is to contrast 1) the incentives of a hypothetical *central planner* who wants to improve consumer welfare in all regions and has the ability to collect taxes from all regions, and 2) the incentives of a hypothetical *regional planner* who wants to improve the welfare of consumers in a specific region and has the ability to levy lump-sum tax only from that region.

2.3 Notations

We use the following notations throughout the paper. We use bold math font to denote vectors (lowercase letters) and matrices (uppercase letters).

Our sufficient statistics will be based on cost share and income shares of of consumers and producers, as well as producer cost elasticities. The cost and income shares can be derived from region-industry level input-output tables. Relative to the cost shares, cost elasticities incorporate additional information on the market imperfections and industrial policies. We discuss measure issues in our empirical sections.

2.3.1 Cost Shares

Let $\Sigma_{nk}^{mi} \equiv p_{mi} g_{nk}^{mi} d_{nk}^{mi} / p_{nk} q_{nk}$ denote the input cost share of producer nk on good mi. Note the numerator is the cost of input mi before applying market imperfection or industrial policy wedges.

Let $\boldsymbol{\Gamma} \equiv (\boldsymbol{I} - \boldsymbol{\Sigma})^{-1}$ be the Leontief-inverse of the $NK \times NK$ matrix $\boldsymbol{\Sigma}$. Let $\boldsymbol{\Lambda}$ be the $NK \times NK$ matrix with entries $\Lambda_{nk}^{mi} \equiv \eta_{mi} \Gamma_{nk}^{mi}$. The Leontief-inverse $\boldsymbol{\Gamma}$ can be re-written as a power series $\boldsymbol{\Gamma} = \boldsymbol{I} + \boldsymbol{\Sigma} + \boldsymbol{\Sigma}^2 + \cdots$; hence Λ_{nk}^{mi} captures the network-adjusted cost share of producer nk on labor employed for producing good mi, including direct usage $\eta_{mi} \cdot [\boldsymbol{\Gamma}^0]_{nk}^{mi}$, indirect usage through buying good mi as intermediate inputs, $\eta_{mi} \cdot [\boldsymbol{\Gamma}^1]_{nk}^{mi}$, as well as indirect usage through higher order production linkages $\eta_{mi} \cdot [\boldsymbol{\Gamma}^s]_{nk}^{mi}$ for all $s \geq 2$.

Let $\rho_{nc}^{mi} \equiv \frac{p_{mi} d_{nc}^{mi} c_n^{mi}}{\sum_{o=1}^{N} p_{oi} d_{nc}^{oi}}$ denote the region n consumer expenditure on good mi as a share of total expenditure on goods bundle i. Note $\rho_{nc}^{mi} \beta_n^i = \frac{p_{mi} d_{nc}^{mi} c_n^{mi}}{w_n \ell_n}$ is equal to the consumer expenditure share on good mi.

2.3.2 Income Shares

Let Θ_{nk}^{mi} denote the fraction of goods mi sold to producer nk, including the iceberg trade costs:

$$\Theta_{nk}^{mi} \equiv \frac{g_{nk}^{mi} d_{nk}^{mi}}{\sum_{o=1}^{N} \sum_{j=1}^{K} g_{oj}^{mi} d_{oj}^{mi}}.$$

Let $\boldsymbol{\Omega} \equiv (\boldsymbol{I} - \boldsymbol{\Theta})^{-1}$ denote the Leontief inverse of $\boldsymbol{\Theta}$, i.e., Ω_{nk}^{mi} is the network-adjusted fraction of good mi sold to producer nk, including goods sold directly from mi to nk and indirectly through selling first to other producers. Likewise, let Θ_{nc}^{mi} denote the fraction of good mi sold to consumer in region n.

Both cost and income share matrices $\boldsymbol{\Sigma}$ and $\boldsymbol{\Theta}$ can be derived from region-industry input-output table. $\boldsymbol{\Sigma}$ is obtained by dividing trade flows with the total revenue of input-using industry, whereas $\boldsymbol{\Theta}$ divides trade flow by the total revenue of input-supplying industry.

Let $\alpha_{nk} \equiv \ell_{nk} / \bar{\ell}_n$ denote the fraction of factor income in region n derived from industry k.

Let $T_n^m \equiv \sum_{k=1}^K \alpha_{mk} \sum_{o=1}^N \Omega_{oi}^{mk} \Theta_{nc}^{oi}$ be the fraction of factor income in region m that is derived, directly and indirectly through input-output linkages, from selling to the consumer in region n.

2.3.3 Cost Elasticity

Let $\tilde{\Sigma}_{nk}^{mi}$ denote the cost elasticity of good nk with respect to input mi. In a market equilibrium, $\tilde{\Sigma}_{nk}^{mi} = \Sigma_{nk}^{mi} (1 + \chi_{nk}^{mi})$, and in matrix form $\tilde{\boldsymbol{\Sigma}} = \boldsymbol{\Sigma} \circ \boldsymbol{\chi}$. That is, market imperfection $(1 + \chi_{nk}^{mi})$ is equal to the ratio between cost elasticity and the cost share in a market equilibrium. With industrial policies, $\tilde{\Sigma}_{nk}^{mi} = \Sigma_{nk}^{mi} (1 + \chi_{nk}^{mi}) (1 - \tau_{nk}^{mi})$.

Let $\tilde{\boldsymbol{\Gamma}} \equiv \left(\boldsymbol{I} - \tilde{\boldsymbol{\Sigma}} \right)^{-1}$ denote the Leontief-inverse of $\tilde{\boldsymbol{\Sigma}}$; its entry $\tilde{\Gamma}_{nk}^{mi}$ captures the cost elasticity of good nk with respect to the productivity z_{mi} of good mi, holding constant all factor prices w_n. Intuitively, TFP shock for good mi affects the cost of good nk through the direct use of input mi in the production of good nk, as well as indirect use through higher rounds of input-output linkages; the Leontief-inverse captures all higher round effects.

We analogously define $\tilde{\Lambda}_{nk}^{mi} \equiv \eta_{mi} \tilde{\Gamma}_{nk}^{mi}$; this is the elasticity of output nk with respect to labor hired in mi, holding all inputs costs.

We let $\tilde{\rho}_{nk}^{mi} \equiv \tilde{\Sigma}_{nk}^{mi} / \sigma_{nk}^i$ denote the cost elasticity of good nk with respect to input mi relative to the cost elasticity with respect to the every input in bundle i. Note $\sum_{m=1}^N \tilde{\Sigma}_{nk}^{mi} = \sigma_{nk}^i$, hence $\sum_m \tilde{\rho}_{nk}^{mi} = 1$.

2.3.4 Additional Notations

Let γ_{nk} denote the total revenue of industry k in region n. Let $\tilde{A}_{mi}^{rj,qs} \equiv \theta \left(\sum_o \tilde{\rho}_{ni}^{oj} \tilde{\Lambda}_{oj}^{qs} - \tilde{\Lambda}_{rj}^{qs} \right)$; as we show below, $\tilde{A}_{mi}^{rj,qs}$ is the cross-price elasticity of expenditure by producer mi on good rj with respect to subsidies to labor inputs for good qs. Likewise, define $\tilde{A}_{mc}^{rj,qs} \equiv \theta \left(\sum_o \tilde{\rho}_{nc}^{oj} \tilde{\Lambda}_{oj}^{qs} - \tilde{\Lambda}_{rj}^{qs} \right)$, which is the cross-price elasticity of expenditure by consumer m on good rj with respect to subsidies to labor inputs for good qs.

2.4 First-Order Sufficient Statistics for Evaluating Industrial Policy

In this section we derive sufficient statistics for the distributional and aggregate impact of industrial policy. We begin by analyzing on subsidies τ_{mi}^{ℓ} to value-added inputs, and we later show the same welfare sufficient statistics hold for subsidies to intermediate inputs as well. We proceed in three steps. First, in Proposition 1 we derive the first-order general equilibrium response of regional factor income $\{ \mathrm{d} \ln w_n \}$ to a set of region-industry subsidies $\{ \mathrm{d}\tau_{mi}^{\ell} \}$ and regional lump-sum taxes $\{ \mathrm{d}x_n \}$, starting from a market equilibrium. Second, in Proposition 2 we derive the general equilibrium response of welfare $\{\mathrm{d}\ln u_n\}$ in every region to subsidies and lump-sum taxes. Third, we use Proposition 2 to derive the distributional welfare impact of value-added subsidies by requiring the government budget to balance. We derive welfare sufficient statistics for *local industrial policies*, i.e., subsidies applied to industries in a specific region and financed by lump-sum taxes levied from the same region. We also posit a social welfare function to aggregate regional welfare, and we derive sufficient statistics for *central industrial policies* where subsidies are financed by lump-sum taxes that is distribution-neutral under our social welfare function.

Proposition 1. ***Factor Income Response to Industrial Policies.*** *To first-order, introducing region-industry factor subsidies* $\{\mathrm{d}\tau_{mi}^{\ell}\}$ *and regional lump-sum taxes* $\{\mathrm{d}x_n\}$ *to the market equilibrium generates factor price response* $\{\mathrm{d}\ln w_n\}$ *that solves*

$$\begin{aligned}\underbrace{\mathrm{d}\ln w_n}_{\textit{income effect}} &= \underbrace{\sum_k \alpha_{nk}\,\mathrm{d}\tau_{nk}^{\ell}}_{\textit{subsidies}} + \underbrace{\sum_m T_m^n \left(\mathrm{d}\ln w_m - \frac{\mathrm{d}x_m}{w_m\bar{\ell}_m}\right)}_{\textit{market size effect}} \\ &\quad \underbrace{+\theta \sum_{o,m,q=1}^{N}\sum_{k,j,s=1}^{K} \alpha_{nk}\Omega_{oj}^{nk}\left(\Theta_{mc}^{oj}\tilde{A}_{mc}^{oj,qs} + \sum_{i=1}^{K}\Theta_{mi}^{oj}\tilde{A}_{mi}^{oj,qs}\right)\left(\mathrm{d}\ln w_q - \mathrm{d}\tau_{qs}^{\ell}\right)}_{\textit{cross-substitution effect}}.\end{aligned}$$

Proof. We begin by re-writing goods market clearing condition as

$$\gamma_{nk} = \sum_m (w_m\ell_m - x_m)\,\beta_m^k\rho_{mc}^{nk} + \sum_{mi}\gamma_{mi}\Sigma_{mi}^{nk}.$$

Totally-differentiating,

$$\mathrm{d}\gamma_{nk} = \sum_m (w_m\ell_m - x_m)\,\beta_m^k\,\mathrm{d}\rho_{mc}^{nk} + \sum_m (\ell_m\,\mathrm{d}w_m - \mathrm{d}x_m)\,\beta_m^k\rho_{mc}^{nk} + \sum_{mi}\gamma_{mi}\,\mathrm{d}\Sigma_{mi}^{nk} + \Sigma_{mi}^{nk}\,\mathrm{d}\gamma_{mi}.$$

Dividing both sides by γ_{nk} and recognizing that in a market $\tau_{mi}^{\ell} = x_m = 0$ in a market equilibrium,

$$\mathrm{d}\ln\gamma_{nk} = \sum_m \Theta_{mc}^{nk}\left(\mathrm{d}\ln\rho_{mc}^{nk} + \mathrm{d}\ln w_m - \frac{\mathrm{d}x_m}{w_m\ell_m}\right) + \sum_{mi}\Theta_{mi}^{nk}\left(\mathrm{d}\ln\Sigma_{mi}^{nk} + \mathrm{d}\ln\gamma_{mi}\right).$$

Moving $\Sigma_{mi}^{nk}\,\mathrm{d}\ln\gamma_{mi}$ to the left-hand side and recognizing $\boldsymbol{\Omega} \equiv (\boldsymbol{I} - \boldsymbol{\Theta})^{-1}$, we obtain

$$\mathrm{d}\ln\gamma_{nk} = \sum_{oj}\Omega_{oj}^{nk}\left(\sum_m \Theta_{mc}^{oj}\left(\mathrm{d}\ln\rho_{mc}^{oj} + \mathrm{d}\ln w_m - \frac{\mathrm{d}x_m}{w_m\ell_m}\right) + \sum_{mi}\Theta_{mi}^{oj}\,\mathrm{d}\ln\Sigma_{mi}^{oj}\right). \quad (9)$$

Now recognize

$$w_n \ell_n = \sum_k \frac{\eta_{nk}\gamma_{nk}}{1-\tau^{\ell}_{nk}}.$$

Totally differentiate and again recognize $\tau^{\ell}_{nk}=0$ in a market equilibrium,

$$\mathrm{d}\ln w_n = \sum_k \alpha_{nk}\left(\mathrm{d}\ln\gamma_{nk} + \mathrm{d}\tau^{\ell}_{nk}\right).$$

Substitute out $\mathrm{d}\ln\gamma_{nk}$ using (9):

$$\mathrm{d}\ln w_n - \sum_k \alpha_{nk}\,\mathrm{d}\tau^{\ell}_{nk} = \sum_k \alpha_{nk}\sum_{oj}\Omega^{nk}_{oj}\left(\sum_m \Theta^{oj}_{mc}\left(\mathrm{d}\ln\rho^{oj}_{mc} + \mathrm{d}\ln w_m - \frac{\mathrm{d}x_m}{w_m\ell_m}\right) + \sum_{mi}\Theta^{oj}_{mi}\,\mathrm{d}\ln\Sigma^{oj}_{mi}\right). \tag{10}$$

The last step is to solve for $\mathrm{d}\ln\rho^{oj}_{mc}$ and $\mathrm{d}\ln\Sigma^{oj}_{mi}$ as a functions of industrial policies and changes in factor prices. Given CES demand,

$$\begin{aligned}\mathrm{d}\ln\rho^{oj}_{mc} &= \theta\left(\sum_r \rho^{rj}_{mc}\,\mathrm{d}\ln p_{rj} - \mathrm{d}\ln p_{oj}\right)\\ &= \sum_{rs}\tilde{A}^{rj,qs}_{mc}\left(\mathrm{d}\ln w_q - \mathrm{d}\tau_{qs}\right).\end{aligned}$$

Likewise,

$$\mathrm{d}\ln\Sigma^{oj}_{mi} = \sum_{rs}\tilde{A}^{rj,qs}_{mi}\left(\mathrm{d}\ln w_q - \mathrm{d}\tau_{qs}\right).$$

Substitute into (10) and using the definition of T^n_m,

$$\begin{aligned}&\mathrm{d}\ln w_n - \sum_k \alpha_{nk}\,\mathrm{d}\tau^{\ell}_{nk} - \sum_m T^n_m\left(\mathrm{d}\ln w_m - \frac{\mathrm{d}x_m}{w_m\ell_m}\right)\\ =\ &\sum_{o,m,q=1}^{N}\sum_{k,j,s=1}^{K}\alpha_{nk}\Omega^{nk}_{oj}\left(\Theta^{oj}_{mc}\tilde{A}^{oj,qs}_{mc} + \sum_{i=1}^{K}\Theta^{oj}_{mi}\tilde{A}^{oj,qs}_{mi}\right)\left(\mathrm{d}\ln w_q - \mathrm{d}\tau^{\ell}_{qs}\right),\end{aligned}$$

as desired. □

Proposition 1 enables one to solve, to first-order, the general equilibrium changes in factor income when introducing factor subsidies and lump-sum taxes into the market equilibrium.

Intuitively, the general equilibrium change in factor income $\mathrm{d}\ln w_n$ can be decomposed into three effects. First, factor income is increasing in the proportional factor subsidies given to the producers in the region, with the overall effect $\sum_k \alpha_{nk}\,\mathrm{d}\tau^{\ell}_{nk}$ being the average subsidies across industries weighted by the share of factor income earned from each industry k.

Second, factor income in region n depends on the disposable income of consumers from all other regions m. When consumer m has more income to spend—either because of higher income $\mathrm{d}\ln w_m$ or lower lump-sum taxes $\mathrm{d}x_m/(w_m\ell_m)$—the spending raises the demand for goods that, directly or indirectly, uses the factor in region n for production. The extent to which factor income in n increases depends on the fraction n's income that is derived, directly and indirectly through the input-output linkages, from selling to the consumer in region m. We call this the market size effect.

Third is the substitution effect. The term $\mathrm{d}\ln w_q - \mathrm{d}\tau^{\ell}_{qs}$ captures the increase in the effective cost of factor inputs for good qs; it raises the unit cost of not only good qs but also any other good that indirectly uses good qs as production inputs. As varieties of good bundle j become more expensive, consumers and producers in all regions m and industries i will substitute towards goods oj and away from varieties of good bundle j produced in other regions. The extent of cross-substitution is captured by the cross-price elasticities, $\tilde{A}^{oj,qs}_{mc}$ and $\tilde{A}^{oj,qs}_{mi}$. Finally, the cross-substitution effect passes down to the factor income in n because good oj may directly or indirectly use factor n in production, hence the terms $\alpha_{nk}\Omega^{nk}_{oj}\Theta^{oj}_{mc}$ and $\alpha_{nk}\Omega^{nk}_{oj}\Theta^{oj}_{mi}$. These terms are the network-adjusted share of factor income in n derived from selling to consumer m and producer mi, respectively; these terms therefore capture the fraction of n's factor income that is subject to the substitution effect that takes place in m.

Proposition 2. ***Welfare Response to Industrial Policies.*** *To first-order, introducing region-industry factor subsidies $\{\mathrm{d}\tau^{\ell}_{mi}\}$ and regional lump-sum taxes $\{\mathrm{d}x_n\}$ to the market equilibrium generates regional welfare response $\{\mathrm{d}\ln u_n\}$ that solves*

$$\mathrm{d}\ln u_n = \underbrace{\mathrm{d}\ln w_n - \frac{\mathrm{d}x_n}{w_n\bar{\ell}_n}}_{\text{change in income}} - \underbrace{\sum_{m,q=1}^{N}\sum_{i,s=1}^{K}\beta^i_n\rho^{mi}_{nc}\tilde{\Lambda}^{qs}_{mi}\left(\mathrm{d}\ln w_q - \mathrm{d}\tau^{\ell}_{qs}\right)}_{\text{cost-of-living effect}}.$$

Proof. The change in welfare of consumer n is difference between the log-change in n's disposable income, $\mathrm{d}\ln w_n - \frac{\mathrm{d}x_n}{w_n\ell_n}$, and the log-change in the consumer price index of region n. The latter can be written as the expenditure share-weighted average of price changes of goods mi, $\sum_m\sum_i\beta^i_n\rho^{mi}_{nc}\,\mathrm{d}\ln p_{mi}$. The proof is complete by recognizing that

$$\mathrm{d}\ln p_{mi} = \sum_q\sum_s\tilde{\Lambda}^{qs}_{mi}\left(\mathrm{d}\ln w_q - \mathrm{d}\tau^{\ell}_{qs}\right).$$

□

Definition 3. We define the *local intervention index* ζ^L_{nk} of sector k in region n to be the elasticity of welfare in region n to subsidy spending to good nk, i.e.,

$$\zeta^L_{nk} \equiv \frac{\mathrm{d}\ln u_n}{\alpha_{nk}\,\mathrm{d}\tau^\ell_{nk}},$$

when the lump-sum taxes are levied from consumer n such that government budget is balanced within each region: $x_n = \sum_k \left(\tau^\ell_{nk} w_n \ell_{nk}\right)$. We refer to industrial policies with locally balanced budget as *locally financed industrial policies.*

The local intervention index of industry k in region n local welfare response when local industrial policy is financed by local taxes. Starting from a market equilibrium, a benevolent local planner in region n should subsidize sectors with higher ζ^L_{nk}.

We use the Bergson-Samuelson social welfare function for a central planner:

$$\ln u^C = \sum_n w_n \bar{\ell}_n \ln u_n.$$

By using the regional factor income as the Pareto weight, the central planner has no incentive to redistribute across regions at the initial equilibrium.

Definition 4. We define the *central intervention index* ζ^C_{nk} of sector k in region n to be the elasticity of social welfare u^C to subsidy spending τ^ℓ_{nk} to the market equilibrium, i.e.,

$$\zeta^C_{nk} \equiv \frac{\mathrm{d}\ln u^C}{w_n \ell_{nk}\,\mathrm{d}\tau^\ell_{nk}}$$

, when the lump-sum taxes are levied from all regions in proportion to the initial regional income:

$$x_m = \frac{w_m \bar{\ell}_m}{\sum w_m \bar{\ell}_m} \times \sum_n \sum_k \left(\tau^\ell_{nk} w_n \ell_{nk}\right) \qquad \text{for all } m.$$

We refer to industrial policies financed with these taxes as *centrally financed industrial policies.*

The local intervention index captures the "bang-for-the-buck" of industrial policy subsidies directed towards specific industries when viewed from the perspective of each region. The central intervention index captures the bang-for-the-buck of industrial policy targeted region-industry subsidies evaluated using the Bergson-Samuelson social welfare function.

The next several Propositions show how the intervention indices are sufficient statistics for evaluating industrial policies.

Proposition 3. *The local intervention index averages to zero across industries when weighted by* *industry-level employment shares:*

$$\sum_{k=1}^{K} \alpha_{nk}\zeta_{nk}^{L} = 0 \qquad \textit{for all } n.$$

The central intervention index average to zero across industries and regions when weighted by factor income share

$$\sum_{n=1}^{N}\sum_{k=1}^{K} w_n \ell_{nk}\zeta_{nk}^{C} = 0.$$

Proposition 4. *Let $Spending_{nk}^{L}$ denote the total fiscal cost of locally financed subsidies directed to the production of good nk:*

$$Spending_{nk}^{L} \equiv \alpha_{nk}\tau_{nk}^{\ell}.$$

Then to first order, relative to the market economy,

$$\Delta u_n = \sum_{k} \zeta_{nk}^{L} \times Spending_{nk}^{L}. \tag{11}$$

If instead the subsidies are centrally financed, let $Spending_{nk}^{C}$ denote the total fiscal cost of centrally financed subsidies directed to the production of good nk:

$$Spending_{nk}^{C} \equiv w_n \ell_{nk}\tau_{nk}^{\ell}.$$

Then to first-order, relative to the market economy

$$\Delta u^{C} = \sum_{n}\sum_{k} \zeta_{nk}^{C} \times Spending_{nk}^{C}. \tag{12}$$

Corollary 1. *Equations (11) and (12) can be re-written as the covariance between the respective intervention index and the subsidy spendings per sectoral value-added:*

$$\Delta u_n = Cov^{L}\left(\zeta_{nk}^{L}, \frac{Spending_{nk}^{L}}{\ell_{nk}/\bar{\ell}_n}\right),$$

$$\Delta u^{C} = Cov^{C}\left(\zeta_{nk}^{C}, \frac{Spending_{nk}^{C}}{w_n \ell_{nk}}\right),$$

where Cov^L is the covariance operator taken across industries, using the local income share from each industry as the distribution;[1] Cov^C *is the covariance operator taken across region-industries, using each region-industry's value-added as the distribution.*[2]

Relation to the Literature. In a single-region economy, the local and central intervention indices coincide and are both equal to the distortion centrality (minus a constant) proposed by Liu (2019).

Industrial policies affect factor income because subsidies change prices and lump-sum taxes change disposable income. The price impact of subsidies is analogous to that of productivity shocks; in fact, the factor income response to TFP shock is

$$\begin{aligned} \mathrm{d}\ln w_n &= \sum_k \alpha_{nk}\,\mathrm{d}\tau_{nk}^{\ell} + \sum_m T_m^n\left(\mathrm{d}\ln w_m\right) \\ &\quad + \sum_{o,m,q=1}^{N}\sum_{k,j,s=1}^{K} \alpha_{nk}\Omega_{oj}^{nk}\left(\Theta_{mc}^{oj}\tilde{A}_{mc}^{oj,qs} + \sum_{i=1}^{K}\Theta_{mi}^{oj}\tilde{A}_{mi}^{oj,qs}\right)\left(\mathrm{d}\ln w_q - \frac{\mathrm{d}\ln z_{qs}}{\eta_{qs}}\right), \end{aligned}$$

which is the result of Kleinman et al. (2020).

If consumers across all regions face the same iceberg trade costs for each good ($d_{nc}^{mi} = d_{oc}^{mi}$ for all n, o, m, i), then there exists a representative consumer for the multi-region economy. Suppose further that industrial policy takes the form of a single subsidies τ_{qs} to each producer that applies equally to all inputs: $\mathrm{d}\tau_{qs} \equiv \mathrm{d}\tau_{qs}^{\ell} = \mathrm{d}\tau_{qs}^{oj}$ for all q, s, o, j. Then

[1] $Cov^L\left(a_{nk}, b_{nk}\right) = \sum_k \frac{\ell_{nk}}{\ell_n} a_{nk} b_{nk} - \left(\sum_k \frac{\ell_{nk}}{\ell_n} a_{nk}\right)\left(\sum_k \frac{\ell_{nk}}{\ell_n} b_{nk}\right)$.

[2] $Cov^C\left(a_{nk}, b_{nk}\right) = \sum_n \sum_k w_n \ell_{nk} a_{nk} b_{nk} - \left(\sum_n \sum_k w_n \ell_{nk} a_{nk}\right)\left(\sum_n \sum_k w_n \ell_{nk} b_{nk}\right)$.

$$
\begin{aligned}
\mathrm{d}\ln u^C &= -\sum_n \sum_k \gamma_{nk}\,\mathrm{d}\tau_{nk} - \sum_n w_n \ell_n \sum_{m,q=1}^{N} \sum_{i,s=1}^{K} \beta_n^i \rho_{nc}^{mi} \tilde{\Lambda}_{mi}^{qs} \left(\mathrm{d}\ln w_q - \frac{\mathrm{d}\tau_{qs}}{\eta_{qs}} \right) \\
&= \sum_n w_n \ell_n \sum_{m,q=1}^{N} \sum_{i,s=1}^{K} \beta_n^i \rho_{nc}^{mi} \frac{\tilde{\Lambda}_{mi}^{qs}}{\eta_{qs}}\,\mathrm{d}\tau_{qs} \\
&\quad - \left(\sum_n \sum_k \gamma_{nk}\,\mathrm{d}\tau_{nk} + \sum_n w_n \ell_n \sum_{m,q=1}^{N} \sum_{i,s=1}^{K} \beta_n^i \rho_{nc}^{mi} \tilde{\Lambda}_{mi}^{qs}\,\mathrm{d}\ln w_q \right) \\
&= \sum_n w_n \ell_n \sum_{m,q=1}^{N} \sum_{i,s=1}^{K} \beta_n^i \rho_{nc}^{mi} \frac{\tilde{\Lambda}_{mi}^{qs}}{\eta_{qs}}\,\mathrm{d}\tau_{qs} \\
&\quad - \left(\sum_n w_n \ell_n \sum_{m,q=1}^{N} \sum_{i=1}^{K} \beta_n^i \rho_{nc}^{mi} \sum_{s=1}^{K} \tilde{\Lambda}_{mi}^{qs}\,\mathrm{d}\ln \frac{w_q}{1 - \sum_n \sum_k \gamma_{nk}\,\mathrm{d}\tau_{nk}} \right).
\end{aligned}
$$

This is analogous to Baqaee and Farhi (2020) Theorem 1, which concerns the aggregate impact of markups. The term $\sum_{n,m,i} w_n \ell_n \beta_n^i \rho_{nc}^{mi} \tilde{\Lambda}_{mi}^{qs} / \eta_{qs}$ corresponds to the cost-based Domar weight of sector qs, $\sum_{n,m,i,s} \beta_n^i \rho_{nc}^{mi} \tilde{\Lambda}_{mi}^{qs}$ is the cost-based Domar weight of factor q, and $\frac{\mathrm{d}\ln w_q}{1-\sum_n \sum_k \gamma_{nk}\,\mathrm{d}\tau_{nk}}$ is the log-change in the revenue based the Domar weight of factor q.

3 Empirical Results

3.1 Intervention Index

We use the 2012 multi-regional input-output table of China, the most recent version released by China's National Bureau of Statistics (henceforth NBS). The input-output table covers a total of 42 industries and all the 31 provinces. The detailed description of industry classification is provided in Appendix A. We obtain 1273 region-industry pairs after excluding those associated with zero sales in the input-output table.

Liu (2019) has shown that central intervention indices are very robust to wedges. We first assume a constant wedge of 10% for each region-industry pair. The corresponding central and local intervention indices are used as our benchmark measures.[3] We next simulate central and local intervention indices by randomly drawing region-industry-specific wedges from different distributions assumed in Liu (2019). Table 1 shows that the simulated intervention indices are highly correlated with the benchmark, suggesting that both central and local intervention indices be primarily determined by the structure of production network, rather than wedges. We will use

[3]Data source see Liu et al. (2018).

intervention indices with constant wedge in the following analysis. However, all the results are robust to randomly simulated wedges.

Table 1: Average Correlation with Benchmark across Different Specifications

	Pearson's r		Spearman's ρ	
Specifications	Central	Local	Central	Local
constant $\chi_{ij} = 5\%$	1.00	0.97	1.00	0.95
$log \sim N(0.09, 0.1)$	0.93	0.98	0.95	0.97
$N(0.1, 0.1)$	0.95	0.98	0.96	0.98
$N(0.2, 0.2)$	0.91	0.93	0.93	0.92
$max\{N(0.1, 0.1), 0\}$	0.97	0.99	0.98	0.99
$U[0, 0.1]$	0.98	0.97	0.99	0.95
$U[0, 0.2]$	0.98	0.99	0.99	0.99
$Exp(0.1)$	0.96	0.99	0.97	0.98
$Exp(0.15)$	0.96	0.97	0.97	0.97

Notes: We simulate intervention indices for 100 times under each distributional assumption. This table reports the average correlation coefficient between the benchmark and simulated intervention indices under each distributional assumption.

The summary statistics of the intervention indices are reported in Table 2. The average of local intervention index is close to that of central intervention index. However, local intervention index has a substantially larger variation. The maximum and minimum value of local intervention index is 0.95 and -0.40, respectively, about a third higher and a quarter lower than its counterpart of central intervention index. The more dispersed local intervention index suggests higher sensitivity of local welfare to industrial policy.

Table 2: Summary Statistics

	N	Mean	Median	Max	Min	Std
ζ^C	1273	0.01	-0.01	0.41	-0.22	0.12
ζ^L	1273	0.05	0.03	0.95	-0.40	0.16

Moreover, the correlation between central and local intervention index is low. The correlation coefficient weighted by value added is only 0.24. There are two main reasons for the low correlation. First, central intervention index of an industry is mainly determined by its upstreamness, which is similar across regions. Therefore, industry fixed effects account for 90% of the variations in central intervention index (see Column 2 in Table 3).

The determination of local intervention index is more involved. Industry fixed effects only account for 23% of the variations in local intervention index. The regional trade linkages play an

Table 3: Region and Industry Effect

	Central Intervention Index			Local Intervention Index		
	(1)	(2)	(3)	(4)	(5)	(6)
R-squared	0.00406	0.902	0.934	0.00147	0.225	0.228
Province Dummy	YES	NO	YES	YES	NO	YES
Industry Dummy	NO	YES	YES	NO	YES	YES
N	1273	1273	1273	1273	1273	1273

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

important role. Table 4 reports the summary statistics of several model-free indicators for China's province-to-province production and trade network. Table 5 shows that the correlations between intervention index measures and the indicators.[4] Central and local intervention index are generically different in their correlations with "non-local intermediate share", – i.e., the proportion of a region-industry output used as intermediate input outside the region. The correlation is positive for central intervention index but negative for local intervention index. Intermediate goods sold to the other regions do not directly benefit the local economy and are therefore discounted in local intervention index. In contrast, central intervention index internalizes the positive spillovers of local production to the other regions.

In summary, despite the similarity of the vertical structure of production network across regions, the differences between central and local intervention index are substantial. In the following empirical analysis, we will use the differences to shed lights on central and local industrial policies.

[4]The results for index_central_nonlocal are shown in Table A.3 in Appendix A.

Table 4: Summary of Statistics

	N	Mean	Median	Max	Min	Std
share of sales as final use	1273	0.37	0.32	1.00	0.00	0.32
share of sales as local input	1273	0.52	0.53	1.00	0.00	0.28
share of sales as non-local input	1273	0.12	0.06	0.93	0.00	0.15
index_local	1273	1.00	1.00	1.50	0.58	0.07
index_central	1273	1.00	1.00	2.18	0.74	0.08
index_central_nonlocal	1273	1.00	1.00	1.22	0.00	0.09

Notes: We use the 2012 multi-regional input-output table of China. All the indicators are calculated at the region-industry level. For industry k in region n, ζ^L_{nk} and ζ^C_{nk} denote local intervention index and central intervention index, respectively. We decompose nk's total output into three parts: intermediate input used locally; intermediate input used by other regions and final use. *share of sales as final use* is calculated as $\sum_m \Theta^{nk}_{mf}$, the sales share of final use; *share of sales as local input* equals to $\sum_i \Theta^{nk}_{ni}$, which is the share of sales used as intermediate inputs in local production; *share of sales as non-local input is calculated as* $1 - \sum_m \Theta^{nk}_{mf} - \sum_i \Theta^{nk}_{ni}$, which is the share of sales used as intermediate inputs by production outside the region; *index_local* denotes the average local intervention index of all the local users in the region-industry pair nk, $\sum_i (sales^{nk}_{ni} / \sum_i sales^{nk}_{ni})\zeta^L_{ni}$, where $sales^{nk}_{ni}$ is ni's expenditure on nk; *index_central* denotes the average central intervention index of all the local users in nk, $\sum_i (sales^{nk}_{ni} / \sum_i sales^{nk}_{ni})\zeta^C_{ni}$; and *index_central_nonlocal* denotes the average central intervention index of all the users outside region n, $\sum_{m\neq n} \sum_j (sales^{nk}_{mj} / \sum_{m\neq n} \sum_j sales^{nk}_{mj})\zeta^C_{mj}$.

Table 5: Intervention Index

	Panel A: Central Intervention Index					
	(1)	(2)	(3)	(4)	(5)	(6)
share of sales as local input	0.303***	0.134***	0.282***	0.264***	0.207***	0.227***
	(0.00863)	(0.0122)	(0.00776)	(0.0130)	(0.00599)	(0.0108)
share of sales as non-local input			0.397***	0.235***	0.249***	0.199***
			(0.0235)	(0.0168)	(0.0128)	(0.0122)
index_central					0.832***	0.469***
					(0.0353)	(0.0411)
R-squared	0.610	0.953	0.820	0.967	0.935	0.981
	Panel B: Local Intervention Index					
	(1)	(2)	(3)	(4)	(5)	(6)
share of sales as local input	0.208***	0.535***	0.233***	0.0161	0.202***	0.127***
	(0.0114)	(0.0399)	(0.0100)	(0.0431)	(0.00821)	(0.0351)
share of sales as non-local input			-0.457***	-0.936***	-0.344***	-0.654***
			(0.0345)	(0.0598)	(0.0214)	(0.0440)
index_local					1.024***	0.904***
					(0.0492)	(0.0539)
R-squared	0.236	0.469	0.464	0.649	0.692	0.774
Province Dummy	YES	YES	YES	YES	YES	YES
Industry Dummy	NO	YES	NO	YES	NO	YES
N	1273	1273	1273	1273	1273	1273

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Dependent variables in Panel A are central intervention indices; and dependent variables in Panel B are local intervention indices.

3.2 Policy Platforms

The distinctive differences between central and local intervention index imply testable predictions for central and local industrial policies. Liu (2019) provides evidence for policies in favor of the industries with high central intervention index, which can be interpreted as central industrial policy through the lens of our model. In the countries with empowered local governments, there should be room for local industrial policies that aim to improve local welfare rather than aggregate welfare.

China has a particularly strong local state capacity (Bai et al., 2020a). Local governments often favor local firms and industries by bending policies and regulations set by the central government (Bai et al., 2020b). Moreover, local governments have discretions in allocating self-raised fund from selling local land use rights and borrowing through local financing vehicles (Bai et al., 2016; Song and Xiong, 2018). While personnel decisions on high-ranked officials are made by the central government, the promotion likelihood of local officials is related to local economic performance in their tenure (e.g., Li and Zhou, 2005). Local officials also benefit directly from local economic development.[5] In short, Chinese local officials are endowed with substantial resources and well-motivated to promote local industrial policies.

The empirical challenge is that many industrial policies are not observable. Distinguishing central and local industrial policies is even harder. Instead of directly identifying industrial policies, we infer them indirectly from central and local "policy platforms". One example is Special Economic Zone (SEZ), is perhaps the most popular platform for industrial policy around the world. Like many other countries, China has used SEZs to support targeted industries. As of 2018, China established 2543 SEZs. Industrial upgrading is one of SEZ's missions. Each SEZ specifies about 3 priority industries. A key to our analysis is that a quarter of SEZs were approved by the central government and the rest were approved by provincial governments. We can infer central and local industrial policies from the industries prioritized by central and local SEZs, respectively.

Another policy platform is the state sector. Bai et al. (2020b) show that the state sector accounted for about a quarter of capital in China in 2019. It has been widely documented that many state-owned enterprises (SOEs) are supported by discriminative policies and subsidies (Hsieh and Song, 2015; König et al., 2020). Many of the policies and subsidies target SOEs in specific industries. For example, the central government explicitly identified 7 strategic industries and 9 pillar industries to be controlled and dominated by the state sector, respectively (Document No. 97, General Office of the State Council, 2006). The share of SOEs in an industry is thus a mani-

[5] See Xu (2011) and Bai et al. (2020a) for local officials' incentives of promoting local economy in additional to the promotion incentives.

festation of the intensity of industrial policy on the platform. Analogous to SEZs approved by central and local government, in our sample, 40% of SOEs are directly controlled by the central government and central SOEs account for 65% of total capital owned by the state. The rest of SOEs are controlled by various levels of local governments. We can therefore infer central and local industrial policies from variations in the share of central and local SOEs across regions and industries.

If the central government exerts full control over local governments, central industrial policies can also be implemented through local policy platforms. However, the standard principle-agent problem would arise whenever the control is imperfect. The resources for central industrial policies can be diverted by local SEZs or SOEs for other purposes. Therefore, the central government is be more willing to implement central industrial policies through the units controlled by themselves. This leads to the following hypotheses that can be tested by the data.

1. The intensity of central (local) industrial policy should be stronger in the industries with higher central (local) intervention index.

2. The correlation between the intensity of local industrial policy and local intervention index should be stronger for the policies associated with more divertible resources and in the regions where the central government exerts less control over the local government.

3.2.1 Special Economic Zone

We extract information from Catalogue of China's Development Zones (2018 version) to construct our SEZ measures. Among the 2543 SEZs approved up to 2018, 552 and 1991 SEZs were approved by central and provincial governments, respectively. We code the industries targeted by each SEZ according to the industry classifications in our input-output table. We then construct two province-industry-specific measures for the intensity of industrial policy on the SEZ platform: the likelihood for the industry to be targeted by central and local SEZs in the province, respectively, referred to as central and local SEZ intensity.

The correlations between SEZ intensities and intervention indices are reported in Table 6. The likelihood of an industry to be targeted by both central and local SEZs is positively correlated with central intervention index but uncorrelated with local intervention index. We interpret the correlations as evidence for central industrial policies implemented through SEZs. Local SEZ intensity turns out to be more correlated with central intervention index than local intervention index. The weaker correlation with local intervention index does not necessarily disapprove local industrial policies. Rather, it seems in line with the second hypothesis for the following two reasons. First, the central government can easily monitor the priority industries selected by local government. Moreover, the central government seldom provides subsidy for local SEZs. Both alleviate the principle-agent problem for local SEZs to implement central industrial policies.

Table 6: Special Economic Zone: Central v.s. Local

	log(central SEZ intensity)			log(local SEZ intensity)		
	(1)	(2)	(3)	(4)	(5)	(6)
central intervention index	2.037*		2.241*	2.918***		3.498***
	(1.159)		(1.170)	(0.836)		(0.839)
local intervention index		0.0939	-0.454		-0.397	-1.248**
		(0.618)	(0.549)		(0.530)	(0.508)
Province Dummy	YES	YES	YES	YES	YES	YES
Industry Dummy	NO	NO	NO	NO	NO	NO
N	346	346	346	484	484	484
R-squared	0.149	0.119	0.152	0.238	0.194	0.252

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

3.2.2 State Share

Our second empirical analysis is to examine if the size of the state sector correlates to central and local intervention index across industries and regions. The official statistics only reveal the share of SOEs in the industrial sector. We overcome the difficulty by using the 2015 firm registration records of China's State Administration for Market Regulation, which provide ownership and registration information for all the 17 million active firms in that year. Following Bai et al. (2020b), we work through the ownership chain to identify each firm's ultimate owners, who can be government units, private individuals and foreign legal persons. We then calculate the province-industry-specific central and local state share, defined as the proportion of capital owned by central and local governments in the total capital of the province-industry pair, respectively. Local governments include provincial and lower level governments.

We find a striking dichotomy between central and local state shares. The first column in Table 7 shows that central state share is highly correlated with central intervention index. Its correlation with local intervention index is much weaker (Column 2) and disappears entirely when central intervention index is added to the regression (Column 3). In contrast, local state share is always highly correlated with local intervention index but uncorrelated with central intervention index (Column 4 to 6). These findings are consistent with the second hypothesis implied by our model.

We also find different correlations between state shares and intervention indices across regions. We group the 30 Chinese provinces into three regions: East China, Central China, West & Northeast China. East China has the highest GDP per capita, which is 64% and 83% higher than

Table 7: State Share and Intervention Index

	log(central state share)			log(local state share)		
	(1)	(2)	(3)	(4)	(5)	(6)
central intervention index	3.798***		3.659***	0.487		0.125
	(0.685)		(0.690)	(0.701)		(0.728)
local intervention index		1.317*	0.559		1.535***	1.509***
		(0.694)	(0.682)		(0.545)	(0.580)
Province Dummy	YES	YES	YES	YES	YES	YES
Industry Dummy	NO	NO	NO	NO	NO	NO
N	1118	1118	1118	1209	1209	1209
R-squared	0.231	0.188	0.232	0.105	0.120	0.120

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

the GDP per capita of Central China and West & Northeast China, respectively, in 2018. We run the same regressions for each region and report the results in Table 8. Central state share positively correlates to central intervention index in all the three regions. The positive correlation is robust to adding local intervention index in the regression, except for East China. Local state share is uncorrelated with central intervention index in East China and West & Northeast China but positively correlated with central China. Moreover, the positive correlation between local state share and local intervention index is mainly driven by East China. These findings suggest the correlations between state shares and intervention indices are correlated with regional income level. In particular, there is evidence for local industrial policy implemented through both central and local SOEs in East China, the most developed region.

To further explore the variations in the correlations, we run the regressions in Column 3 and 6 province by province. Panel A and B in Figure 1 plot the estimated coefficients of central and local intervention index in the regression for central state share, respectively. In line with the results in Table 8, the estimated coefficients of central intervention index are positive in 26 out of 30 provinces. Only a third of the provinces have a positive estimated coefficient of local intervention index[6]. None of the two estimates is correlated with provincial income.

Panel C and D plot the estimated coefficient of central and local intervention index in the regression for local state share, respectively. Consistent with the results in Table 8, the estimated coefficient of central intervention index is positive in 19 provinces but turns significantly negative for Jiangsu and Zhejiang, the two highest-income provinces in East China. This leads to a negative correlation between the estimates and provincial income, which is statistically significant at the

[6] 8 out of 11 positive estimated coefficient of local intervention index are insignificant. 2 out of 3 significant coefficients are in East China.

Table 8: State Share and Intervention Index: Regional Results

	log(central state share)			log(local state share)		
	(1)	(2)	(3)	(4)	(5)	(6)
			Panel A: East			
central intervention index	3.028***		1.793	-0.563		-2.173
	(1.127)		(1.279)	(1.215)		(1.379)
local intervention index		3.606***	2.889**		2.941***	3.839***
		(1.185)	(1.356)		(1.017)	(1.249)
N	375	375	375	392	392	392
R-squared	0.269	0.285	0.293	0.0398	0.0847	0.105
			Panel B: Central			
central intervention index	4.068***		4.273***	2.305**		2.336**
	(1.268)		(1.239)	(0.944)		(0.917)
local intervention index		-0.310	-0.903		0.214	-0.132
		(0.924)	(0.779)		(0.692)	(0.574)
N	228	228	228	238	238	238
R-squared	0.136	0.0738	0.141	0.192	0.158	0.192
			Panel C: West & Northeast			
central intervention index	4.890***		4.870***	1.054		1.072
	(0.943)		(0.965)	(0.906)		(0.881)
local intervention index		-0.755	-0.625		0.645	0.670
		(0.863)	(0.895)		(0.707)	(0.721)
N	515	515	515	579	579	579
R-squared	0.153	0.0552	0.155	0.141	0.135	0.145
Province Dummy	YES	YES	YES	YES	YES	YES
Industry Dummy	NO	NO	NO	NO	NO	NO

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: East area covers 10 provinces: 4 provinces (Beijing, Tianjin, Hebei and Shandong) in Circum-Bohai-Sea, 3 provinces (Shanghai, Jiangsu and Zhejiang) in Yangtze River Delta, and another 3 provinces (Fujian, Guangdong and Hainan) in southeastern costal region; Central area includes 6 provinces: Shanxi, Anhui, Jiangxi, Henan, Hubei and Hunan; the remaining 15 provinces are in West & Northeast area.

level of 99%. The estimated coefficient of local intervention index is positive for 16 provinces, many of which are high-income provinces such as Jiangsu and Zhejiang. The correlation between the estimates and provincial income is positive and statistically significant at the level of 99%. High-income provinces are more likely to support the industries with high local intervention index through SOEs. In contrast, low-income provinces are more likely to support the industries with high central intervention index.

An interesting question is why industrial policies implemented through SOEs are more in line with central intervention index in poorer regions? One possibility is that low-income provinces are more dependent of fiscal transfers from the central government. Local fiscal revenue only accounted for 42% of local fiscal expenditure in Central and West & Northeast China, while the ratio was 73% for East China and 79% for Jiangsu and Zhejiang[7]. The correlation coefficient between GDP per capita and the ratio of local fiscal revenue to local fiscal expenditure is 0.85 across provinces. The fiscal redistribution alleviates the principle-agent problem between the central and local governments in implement central industrial policies. Figure 2 shows a strong negative correlation between the estimated coefficient of central intervention index in the regression for central state share and the ratio of of local fiscal revenue to local fiscal expenditure. The evidence is consistent with the second hypothesis and suggests that the central government be in a stronger position to implement central industrial policies in the provinces that are more dependent of fiscal redistribution[8].

[7]Local fiscal revenue and expenditure data are from website of NBS and data year is 2015.

[8]For robustness check, we trim state share data by top and bottom 5% for each province and re-do all the analysis in this section. Results are shown in Appendix B and they are quite similar to the full sample results here.

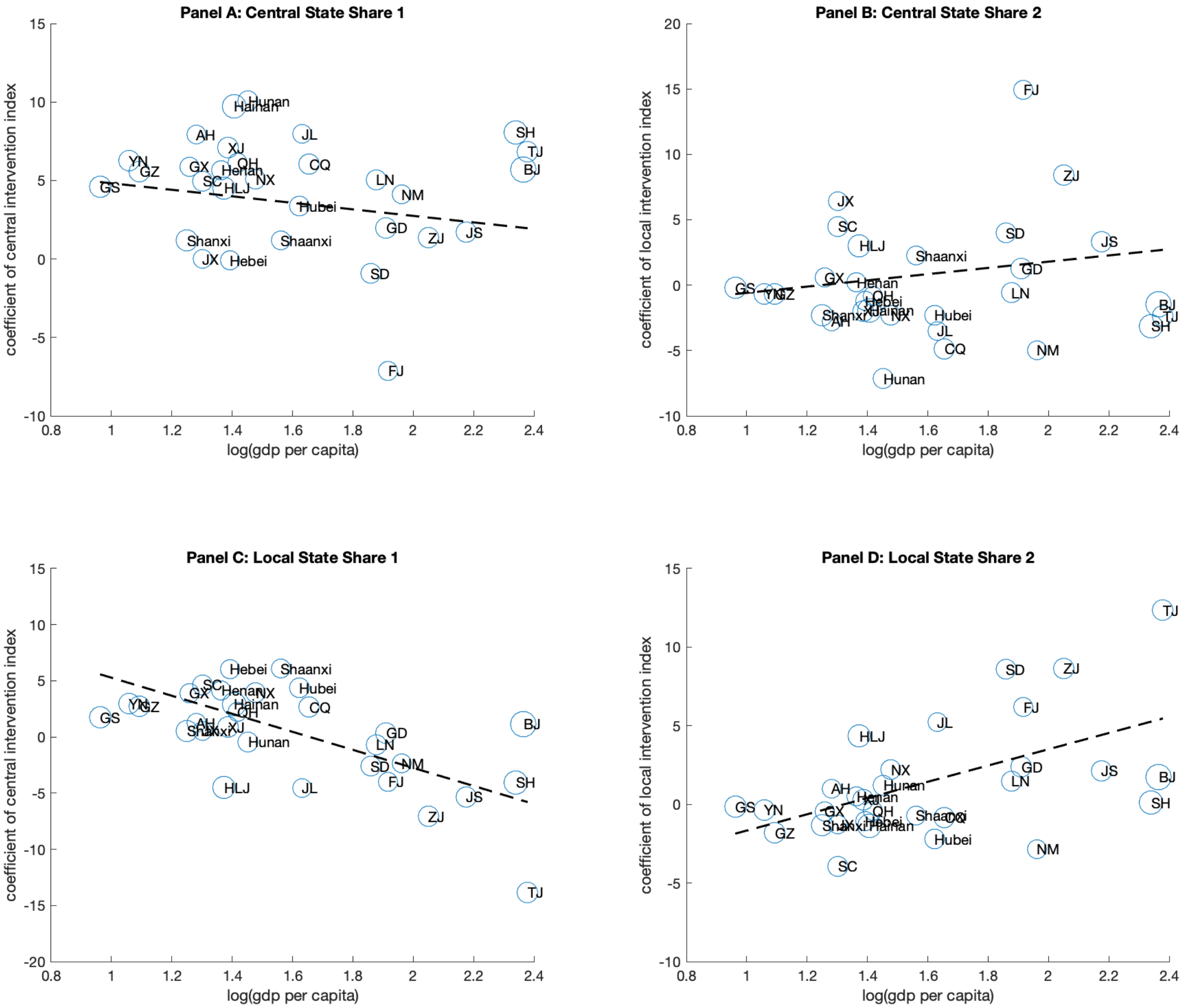

Figure 1: State Share Sensitivity to Intervention Index: Provincial Variation

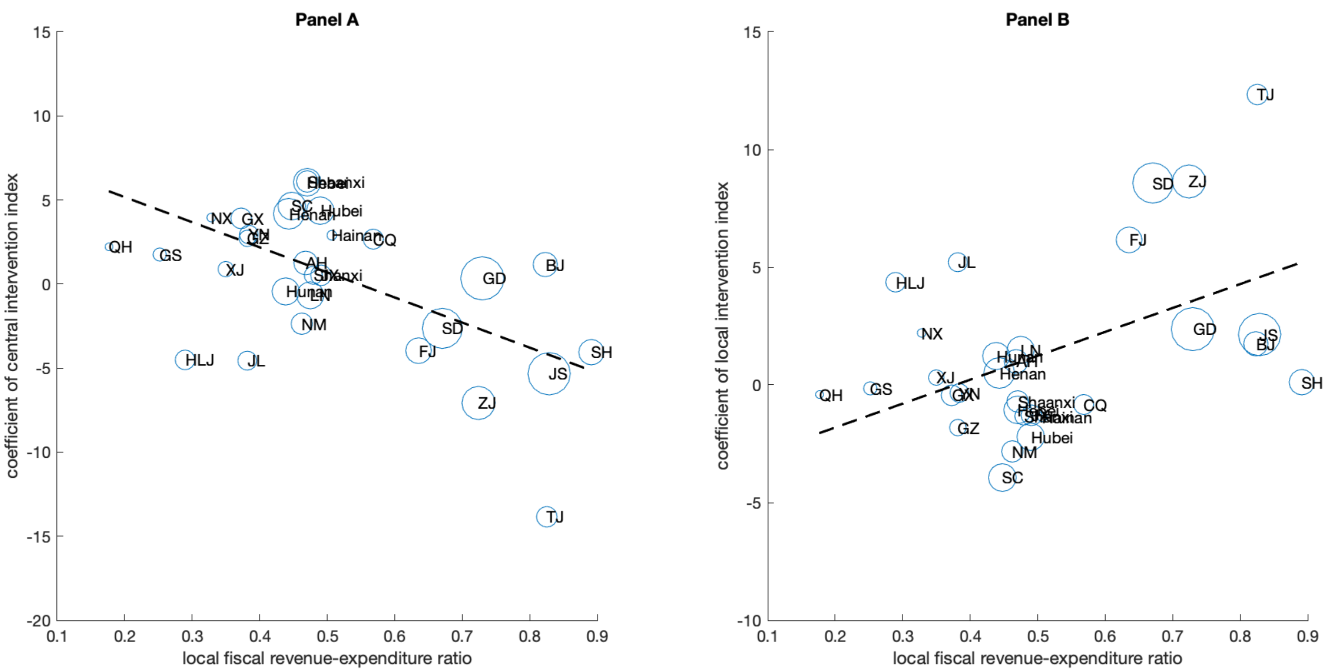

Figure 2: Local State Share Sensitivity to Intervention Index: Provincial Variation

3.3 Region-Industry-Ownership-Specific Wedges

In this section, we want to understand how the central and local governments implement industrial policies through SOEs. To this end, we use the firm survey data from China's State Administration of Taxation (SAT henceforth). The SAT survey data, which covers both manufacturing and service industries, has a much better sectoral composition than the Annual Survey of Above-Scale Industrial Firms that has been widely used in the literature.

To identify central and local SOEs, we merge the SAT data with the registration data. Following Hsieh and Song (2015), we take two steps to identify SOEs. First, all the firms registered as SOEs in the SAT data are taken as SOEs. [9] Second, the firms registered as non-SOEs in the SAT data but identified as SOEs by their registration information (i.e., with state share above or equal to 50%) are also taken as SOEs. We next define central and local SOEs in the same way as before. Table 9 reports the summary statistics of firms with three ownership types: private, central and local SOEs in our sample. About 5% of the firms are SOEs and 40% of SOEs are central SOEs.

Table 9: Summary Statistics of Sample by Ownership

	non-SOE	Central SOE	Local SOE
Share of Firm Number	95.1%	2.0%	2.9%
Share of Sales	80.2%	13.2%	6.6%
Share of Capital	64.4%	23.3%	12.3%
Share of Labor	83.3%	8.5%	8.2%

Note: For each statistic, we show average number between the year 2011 and 2015; sum of each row is 100%; and average annual total firm number is 550931.

We construct three province-industry-ownership-specific wedges: capita, land and labor wedges. Capital wedge is the median value of firm's sales-to-capital ratio in a province-industry-ownership group between 2011 and 2015. There are 30 provinces, 42 industries consistent with input-output table and three ownership types. As a robustness check, we construct year-specific capital wedge by using the median value of the ratio in each group in each year and control year fixed effect in all the regressions below. The results are very robust and reported in Appendix C. Following Hsieh and Klenow (2009), we interpret the sales-to-capital ratio as the average cost of capital. Lower capital wedge implies lower capital tax or higher capital subsidy.

Similar to capital wedge, we also construct land wedge as the sales-to-land ratio and labor

[9]We use the code for registration type of taxpayer in the SAT data. Taxpayers registered as "state-owned enterprise", "joint-stock cooperative enterprise restructured from state-owned enterprise", "state-owned associated enterprise" and "wholly state-owned enterprise" are identified as SOEs.

wedge as the sales-to-employment ratio for each region-industry-ownership group. The robustness checks are reported in Appendix E.2 and D.2, respectively.

3.3.1 Capital Wedge

Table 10 reports the regression results for capital wedge. In the first column, we regress capital productivity on the dummies for central SOEs and private firms, using local SOEs as the benchmark group. We add central intervention index and the interactions with ownership dummies. Industry and province fixed effects are controlled. Consistent with what has been widely documented in the literature (e.g., Song et al., 2011; Hsieh and Song, 2015), we find capital productivity of private firms to be significantly higher than that of SOEs. What is new here is that capital productivity of central SOEs is higher than that of local SOEs. As we will elaborate in the next subsection, the difference is likely to be explained by stronger market power granted to central SOEs.

Table 10: Capital Wedge and Intervention Index

	(1)	(2)	(3)
soe_central	0.310***	0.300***	0.315***
	(0.0631)	(0.0639)	(0.0622)
private	0.683***	0.688***	0.691***
	(0.0505)	(0.0497)	(0.0495)
central intervention index	-0.218		0.0288
	(0.491)		(0.498)
soe_central×central intervention index	0.211		0.0189
	(0.722)		(0.749)
private×central intervention index	1.171***		0.938**
	(0.412)		(0.421)
local intervention index		-1.183***	-1.066***
		(0.310)	(0.323)
soe_central×local intervention index		0.839**	0.855*
		(0.424)	(0.451)
private×local intervention index		1.124***	0.992***
		(0.317)	(0.331)
Province Dummy	YES	YES	YES
Industry Dummy	YES	YES	YES
N	3299	3299	3299
R-squared	0.944	0.944	0.944

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Dependent variable is log of sales-capital ratio at region-industry-ownership level which is the median value among all the firms in each region-industry-ownership group between the year 2011 and 2015; reference group is local SOEs whose central state share is lower than local state share; dummy variable *soe_central* equals 1 if it is the region-industry level sales-capital ratio for SOEs whose central state share is larger than or equal to local state share, otherwise it is 0; dummy variable *private* equals 1 if it is the region-industry level sales-captial ratio for private firms, otherwise it is 0.

Central intervention index is not significantly correlated with capital productivity among local SOEs. The interaction term with central SOE dummy is also statistically insignificant. In words, there is no evidence for subsidizing capital cost of SOEs as central industrial policy. Note that this does not necessarily contradict the previous findings. The larger shares of central SOEs in the industries with higher central intervention index can be driven by other industrial policies such as entry barriers and discriminative regulations. The interaction between central intervention index and private firm dummy is positive and significant. This is a strong rejection of central industrial policy implemented by subsidizing capital cost of private firms.

We then replace central intervention index with local intervention index in the regressions and report the results in the second column of Table 10. The estimated coefficients of the ownership dummies are very robust. The correlation between local intervention index and capital productivity is now negative and highly significant for the benchmark group, indicating that local SOEs receive more capital subsidies than the average in the industries with local intervention index above the mean value.[10] This provides evidence for local industrial policy implemented by subsidizing capital cost of local SOEs and is consistent with the larger share of local SOEs in the industries with higher local intervention index. The interaction between local intervention index and central SOE or private firm dummy is positive. Adding back the estimate coefficient of local intervention index for local SOEs, the estimates of local intervention index are much closer to zero and statistically insignificant.

We include both central and local intervention index and their interactions with ownership dummies in the third column. The results are similar to those in the first and second columns. Most importantly, capital productivity remains uncorrelated with central intervention index but negatively correlated with local intervention index at the significance level of 1%. the interaction term between local SOE dummy and local intervention index remains negative, though the level of significance is slightly below 5%.

3.3.2 Labor Wedge

Table 11 reports the results for labor wedge. Labor productivity of central SOEs is about a third higher than local SOEs and private firms. Using annual survey of industrial firms, Hsieh and Song (2015) also found higher labor productivity for SOEs after 2007. The labor productivity gap can be explained by capital intensity if the productivity technology is not Cobb-Douglas. We add capital-to-labor ratio as a additional control and find essentially the same results.[11] Market power is another potentially important factor. The average market share of a central SOE in an industry

[10]Both central and local intervention index have mean values close to one.

[11]The regression results without capital intensity are reported in the Appendix D.1.

is 13.2%, twice of a local SOE. This implies that central SOEs be granted with more market power than local SOEs, which, in turn, is consistent with higher labor productivity for central SOEs but not for local SOEs. If we assume that the labor productivity premium for central SOEs is all driven by markups, the same difference in markups can also explain nearly all the capital productivity gap between local and central SOEs in Table 10.

The remaining results for labor productivity are similar to those for capital productivity. The weak correlation between labor productivity and central intervention index does not support labor subsidy as central industrial policy implemented through SOEs. Instead, the correlations between labor productivity and local intervention index for local SOEs implies local industrial policy by subsidizing local SOEs only.

Table 11: Labor Wedge and Intervention Index: Add Controls

	(1)	(2)	(3)
soe_central	0.353***	0.351***	0.355***
	(0.0551)	(0.0553)	(0.0546)
private	0.0335	0.0302	0.0344
	(0.0481)	(0.0480)	(0.0477)
central intervention index	-0.518		-0.306
	(0.433)		(0.423)
soe_central×central intervention index	0.786*		0.668
	(0.420)		(0.425)
private×central intervention index	1.089***		0.913***
	(0.340)		(0.340)
local intervention index		-1.067***	-0.945***
		(0.209)	(0.213)
soe_central×local intervention index		0.644**	0.543
		(0.327)	(0.337)
private×local intervention index		0.847***	0.715***
		(0.219)	(0.226)
log(capital intensity)	0.336***	0.331***	0.333***
	(0.0361)	(0.0366)	(0.0364)
Province Dummy	YES	YES	YES
Industry Dummy	YES	YES	YES
N	3299	3299	3299
R-squared	0.905	0.906	0.907

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Dependent variable is log of sales-labor ratio at region-industry-ownership level which is the median value among all the firms in each region-industry-ownership group between the year 2011 and 2015; reference group is local SOEs whose central state share is lower than local state share; dummy variable *soe_central* equals 1 if it is the region-industry level sales-capital ratio for SOEs whose central state share is larger than or equal to local state share, otherwise it is 0; dummy variable *private* equals 1 if it is the region-industry level sales-captial ratio for private firms, otherwise it is 0; *log(capital intensity)* is the log of capital-labor ratio at region-industry-ownership level which is the median value among all the firms in each region-industry-ownership group between the year 2011 and 2015.

3.3.3 Land Wedge

Industrial land use rights are often sold by local government at a much lower price than residential land use rights (Bai et al., 2020a). So, it would be interesting to check if industrial policies are implemented through land subsidy. Different from annual survey of industrial firms, the SAT data provides data on land used by each firm. The summary statistics are reported in Table 12.

Table 12: Land Distribution

	Private	Central SOE	Local SOE
Share of Firms with Land Data	36.2%	61.3%	54.1%
Land Allocation	62.5%	15.7%	21.8%

Notes: First row shows share of firms that report land usage data for each ownership type. Second row shows land distribution across ownership types and row sum is 100%.

We run the same regressions as those in Table 11 for land productivity. The results are reported in Table 13. Like labor productivity, land productivity of central SOEs is higher than local SOEs and private firms. The result is robust to capital intensity. Again, if we assume that the labor productivity premium is all driven by markups, the same difference in markups can explain about three quarters of the land productivity gap between central and local SOEs. There is no significant correlation between land productivity and central intervention index for local SOEs and private firms. The correlation turns positive for central SOEs, indicating that central SOEs pay higher land prices in the industries that should be supported by central industrial policy. All these are against land subsidy as central industrial policy. The correlations between land productivity and local intervention index are similar to those for capital and labor productivity. Local SOEs are associated with lower land productivity in the industries with higher local intervention index and the correlations are much weaker for central SOEs and private firms[12].

In summary, we find (1) no evidence for central industrial policy implemented by capital, labor or land subsidy; (2) evidence consistent with local industrial policy implemented by subsidizing local SOEs.

3.3.4 Welfare Analysis

Proposition 4 provides a simple way to assess the magnitude of welfare losses caused by decentralized industrial policies. We look at a specific local industrial policy: Subsidizing local SOEs by the correlations between wedges and local intervention index.

[12]The regression results without capital intensity are reported in the Appendix E.1.

Table 13: Land Wedge and Intervention Index: Add Controls

	(1)	(2)	(3)
soe_central	0.433***	0.449***	0.432***
	(0.0761)	(0.0766)	(0.0762)
private	0.195***	0.202***	0.199***
	(0.0559)	(0.0547)	(0.0549)
central intervention index	0.849		1.064*
	(0.574)		(0.581)
soe_central×central intervention index	1.369**		1.261**
	(0.578)		(0.598)
private×central intervention index	0.723*		0.505
	(0.434)		(0.434)
local intervention index		-1.156***	-1.098***
		(0.351)	(0.368)
soe_central×local intervention index		0.712	0.508
		(0.572)	(0.583)
private×local intervention index		0.935***	0.883**
		(0.357)	(0.376)
log(capital intensity)	-0.159***	-0.155***	-0.161***
	(0.0446)	(0.0439)	(0.0441)
Province Dummy	YES	YES	YES
Industry Dummy	YES	YES	YES
N	3116	3116	3116
R-squared	0.896	0.895	0.896

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Dependent variable is log of sales-land ratio at region-industry-ownership level which is the median value among all the firms in each region-industry-ownership group between the year 2011 and 2015; reference group is local SOEs whose central state share is lower than local state share; dummy variable *soe_central* equals 1 if it is the region-industry level sales-capital ratio for SOEs whose central state share is larger than or equal to local state share, otherwise it is 0; dummy variable *private* equals 1 if it is the region-industry level sales-captial ratio for private firms, otherwise it is 0; *log(capital intensity)* is the log of capital-labor ratio at region-industry-ownership level which is the median value among all the firms in each region-industry-ownership group between the year 2011 and 2015.

Define

$$Spending^L_{nk} = \alpha_{nk}\tau_{nk}$$

$$\tau_{nk} = share^{lsoe}_{nk} \times \tau^{lsoe}_{nk} = share^{lsoe}_{nk} \times (0.4\tau^{capital}_{nk} + 0.5\tau^{labor}_{nk} + 0.1\tau^{land}_{nk})$$

$$\tau^{i}_{nk} = \beta^{i}_{local} \times (\zeta^L_{nk} - \bar{\zeta})$$

where $i \in \{capital, labor, land\}$; $\beta^{capital}_{local}$ β^{labor}_{local} and β^{land}_{local} are the sensitivity of the intensity of capital, labor and land subsidy to local intervention index, – i.e., the absolute value of the estimated coefficient of local intervention index in the last column of Table 10, 11 and 13; $share^{lsoe}_{nk}$ is the value-added share of local SOEs in region n industry k and ζ^L_{nk} is our local intervention index for the region-industry pair. The capital, labor and land output shares are set to 0.4, 0.5 and 0.1, respectively. $\bar{\zeta}$ is the minimum local intervention index. The idea is to set zero subsidy for local SOEs in the region-industry pair $\zeta = \bar{\zeta}$.

$Spending^L_{nk}$ consists of capital, labor and land subsidy to local SOEs. The average wedge at the region-industry level is 5.7%. Total subsidies as a share of GDP is 3%. Applying Proposition 4, we find a aggregate welfare gain of 0.2 percentage points by subsidizing local SOEs following the above formula. If we instead allocate the same amount of subsidies across industries by central intervention index, keeping the sensitivity of the policy intensity to central intervention index the same as that to local invention index, the aggregate welfare gain would be doubled.

4 Conclusion

Many industrial policies are decentralized and implemented on the policy platforms administered by local governments. This paper derives sufficient statistics that guides centralized and decentralized industrial policies. We find that the statistics can predict the intensity of central and local industrial policies enacted by the respective government. Moreover, the predictive power increases in fiscal autonomy of the local government. Delegating decisions to regional governments in a large, multi-region economy such as China can cause significant welfare losses at the aggregate level.

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A Intervention Index

Table A.1: Industry Classification in Input-Output Table: Agriculture and Secondary Sectors

Classification	Code in IO Table	2-Digit Code (2011 version)
Farming, Forestry, Animal Production and Fishery	1	1-5
Mining and Washing of Coal	2	6
Extraction of Crude Petroleum and Natural Gas	3	7
Mining of Metal Ores	4	8-9
Mining and Quarrying of Nonmetallic Mineral and Other Mineral	5	10-12
Manufacture of Food and Tobacco	6	13-16
Manufacture of Textiles	7	17
Manufacture of Textile Wearing Apparel, Footwear, Leather, Fur, Feather and Its Products	8	18-19
Processing of Timbers and Manufacture of Furniture	9	20-21
Papermaking, Printing and Manufacture of Articles for Culture, Education and Sports Activities	10	22-24
Manufacture of Refined Petroleum, Coke Products, Processing of Nuclear Fuel	11	25
Manufacture of Chemicals and Chemical Products	12	26-29
Manufacture of Nonmetallic Mineral Products	13	30
Manufacture and Processing of Metals	14	31-32
Manufacture of Fabricated Metal Products, Except Machinery and Equipment	15	33
Manufacture of General-Purpose Machinery	16	34
Manufacture of Special-Purpose Machinery	17	35
Manufacture of Transport Equipment	18	36-37
Manufacture of Electrical Machinery and Apparatus	19	38
Manufacture of Communication Equipment, Computer and Other Electronic Equipment	20	39
Manufacture of Measuring Instruments	21	40
Other Manufacture	22	41
Scrap and Waste	23	42
Repair of Fabricated Metal Products, Machinery and Equipment	24	43
Production and Supply of Electricity and Steam	25	44
Production and Distribution of Gas	26	45
Production and Distribution of Water	27	46
Construction	28	47-50

Table A.2: Industry Classification in Input-Output Table: Service Sector

Classification	Code in IO Table	2-Digit Code (2011 version)
Wholesale and Retail Trade	29	51-52
Transport, Storage and Post	30	53-60
Accommodation, Food and Beverage Services	31	61-62
Information Transmission, Software and Information Technology Services	32	63-65
Finance	33	66-69
Real Estate	34	70
Renting and Leasing, Business Services	35	71-72
Scientific Research and Development, Technical Services	36	73-75
Management of Water Conservancy, Environment and Public Facilities	37	76-78
Services to Households, Repair and Other Services	38	79-81
Education	39	82
Health Care and Social Work Activities	40	83-84
Culture, Sports and Entertainment	41	85-89
Public Management, Social Security and Social Organization	42	90-95

Table A.3: Central Intervention Index

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
share of sales as local input	0.303***	0.134***	0.282***	0.264***	0.207***	0.227***	0.202***	0.228***
	(0.00863)	(0.0122)	(0.00776)	(0.0130)	(0.00599)	(0.0108)	(0.00582)	(0.0108)
share of sales as non-local input			0.397***	0.235***	0.249***	0.199***	0.227***	0.199***
			(0.0235)	(0.0168)	(0.0128)	(0.0122)	(0.0115)	(0.0122)
index_central					0.832***	0.469***	0.632***	0.471***
					(0.0353)	(0.0411)	(0.0487)	(0.0409)
index_central_nonlocal							0.345***	0.0744
							(0.0518)	(0.0912)
Province Dummy	YES	YES	YES	YES	YES	YES	YES	YES
Industry Dummy	NO	YES	NO	YES	NO	YES	NO	YES
N	1273	1273	1273	1273	1273	1273	1273	1273
R-squared	0.610	0.953	0.820	0.967	0.935	0.981	0.942	0.981

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Dependent variables in all the columns are central intervention indices.

B State Share: Trimmed Sample

Table B.1: State Share and Intervention Index (trim)

	log(central state share)			log(local state share)		
	(1)	(2)	(3)	(4)	(5)	(6)
central intervention index	2.230***		2.128***	0.885		0.613
	(0.597)		(0.610)	(0.539)		(0.542)
local intervention index		0.843	0.427		1.210**	1.084**
		(0.672)	(0.678)		(0.501)	(0.486)
Province Dummy	YES	YES	YES	YES	YES	YES
Industry Dummy	NO	NO	NO	NO	NO	NO
N	1048	1048	1048	1111	1111	1111
R-squared	0.272	0.253	0.273	0.130	0.137	0.140

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table B.2: State Share and Intervention Index: Regional Results (trim)

	log(central state share)			log(local state share)		
	(1)	(2)	(3)	(4)	(5)	(6)
			Panel A: East			
central intervention index	1.313		0.0367	-0.0498		-1.209
	(0.989)		(1.118)	(0.903)		(0.957)
local intervention index		2.986**	2.972**		2.424**	2.895***
		(1.209)	(1.368)		(0.956)	(0.995)
N	351	351	351	364	364	364
R-squared	0.323	0.355	0.355	0.0488	0.0878	0.0958
			Panel B: Central			
central intervention index	2.884***		3.135***	1.779**		1.805**
	(1.080)		(1.040)	(0.881)		(0.864)
local intervention index		-0.759	-1.161		-0.0167	-0.169
		(0.822)	(0.720)		(0.648)	(0.572)
N	214	214	214	218	218	218
R-squared	0.161	0.122	0.173	0.219	0.194	0.219
			Panel C: West & Northeast			
central intervention index	3.282***		3.240***	1.923***		1.895***
	(0.774)		(0.787)	(0.586)		(0.592)
local intervention index		-0.969	-0.822		0.564	0.474
		(0.651)	(0.663)		(0.527)	(0.506)
N	483	483	483	529	529	529
R-squared	0.142	0.0764	0.148	0.189	0.153	0.192
Province Dummy	YES	YES	YES	YES	YES	YES
Industry Dummy	NO	NO	NO	NO	NO	NO

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: East area covers 10 provinces: 4 provinces (Beijing, Tianjin, Hebei and Shandong) in Circum-Bohai-Sea, 3 provinces (Shanghai, Jiangsu and Zhejiang) in Yangtze River Delta, and another 3 provinces (Fujian, Guangdong and Hainan) in southeastern costal region; Central area includes 6 provinces: Shanxi, Anhui, Jiangxi, Henan, Hubei and Hunan; the remaining 15 provinces are in West & Northeast area.

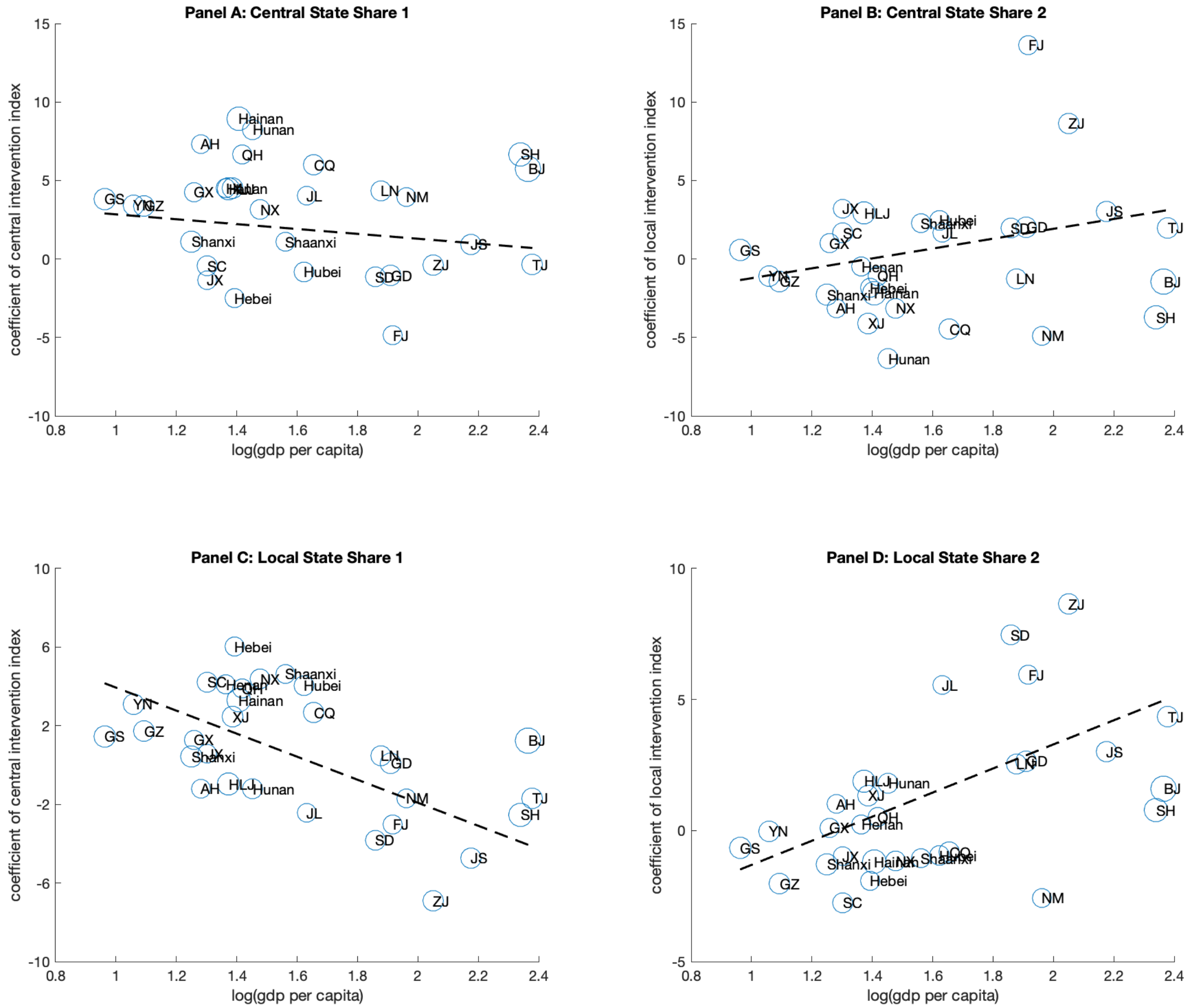

Figure B.1: State Share Sensitivity to Intervention Index: Provincial Variation (trim)

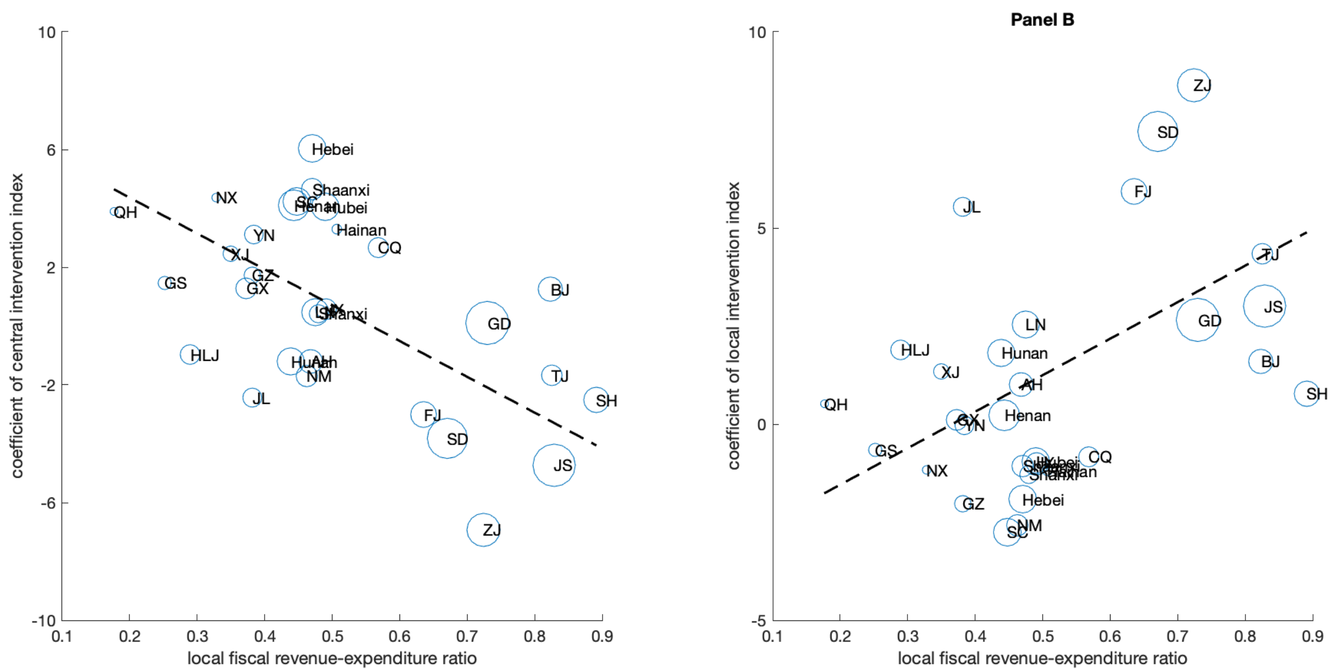

Figure B.2: Local State Share Sensitivity to Intervention Index: Provincial Variation (trim)

C Capital Productivity: Robustness Check

Table C.1: Capital Productivity and Intervention Index 2

	(1)	(2)	(3)
soe_central	0.318***	0.306***	0.322***
	(0.0328)	(0.0334)	(0.0327)
private	0.667***	0.671***	0.673***
	(0.0262)	(0.0260)	(0.0259)
central intervention index	-0.202		0.0294
	(0.301)		(0.305)
soe_central×central intervention index	0.105		-0.0628
	(0.365)		(0.376)
private×central intervention index	1.156***		0.940***
	(0.219)		(0.224)
local intervention index		-1.115***	-0.999***
		(0.169)	(0.176)
soe_central×local intervention index		0.725***	0.757***
		(0.235)	(0.247)
private×local intervention index		1.051***	0.918***
		(0.179)	(0.187)
Province Dummy	YES	YES	YES
Industry Dummy	YES	YES	YES
Year Dummy	YES	YES	YES
N	15221	15221	15221
R-squared	0.911	0.910	0.911

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Dependent variable is log of sales-capital ratio at region-industry-ownership level which is the median value among all the firms in each region-industry-ownership group between the year 2011 and 2015; reference group is local SOEs whose central state share is lower than local state share; dummy variable *soe_central* equals 1 if it is the region-industry level sales-capital ratio for SOEs whose central state share is larger than or equal to local state share, otherwise it is 0; dummy variable *private* equals 1 if it is the region-industry level sales-captial ratio for private firms, otherwise it is 0.

D Labor Productivity

D.1 Benchmark Method: No Controls

Table D.1: Labor Productivity and Intervention Index

	(1)	(2)	(3)
soe_central	0.401***	0.385***	0.385***
	(0.0601)	(0.0606)	(0.0597)
private	-0.278***	-0.303***	-0.302***
	(0.0392)	(0.0388)	(0.0386)
central intervention index	-0.599		-0.420
	(0.500)		(0.480)
soe_central×central intervention index	0.932**		0.873*
	(0.440)		(0.453)
private×central intervention index	1.016***		0.883**
	(0.354)		(0.353)
local intervention index		-0.932***	-0.810***
		(0.208)	(0.206)
soe_central×local intervention index		0.433	0.293
		(0.351)	(0.360)
private×local intervention index		0.649***	0.519**
		(0.223)	(0.225)
Province Dummy	YES	YES	YES
Industry Dummy	YES	YES	YES
N	3299	3299	3299
R-squared	0.888	0.889	0.889

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Dependent variable is log of sales-labor ratio at region-industry-ownership level which is the median value among all the firms in each region-industry-ownership group between the year 2011 and 2015; reference group is local SOEs whose central state share is lower than local state share; dummy variable *soe_central* equals 1 if it is the region-industry level sales-capital ratio for SOEs whose central state share is larger than or equal to local state share, otherwise it is 0; dummy variable *private* equals 1 if it is the region-industry level sales-captial ratio for private firms, otherwise it is 0.

D.2 Robustness Check

Table D.2: Labor Productivity and Intervention Index: Add Controls 2

	(1)	(2)	(3)
soe_central	0.343***	0.339***	0.345***
	(0.0282)	(0.0284)	(0.0280)
private	0.109***	0.110***	0.113***
	(0.0272)	(0.0270)	(0.0270)
central intervention index	-0.428		-0.210
	(0.271)		(0.270)
soe_central×central intervention index	0.600**		0.472*
	(0.237)		(0.241)
private×central intervention index	1.035***		0.848***
	(0.180)		(0.182)
local intervention index		-1.072***	-0.960***
		(0.119)	(0.123)
soe_central×local intervention index		0.657***	0.590***
		(0.184)	(0.191)
private×local intervention index		0.892***	0.770***
		(0.138)	(0.143)
log(capital intensity)	0.430***	0.428***	0.429***
	(0.0228)	(0.0226)	(0.0227)
Province Dummy	YES	YES	YES
Industry Dummy	YES	YES	YES
Year Dummy	YES	YES	YES
N	15221	15221	15221
R-squared	0.848	0.848	0.849

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Dependent variable is log of sales-labor ratio at region-industry-ownership level which is the median value among all the firms in each region-industry-ownership group between the year 2011 and 2015; reference group is local SOEs whose central state share is lower than local state share; dummy variable *soe_central* equals 1 if it is the region-industry level sales-capital ratio for SOEs whose central state share is larger than or equal to local state share, otherwise it is 0; dummy variable *private* equals 1 if it is the region-industry level sales-captial ratio for private firms, otherwise it is 0; *log(capital intensity)* is the log of capital-labor ratio at region-industry-ownership level which is the median value among all the firms in each region-industry-ownership group between the year 2011 and 2015.

Table D.3: Labor Productivity and Intervention Index 2

	(1)	(2)	(3)
soe_central	0.417***	0.414***	0.415***
	(0.0303)	(0.0306)	(0.0304)
private	-0.283***	-0.283***	-0.281***
	(0.0214)	(0.0213)	(0.0213)
central intervention index	-0.546		-0.372
	(0.333)		(0.328)
soe_central×central intervention index	0.852***		0.796***
	(0.234)		(0.241)
private×central intervention index	0.971***		0.842***
	(0.188)		(0.188)
local intervention index		-0.896***	-0.780***
		(0.117)	(0.119)
soe_central×local intervention index		0.409**	0.282
		(0.194)	(0.200)
private×local intervention index		0.632***	0.508***
		(0.147)	(0.150)
Province Dummy	YES	YES	YES
Industry Dummy	YES	YES	YES
Year Dummy	YES	YES	YES
N	15221	15221	15221
R-squared	0.800	0.801	0.801

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Dependent variable is log of sales-labor ratio at region-industry-ownership level which is the median value among all the firms in each region-industry-ownership group between the year 2011 and 2015; reference group is local SOEs whose central state share is lower than local state share; dummy variable *soe_central* equals 1 if it is the region-industry level sales-capital ratio for SOEs whose central state share is larger than or equal to local state share, otherwise it is 0; dummy variable *private* equals 1 if it is the region-industry level sales-captial ratio for private firms, otherwise it is 0.

E Land Productivity

E.1 Benchmark Method: No Controls

Table E.1: Land Productivity and Intervention Index

	(1)	(2)	(3)
soe_central	0.400***	0.389***	0.374***
	(0.0764)	(0.0746)	(0.0741)
private	0.252***	0.218***	0.216***
	(0.0543)	(0.0518)	(0.0520)
central intervention index	0.734		0.933
	(0.579)		(0.588)
soe_central×central intervention index	1.277**		1.158*
	(0.619)		(0.642)
private×central intervention index	0.762*		0.559
	(0.429)		(0.430)
local intervention index		-1.108***	-1.040***
		(0.348)	(0.365)
soe_central×local intervention index		0.713	0.527
		(0.571)	(0.587)
private×local intervention index		0.873**	0.811**
		(0.354)	(0.373)
Province Dummy	YES	YES	YES
Industry Dummy	YES	YES	YES
N	3116	3116	3116
R-squared	0.894	0.893	0.894

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Dependent variable is log of sales-land ratio at region-industry-ownership level which is the median value among all the firms in each region-industry-ownership group between the year 2011 and 2015; reference group is local SOEs whose central state share is lower than local state share; reference group is local SOEs whose central state share is lower than local state share; dummy variable *soe_central* equals 1 if it is the region-industry level sales-capital ratio for SOEs whose central state share is larger than or equal to local state share, otherwise it is 0; dummy variable *private* equals 1 if it is the region-industry level sales-captial ratio for private firms, otherwise it is 0.

E.2 Robustness Check

Table E.2: Land Productivity and Intervention Index: Add Controls 2

	(1)	(2)	(3)
soe_central	0.446***	0.460***	0.445***
	(0.0386)	(0.0389)	(0.0388)
private	0.177***	0.183***	0.181***
	(0.0289)	(0.0285)	(0.0286)
central intervention index	0.803**		1.006***
	(0.315)		(0.319)
soe_central×central intervention index	1.388***		1.282***
	(0.311)		(0.322)
private×central intervention index	0.820***		0.613***
	(0.230)		(0.230)
local intervention index		-1.121***	-1.047***
		(0.194)	(0.201)
soe_central×local intervention index		0.700**	0.493
		(0.304)	(0.311)
private×local intervention index		0.900***	0.833***
		(0.197)	(0.206)
log(capital intensity)	-0.126***	-0.122***	-0.126***
	(0.0216)	(0.0216)	(0.0216)
Province Dummy	YES	YES	YES
Industry Dummy	YES	YES	YES
Year Dummy	YES	YES	YES
N	13927	13927	13927
R-squared	0.850	0.849	0.851

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Dependent variable is log of sales-land ratio at region-industry-ownership level which is the median value among all the firms in each region-industry-ownership group between the year 2011 and 2015; reference group is local SOEs whose central state share is lower than local state share; dummy variable *soe_central* equals 1 if it is the region-industry level sales-capital ratio for SOEs whose central state share is larger than or equal to local state share, otherwise it is 0; dummy variable *private* equals 1 if it is the region-industry level sales-captial ratio for private firms, otherwise it is 0; *log(capital intensity)* is the log of capital-labor ratio at region-industry-ownership level which is the median value among all the firms in each region-industry-ownership group between the year 2011 and 2015.

Table E.3: Land Productivity and Intervention Index 2

	(1)	(2)	(3)
soe_central	0.429***	0.442***	0.429***
	(0.0385)	(0.0388)	(0.0387)
private	0.229***	0.232***	0.233***
	(0.0284)	(0.0281)	(0.0281)
central intervention index	0.720**		0.912***
	(0.316)		(0.320)
soe_central×central intervention index	1.312***		1.196***
	(0.324)		(0.336)
private×central intervention index	0.840***		0.643***
	(0.229)		(0.230)
local intervention index		-1.088***	-1.009***
		(0.191)	(0.199)
soe_central×local intervention index		0.703**	0.511
		(0.303)	(0.312)
private×local intervention index		0.857***	0.784***
		(0.195)	(0.204)
Province Dummy	YES	YES	YES
Industry Dummy	YES	YES	YES
Year Dummy	YES	YES	YES
N	13927	13927	13927
R-squared	0.848	0.848	0.849

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Dependent variable is log of sales-land ratio at region-industry-ownership level which is the median value among all the firms in each region-industry-ownership group between the year 2011 and 2015; reference group is local SOEs whose central state share is lower than local state share; dummy variable *soe_central* equals 1 if it is the region-industry level sales-capital ratio for SOEs whose central state share is larger than or equal to local state share, otherwise it is 0; dummy variable *private* equals 1 if it is the region-industry level sales-captial ratio for private firms, otherwise it is 0.