The Plant-Level View of an Industrial Policy: The Korean Heavy Industry Drive of 1973*

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Abstract

Does industrial policy work? We evaluate Korean government's promotion of heavy and chemical industries in the 1970s. Output and input use of targeted industries/regions grew significantly faster than those of non-targeted ones. However, their total factor productivity did not grow faster because the resource misallocation across plants within targeted industries/regions got significantly worse, especially among entrants. We also provide evidence on how industrial policy reshaped the economy: (i) establishment size distribution of targeted industries/regions shifted right due to the entry of large establishments; (ii) the targeted industries became more important in the economy's input-output structure.

Keywords: Industrial Policy, Industrial Complex, Misallocation
JEL Codes: O14, O25, O53

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1 Introduction

During the East Asian growth miracle period, governments were heavily involved in the economy and selectively nurtured specific industries (Rodrik, 1995). However, there is no definitive answer about the effectiveness of industrial interventions (Noland and Pack, 2003; Harrison and Rodríguez-Clare, 2010; Rodrik, 2012; Bartelme et al., 2021). Using newly digitized microdata, we re-visit Korea's industrial policy during the 1970s. Relative to previous research that relied on industry-level data, e.g. Lee (1996) and Lane (2021), we make progress in two ways. First, we utilize the fact that the policy targeted not only specific industries but also specific regions. This place-based nature of the policy is crucial for understanding the effectiveness of industrial policy. Second, we provide the first analysis of the pattern of resource allocation across manufacturing plants under the policy.

The policy in question is the 1973–1979 heavy and chemical industry drive, launched by the government in 1973 for at least two reasons. First, North Korea's military provocations and the partial pullout of the US troops from South Korea in 1971 motivated the government to strengthen its military capabilities by promoting defense industries and their upstream industries (Ahn and Kim, 1995; Lane, 2021). The other motivation was to promote export, with the explicit target annual export of 10 billion US dollars. The government had been influenced by Japan's experience in this regard. By switching from the labor-intensive, light industries to heavy and chemical industries in 1957, Japan's annual export exceeded 10 billion dollars by 1967. Government support for the targeted industries in Korea came in various forms, including tax incentives, subsidized long-term loans, and the construction of industrial complexes. The policy did not last. After the assassination of President Park in 1979, the next regime adopted private sector-led growth as the pillar of their economic policy, following a period of "rationalization" that reversed the excess investment in the heavy and chemical industries (SaKong and Koh, 2010).

Because the heavy industry drive represents an abrupt change in the government's policy direction in 1973, we utilize a difference-in-differences specification to evaluate the impact of the policy on the targeted industries/regions relative to the non-targeted ones.

Our main findings are as follows. First, under the policy, the output, input use, and labor productivity of the targeted industry-region pairs grew significantly faster than those of the non-targeted ones, while the number of plants did not show differential growth. The differential outcomes between the targeted and the non-targeted industries/regions did not follow a divergent pre-trend, supporting a causal interpretation. Second, while the plant-level total factor productivity (TFP) rose significantly for the plants in the targeted industries/regions, the TFP at the industry-region level did not change relative to that of the non-targeted ones. The reason is that the allocative efficiency worsened significantly within the targeted industries/regions, with production activities growing more concentrated but not necessarily toward the plants with the highest productivity. The misallocation was especially severe among the plants in the targeted industries/regions that entered during the policy period. This evidence is consistent with the rise of large business groups (known as *chaebols*) and the cross-subsidization practices of their business units during this period (SaKong and Koh, 2010). A simple accounting exercise following Hsieh and Klenow (2009) shows that, if the degree of misallocation within the targeted industries/regions relative to the degree within the non-targeted ones had remained the same between 1968 and 1980, the average TFP of the targeted industries/regions would have been 40 percent higher in 1980.

We also provide new evidence on the ways in which industrial policy reshapes the economy. First, the establishment size distribution of the targeted industries/regions shifted right (i.e., larger establishments), with the right tail becoming noticeably thicker. The shift is mostly accounted for by the entry of large plants. This is consistent with what happens in models of technology adoption (Buera et al., 2021), although in our data the relationship between plants' productivity and size became more misaligned under the policy. Second, the input-output structure of the economy evolved in a way that the targeted industries significantly increased their output multipliers. To the best of our knowledge, this is the first evidence drawing attention to the evolution of an economy's input-output structure.[1] Using the formula of Fadinger et al. (forthcoming), we calculate that this change in the input-output structure accounted for about one-third of the TFP growth of the entire Korean manufacturing sector between 1970 and 1980. In this vein, the differential impact of the policy we identify may significantly underestimate the overall impact of the policy on the economy.

The impact of the policy outlasted the policy itself. The impact on output, input, labor productivity, establishment size, and input-output structure remained nearly intact until 1990. One exception is the degree of misallocation within the targeted industries/regions. It fell significantly with the reversal of the policy after 1979, but nevertheless remained above its pre-policy level.

Then, was the heavy industry drive a success? One conclusion we can safely draw without a full cost-benefit analysis is that the policy would have had a more positive effect if the promotion of the targeted industries/regions had not come with a rise in concentration and misallocation within them.

[1] Liu (2019) and Lane (2021) used the input-output structure in 1970 to consider the effectiveness of Korea's industrial policy.

Related Literature. This paper contributes to a long-standing debate on industrial policy. Until recently, econometric evaluations were rare—see the review of Lane (2020). Using quasi-experimental designs, Giorcelli (2019), Hanlon (2020), and Juhász (2018) evaluated the effectiveness of historical policies. Aghion et al. (2015), Criscuolo et al. (2019), Manelici and Pantea (2021), and Rotemberg (2019) quantify the impact of contemporary interventions. Also related is the literature exploring the impact of policy changes on resource allocation within a country, in particular the liberalization of capital flows (Gopinath et al., 2017; Bau and Matray, 2020).

Our analysis also helps settle the debate on the Korean industrial policy, which had often been hailed as a success (for example, Kim and Leipziger, 1997). Analyzing industry-level variables, Lane (2021) concluded that the heavy industry drive of 1973 raised output and labor productivity of the targeted industries and their downstream industries. This contrasts with Lee (1996), who documented a negative relationship between policy interventions and industry-level outcomes. We find that the heavy industry drive of 1973 increased output but did not increase the TFP of targeted industries, because of worsened resource misallocation within the targeted industries and regions.[2]

2 Background

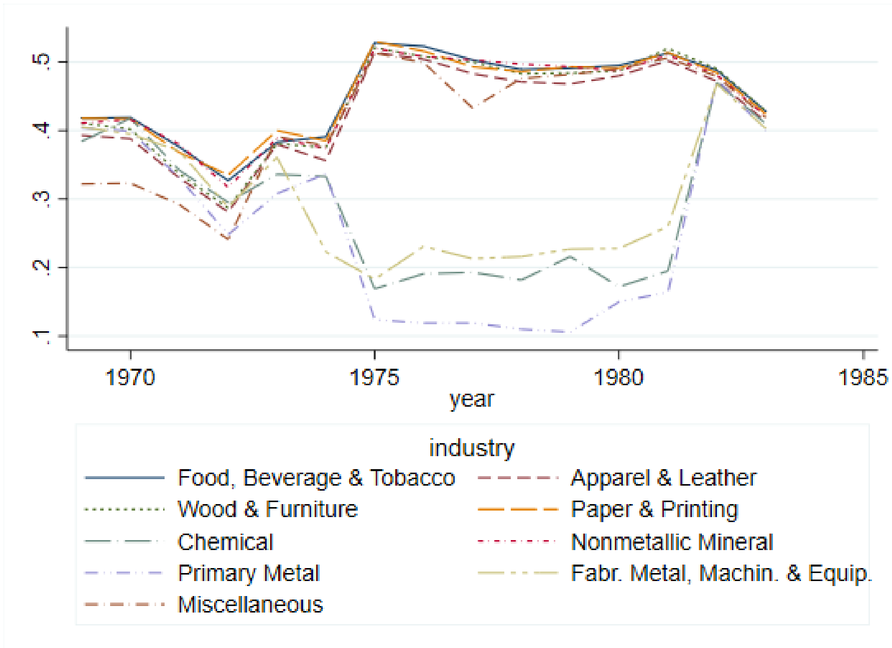
During the rapid industrialization and globalization of the Korean economy, the direction of the government policy changed abruptly multiple times. A systematic effort to jump-start the economy was inaugurated in 1962 in the form of the first Five-Year Plan, which focused on infrastructure and labor-intensive industries such as garments and textiles. The heavy industry drive of 1973, partly motivated by the Nixon doctrine and North Korea's military provocations (Woo, 1991) and partly by Japan's successful export promotion in the previous decade, was a monumental shift. President Park Chung-hee stated in January 1973 that "the government is announcing the Heavy and Chemical Industry project. To achieve a 10-billion-dollar target of annual exports by the early 1980s, [...] the government will accelerate the promotion of HCIs such as steel, shipbuilding and petrochemical industries, and thereby increase their exports" (Park, 2005).[3]

Figure 1 shows the two main instruments of the heavy industry drive. Panel (a) shows the effective tax rates across nine industries from Kwack (1985), who constructed them from the relevant legislation promoting investment in targeted industries. During the policy

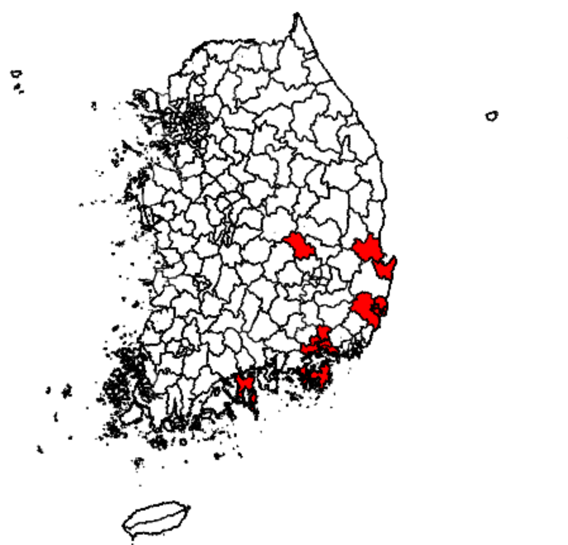
[2] Choi and Levchenko (2021) use firm-level data from the 1970s and find that the effect of industrial policy at the firm level persisted through the 2010s.

[3] The annual export goal of 10 billion dollars was achieved in 1977, well ahead of schedule.

Figure 1: Policies Targeting Industries and Regions



(a) Effective Tax Rates



(b) Construction of Industrial Complexes in Korea

Notes: Panel (a) is the effective tax rates for nine broad industry categories from 1969 to 1983. These numbers are calculated and reported by Kwack (1985). He computed the effective corporate tax rates using the investment deduction, depreciation schedule (including accelerated depreciation), tax holiday, and reserve allowance (a form of deferred tax payment) by industry in the tax law. Targeted industries in panel (a) were "Chemical," "Primary Metal," and "Fabricated Metal Products, Machinery and Equipment." Panel (b) shows the location of the nine industrial complexes planned and built during the policy period: Changwon, Yeocheon, Onsan, Okpo, Anjeong, Jukdo, Ulsan, Pohang, and Gumi.

period, there was a stark divergence in effective tax rates between targeted and non-targeted industries.

Panel (b) shows the locations of industrial complexes during the policy period. In February 1974, the government established the Korean Industrial Complex Corporation, charged with the construction of industrial sites and the necessary infrastructure for targeted industries. The government invested 100 billion won (247 million US dollars in 1974) in the Corporation, which had special privileges, including tax exemption, the right to appropriate land, and access to international capital markets (SaKong and Koh, 2010). Six locations (Changwon, Yeocheon, Onsan, Okpo, Anjeong, Jukdo) were initially chosen. Two other places (Ulsan, Pohang) were added in late 1974 and another (Gumi) in 1977. These areas had previously been remote rural areas but grew rapidly under the policy.

The heavy industry drive of 1973 ended suddenly after President Park was assassinated in October 1979. The new regime drastically changed the policy direction. President Chun Doo-hwan adopted "stability" and "private sector-led growth" as its slogan (Woo, 1991), embodied in the fifth Five-Year Plan (1982–1986). Figure 1(a) shows that the gap in effective tax rates across industries disappeared by 1982. The goal of regional development also shifted from promoting heavy industries in the 1970s to curbing concentration in the Seoul metropolitan area in the 1980s.

3 Data

We use Statistics Korea's annual Mining and Manufacturing Survey (MMS) from 1967 to 1987, except for the two missing years of 1970 and 1972.[4] MMS covers all establishments with at least five employees in the mining and manufacturing sector. Plant-level data includes gross output, fixed assets, number of employees, wage bills, costs of intermediate inputs and location at the province level. Prior to 1978, the fixed asset data is available in only one year, 1968.[5]

We convert nominal gross output and intermediate input values to real measures using industry-level producer price indices from the Bank of Korea (BOK). We then harmonized

[4]MMS started in 1967. Even though there were other surveys covering mining and manufacturing establishments before 1967, plant-level microdata is only available from MMS. We include eight more years in the sample after the demise of the policy in 1979, to see whether it had longer-lasting effects. A democratic uprising in 1987 and the Roh Tae-Woo administration's guiding principle of "economic democratization" drastically changed the structure of the Korean economy and the economic policy, so we do not include the post-1987 period in the study.

[5]The annual report on MMS published by the Economic Planning Board of Korea reports industry-level aggregates based on this microdata. Lane (2021) used this industry-level data at the five-digit level from 1970 to 1986.

them to match industries between the BOK classification and the Korean Standard Industry Classification (KSIC). Real value added is defined as real gross output minus real intermediate input. Capital stock is the sum of the total fixed asset values of building structures, machinery, and transport equipment. The deflator for each type of capital stock is calculated using nominal and real values of the gross capital formation in national accounts from the BOK.

MMS's industrial classification is at the four-digit (before 1970) or five-digit level (since 1970) of the KSIC. During our sample period, the KSIC was revised four times (Revision 2 in 1968, 3 in 1970, 4 in 1975, and 5 in 1984). We constructed a harmonized three-digit industry classification using a crosswalk based on the concordance tables for each revision. We excluded establishments belonging to mining and tobacco industries.

In June 1973, the heavy industry drive committee selected six strategic industries: steel, non-ferrous metal, petrochemical, machinery, shipbuilding, and electronics. After we reviewed historical documents, we were able to determine which three-digit industries were targeted. One important caveat is that the heavy industry drive of 1973 was not the first industrial policy in Korea (Stern et al., 1995). Several of the targeted industries had been targeted before 1973, but they did not receive meaningful support due to the lack of technological expertise and financial resources. The exceptions were chemical, refined petroleum, and cement industries, which by 1973 had already some track record of growth aided by the government, often in the form of joint ventures involving foreign companies. Appendix Table A.I shows the list of industries. We marked an industry as "treated" if the industry was the target of the heavy industry drive of 1973. We also separately mark the three industries that had been materially supported by the government before 1973.

One important feature of the heavy industry drive of 1973 compared with earlier policies was that the government developed industrial complexes specializing in each of the six strategic industries. These industrial complexes were located in three eastern and southern provinces. As a result, geographic regions provide another dimension of variation that helps assess the impact of the policy. We show which regions were targeted at the province level in Appendix Table A.II.

4 Empirical Findings

4.1 Output, Input, and Productivity

We first explore the effect of the industrial policy on output, input, and productivity of targeted industry-region pairs. Out of 28 harmonized three-digit industries, 12 industries were targeted by the heavy industry drive. For our analysis, we drop the establishments in three of the 12 targeted industries (chemicals, refined petroleum, and cement), which had been materially supported by the government before 1973 to isolate the effect of the drive. As for the target region, three out of 11 provinces hosted industrial complexes for the targeted industries. We focus on the industry-region pairs with a targeted industry in a targeted region, and compare them with the industry-region pairs with a non-targeted industry in a non-targeted region.

We use a difference-in-difference estimator to estimate the impact of the policy:

$$\log Y_{ict} = \alpha + \sum_{j=\{1967-1969\}\cup\{1973-1987\}} \beta_j [D_{ic} \times \text{Year}_t^j] + \gamma_i + \delta_c + \theta_t + \epsilon_{ict} \tag{1}$$

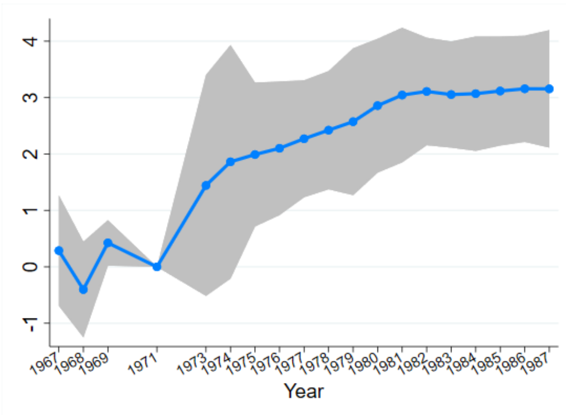
where Y_{ict} is an outcome variable for industry i in region c in year t. D_{ic} is a binary indicator equal to one if the industry and the region were treated and zero otherwise. The variables γ_i, δ_c, and θ_t are industry, region, and year fixed effects, respectively. Plant-level data does not exist for 1970 and 1972. By dropping 1971 from the regression, β_j's show the differential evolution of the targeted and the non-targeted industries/regions relative to 1971. We adjust standard errors with two-way clustering over industries and regions. The regressions are weighted by the average of outcome variables over the sample period for output and input variables. The labor productivity regression is weighted by employment and the TFP regression by value-added.

Panels (a)–(f) of Figure 2 plot the estimated β_j's in our difference-in-differences equation from 1967 to 1987 for six outcome variables.[6] Panels (a), (b), and (d) show that the targeted industries/regions and the non-targeted ones evolved similarly between 1967 and 1971. This parallel pre-trends support a causal interpretation: Without the industrial policy, the targeted industries/regions and the non-targeted ones would have evolved similarly.

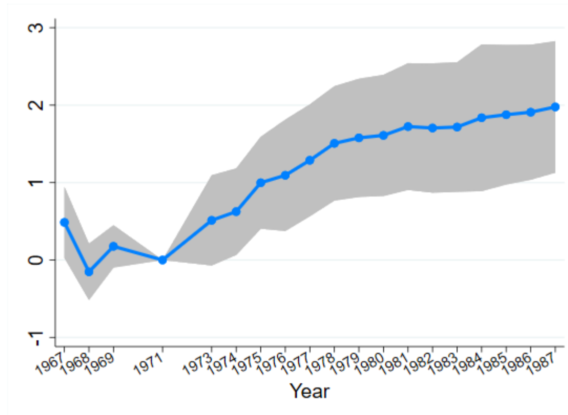
Panel (a) shows the evolution of the real value-added of the targeted industry-region pairs relative to that of the non-targeted ones. The real value-added of the targeted pairs increased significantly more during the policy period, and the difference remained through the 1980s even after the policy ended. We find similar patterns in the number of employees in Panel (b). Panel (c) shows real capital stock. The microdata for capital only exists for 1968 and for 1978 and after. Therefore, we make 1968 the baseline year for all capital related variables. Real capital stock of the targeted industries/regions increased significantly more during the policy period. Panels (a)–(c) show that the targeted industries in the targeted regions used significantly more input and produced significantly more output during and after the heavy

[6] Appendix B shows the levels (rather than the differences) of these outcome variables for the targeted and the non-targeted industries/regions.

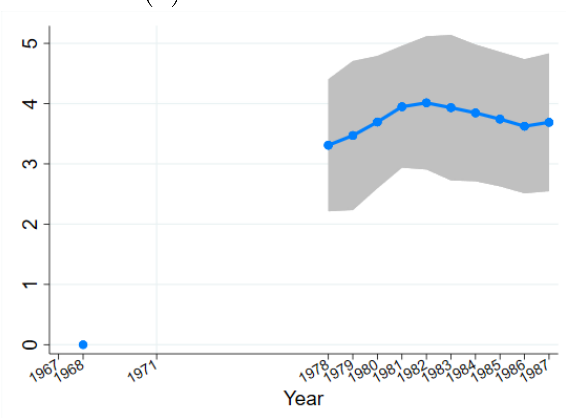
Figure 2: Output, Input, and Productivity



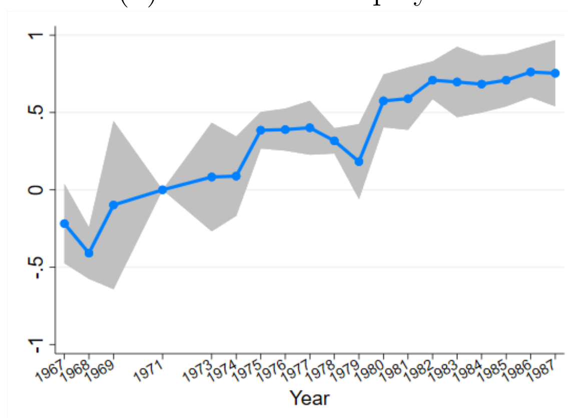
(a) Real Value-added



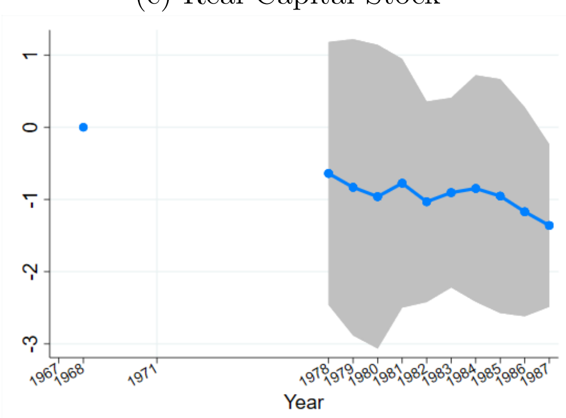
(b) Number of Employees



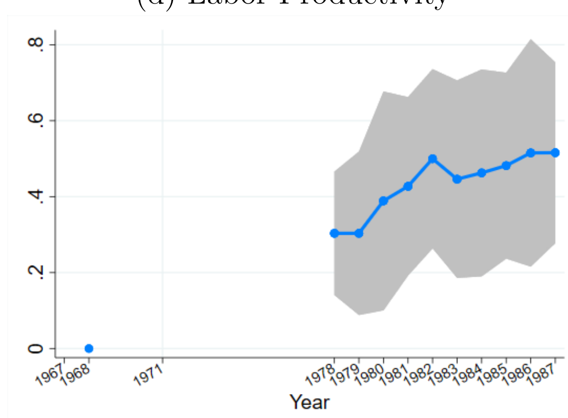
(c) Real Capital Stock



(d) Labor Productivity



(e) Total Factor Productivity



(f) Simple Average of Establishment-level TFPs

Notes: Panels (a) to (f) plot the estimated coefficients along with a 95 percent confidence interval from equation 1. The microdata does not exist in 1970 and 1972, and the year of 1971 is normalized to zero. We adjust standard errors with two-way clustering over industry and region. Regression weights are the average size of outcome variable over the sample period in panels (a), (b), and (c). We use number of employees as a regression weight for panel (d) and real value added for panel (e) and (f).

industry drive relative to the non-targeted industries in non-targeted regions. Although not shown here, these differential increases in industry/region-level output and input did not come from a differential increase in the number of establishments. We find no significant difference in the growth of the number of establishments between the targeted and the non-targeted industries/regions.

Since both output and input grew significantly more for the targeted industries/regions, it is natural to ask what happened to productivity. Panel (d) shows the labor productivity, which grew much faster in the targeted industries/regions than the non-targeted ones, consistent with a comparison of the magnitude in panels (a) and (b): The differential growth in capital is much larger than that in value-added or labor input. Panel (e) shows the industry/region-level TFP. Because the capital data is missing between 1969 and 1977, we again make 1968 the baseline. We calculate the TFP of industry-region pairs by averaging plant-level TFP with value-added as weights.[7] The TFP does not show differential growth. We conclude that the heavy industry drive of 1973 allocated significantly more factors of production into the targeted industries/regions but did not increase the TFP at the industry/region level more.[8]

However, there is more to this non-result on TFP. Panel (f) shows the unweighted average of establishment-level TFP. Unlike in panel (e), the unweighted average in the targeted industry-region pairs increased significantly more than in the non-targeted ones. In other words, the plant-level TFP increased significantly more in the targeted industries/regions during and after the policy, but resource allocation across plants within the targeted industries/regions worsened substantially, to the point where the gains in plant-level TFP were completely undone by the worsened misallocation. We investigate the allocation of resources within industry-region pairs in the next section.

Before we move on, we note that it is important to consider government interventions to industries and regions jointly. Appendix D shows the estimated β_j's when we consider only industry targets. Point estimates are moving in the same direction overall, but their magnitudes are much smaller and much of the statistical significance is lost.

4.2 Allocative Efficiency

The TFP at the industry/region level depends not only on the average productivity of establishments but also on the allocative efficiency across them. Following up on the result of stagnant industry/region-level TFP and higher plant-level TFP growth in the targeted

[7] Appendix C.1 explains plant-level TFP estimation.

[8] This result is consistent with Lee (1996), who found no correlation between tax incentives and industry-level TFP growth across sectors.

industries/regions relative to the non-targeted ones, we analyze the changes in allocative efficiency within industries/regions during and after the heavy industry drive.

We first consider the concentration of output and input in the top decile of plants. The fraction of value-added accounted for by the top decile of plants in the targeted industries/regions was 65 percent in 1968 but increased to 93 percent in 1978. The corresponding number in the non-targeted industries/regions remained around 82 percent over the same period. In the targeted industries/regions, the concentration of employment and capital input in the top decile also rose rapidly from 53 and 65 percent in 1968 to 81 and 95 percent in 1978, respectively. In contrast, the numbers stayed constant at 70 percent and 83 percent in the non-targeted industries/regions over this period. This implies that the significant growth in value-added, employment, and capital of the targeted industries/regions in Figure 2(a) to (c) was not evenly distributed across plants in them.

The rising concentration in the targeted industries/regions does not necessarily imply worsened misallocation. We can measure the degree of resource misallocation by the dispersion of revenue productivity. Foster et al. (2008) made a distinction between physical productivity (TFPQ) and revenue productivity (TFPR), and Hsieh and Klenow (2009) showed that—with parametric assumptions on preferences and technology—TFPR dispersion represents establishment-specific distortions and hence resource misallocation. We apply the methodology of Hsieh and Klenow (2009) and express the TFP at the industry-region level (indexed by s) as:

$$TFP_s = \left(\sum_{i=1}^{N_s} \left(A_{si} \frac{\overline{TFPR}_s}{TFPR_{si}} \right)^{\sigma-1} \right)^{\frac{1}{\sigma-1}} \tag{2}$$

where A_{si} is establishment i's TFPQ defined as $Y_{si}/K_{si}^{\alpha_s}(wL_{si})^{1-\alpha_s}$, $TFPR_{si}$ is defined as $P_{si}A_{si}$, and $\overline{TFPR}$ is the geometric average of the marginal revenue products of capital and labor. Assuming that TFPQ and TFPR follow a joint log-normal distribution, equation (2) gives

$$\log TFP_s = \frac{1}{\sigma - 1} \log \left(\sum_{i=1}^{N_s} A_{si}^{\sigma-1} \right) - \frac{\sigma}{2} \mathrm{var}(\log TFPR_{si}) \ . \tag{3}$$

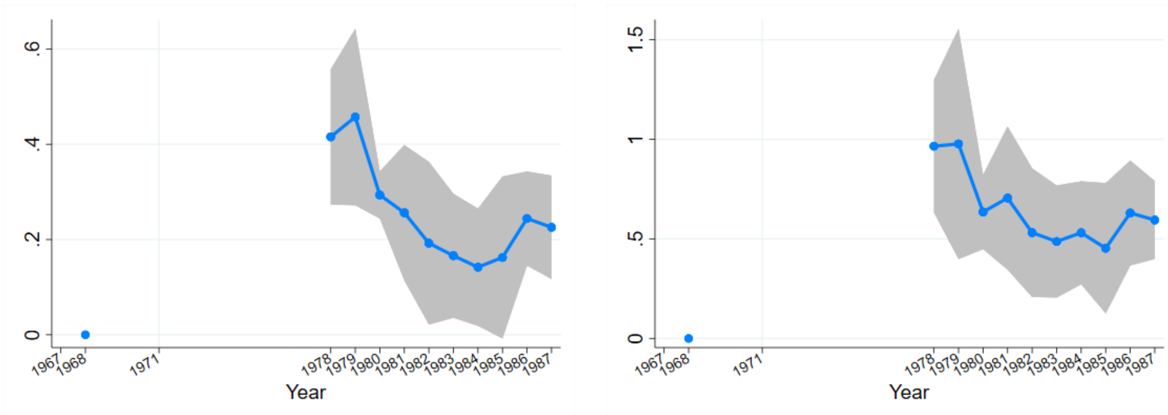
Clearly, the variance of log TFPR adversely affects the aggregate TFP.[9]

Panel (a) of Figure 3 shows the evolution of the standard deviation of TFPR in the targeted industries/regions relative to that in the non-targeted ones.[10] Although we do not know what happened during the intervening years due to the lack of micro-level capital data

[9]We use the parameter values of Kim et al. (2017), who measured the allocative efficiency of the Korean manufacturing sector for the 1982–2007 period. Appendix C.2 provides detailed information.

[10]Note that these are difference-in-differences estimates net of industry, region and time fixed effects as shown in equation (1). Measurement errors are not a concern unless they vary over time systematically between the targeted and the non-targeted groups.

Figure 3: Allocative Efficiency



(a) Standard Deviation of TFPR (b) Correlation b/w TFPR & TFPQ

Notes: Panels (a) to (b) plot estimated coefficients along with a 95 percent confidence interval from equation 1. We adjust standard errors with two-way clustering over industry and region. Regression weights are real value added.

between 1969 and 1977, the standard deviation of TFPR in the targeted industries/regions increased significantly more than in the non-targeted ones between 1968 and 1978, although it fell somewhat after 1979. We conclude that the allocative efficiency worsened in the targeted industries/regions relative to the non-targeted ones under the policy.

In addition, panel (b) shows that, in the targeted industries/regions, those plants with high TFP were subject to higher idiosyncratic distortions (positive correlation between TFPQ and TFPR) relative to the high TFP plants in the non-targeted ones under the policy. This evidence of worsening misallocation within industries/regions is consistent with the observation in Figure 2 that the weighted average of TFP in the targeted industries/regions did not increase more while the plant-level TFP did.

Overall, these results provide micro-level evidence that the heavy industry drive may have come at the cost of worsening resource misallocation within the targeted industries/regions, undoing any positive effect it had on plant-level productivity. The lack of data on the ownership of plants preclude us from investigating resource allocation across business groups (*chaebols*). Anecdotally, the chaebols took advantage of the new opportunities presented by the heavy industry drive of 1973 by founding new business units in the targeted industries and directing other units within the same business group to fund and subsidize the new ventures. In addition, the government gave the leading chaebols preferential treatments (SaKong and Koh, 2010).[11] Our view is that such direct and indirect discriminatory support

[11] For example, President Park favored Chung Ju Yung of the Hyundai Group with contracts for bridges,

contributed to the worsening resource misallocation across plants within growing industries and regions.

The improving allocative efficiency since 1980 in Figure 3 is consistent with the reversal of the heavy industry drive after 1980. The new regime implemented a policy of rationalizing or undoing the over-investment in heavy and chemical industries, often by forcing mergers and acquisitions (SaKong and Koh, 2010).

Economic Impact of the Worsened Misallocation Equation (3) allows us to quantify, albeit approximately, the economic impact of the worsened allocative efficiency in the targeted industries/regions. From 1968 to 1980, the variance of plant-level log TFPR increased by 34 percent on average across the targeted industries/regions, but actually declined by 24 percent on average across the non-targeted industries/regions. We calculate what the TFP of the targeted industries/regions would have been if the degree of misallocation within them relative to the degree within the non-targeted ones had remained the same between 1968 and 1980. In this counterfactual, the average TFP of the targeted industries/regions would have been higher than their actual average by 0.34 log point, or about 40 percent, in 1980. In other words, the exacerbated misallocation within the targeted industries/regions relative to the non-targeted ones had the effect amounting to a 2.8-percent-per-year loss in TFP at the industry/region-level over 12 years.

Misallocation among Entrants vs. Incumbents In MMS, the establishment age variable is only available from 1980, and we cannot distinguish between entrants and incumbents during the policy period (1973–79). However, in the 1980 data, we can ask whether the plants that entered during the policy period (age 0–7, 'young') and the plants that had entered before the policy (age 8 and older, 'old') contributed to the misallocation in a different manner. One obvious limitation is that this backward-looking analysis misses plants that exited before 1980.

For each industry and region, we can decompose the variance of TFPR as follows to quantify the relative contribution of the young and old plants (noted by y and o, respectively):

$$\begin{aligned} Var(\text{TFPR}_i) = & \frac{N_y}{N} Var_y(\text{TFPR}_i) + \frac{N_o}{N} Var_o(\text{TFPR}_i) \\ & + \frac{N_y}{N}(\overline{\text{TFPR}}_y - \overline{\text{TFPR}})^2 + \frac{N_o}{N}(\overline{\text{TFPR}}_o - \overline{\text{TFPR}})^2 \end{aligned} \tag{4}$$

where N_y, N_o, and N are the number of the young, old, and all plants, and $\overline{\text{TFPR}}_y$ and $\overline{\text{TFPR}}_o$ are the respective group mean of TFPR. The first term on the right-hand side is

dams and roads, and Hyundai Construction funded Hyundai Motors until the latter became competitive.

the TFPR variance among the young plants. It accounts for 74 percent of the total TFPR variance in the targeted industries/regions on average, and 65 percent in the non-targeted ones. The second term is the TFPR variance among the old plants, which accounts for 24 percent of the total variance in the targeted industries/regions and 33 percent in the non-targeted ones. The third and fourth terms capture the difference between the group mean and the overall mean, but are negligible. The variance decomposition shows that the plants that entered during the policy period may have been disproportionately responsible for the worsened misallocation in the targeted industries/regions.

4.3 Establishment Size Distribution

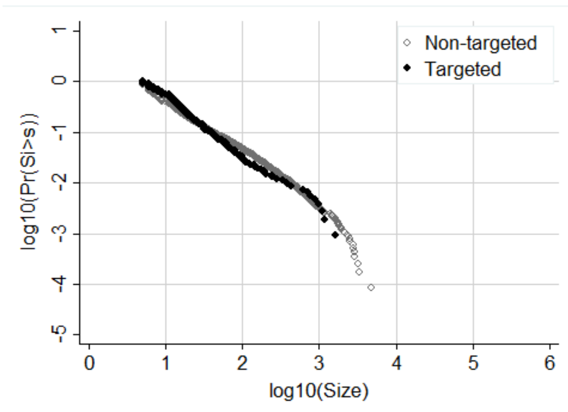
The previous results show that the number of workers in the targeted industries/regions grew faster than in the non-targeted ones, Figure 2(b), but there was no such difference in the number of establishments. It must follow that the average establishment size grew more in the targeted than in the non-targeted industries/regions.

Figure 4 shows how the establishment size distribution changed in both the targeted and the non-targeted industry-region pairs. Panels (a) and (b) are the log-log plots in 1967 and 1980. In a log-log plot, the horizontal axis is the log of the number of employees and the curve traces the log of the fraction of establishments with at least as many employees as the corresponding number on the horizontal axis. Panel (a) shows that, before the policy, the establishment size distributions of the targeted industries/regions and the non-targeted industries/regions were not too different. Going from 1967 to 1980, panel (b) shows that, after the policy, both log-log plots shifted to the right and became flatter, but much more so in the targeted industries/regions than in the non-targeted ones. A right shift of the log-log plot implies that there are more establishments at larger scales.[12] The average size of an establishment in the targeted industry-region pairs increased from 30.4 in 1967 to 127.5 employees in 1980, while the average size in the non-targeted ones increased from 26.8 to 63.2 over the same period. The flattening of the log-log plot implies that the right tail became thicker, with a disproportionate increase in the number of very large establishments.

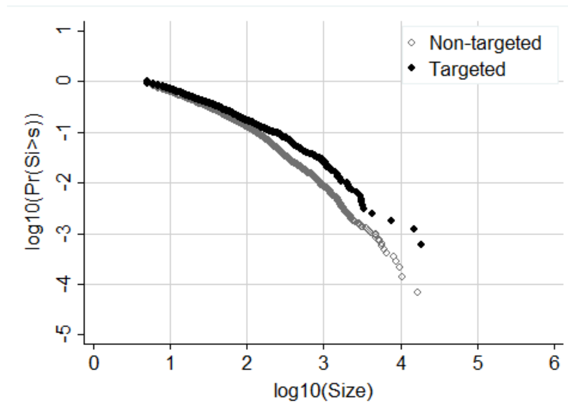
There are at least two possible explanations for the differential shift in the size distribution. One possibility is that establishments were smaller initially because of barriers to firm growth (e.g., credit constraints), and the industrial policy helped firms in the targeted industries overcome such barriers and grow larger. This view is consistent with the evidence provided by Buera and Shin (2013). The other is that the shift in size distribution reflects the adoption of more productive modern technologies in the targeted sector, partly subsi-

[12] If all establishments grow proportionally, the log-log plot makes a parallel shift to the right.

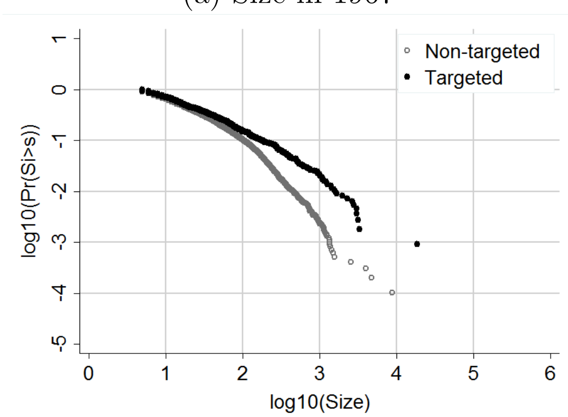
Figure 4: Establishment Size Distribution



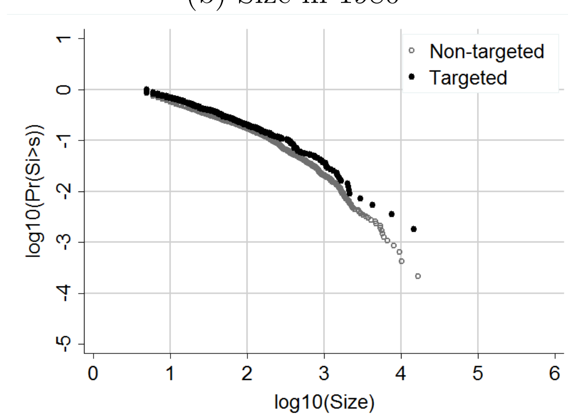
(a) Size in 1967



(b) Size in 1980



(a) Size in 1980 among age 0-7 plants



(b) Size in 1980 among age 8+ plants

Notes: Panels (a) to (d) show the log of the fraction of establishments larger than or equal to size s on the horizontal axis, where size is the number of employees. The data is truncated at 5 employees. The black dots are for the targeted industry-region pairs and the gray dots for the non-targeted ones. The three industries (chemicals, refined petroleum, and cement) that were excluded from the main analysis are included as targeted here. The results were similar when we excluded these three industries.

dized by the policy. This view is consistent with the analysis of Buera et al. (2021) and also with our finding that the establishment-level productivity increased significantly more in the targeted industries/regions. Because ours is repeated cross-sections and the establishment age is only available from 1980, the data does not permit a clean test of either hypothesis.

Nevertheless, a comparison of the young and old firms in 1980 again provides some insights. Figure 4(c) and (d) are the log-log plots for the young (age 0–7) plants and the old (age 8 and older) plants in 1980. We see that the size difference between the targeted and the non-targeted industries/regions is mostly accounted for by the young plants that entered during the policy period. Furthermore, the size distributions of the young plants and the old plants in the targeted industries/regions—black dots in panels (c) and (d)—are nearly identical except for the few points at the right extreme. This very unusual fact, that young plants are as large as old plants, indicates that the cohort of plants that entered the targeted industries/regions under the policy was not a usual cohort, giving some weight to the technology adoption view.[13]

However, our results on concentration and misallocation raise an important caveat. The largest establishments in 1980 were not necessarily the most productive ones, and hence the selective support from the government and from within business groups may have been more responsible for the emergence of the very large establishments.

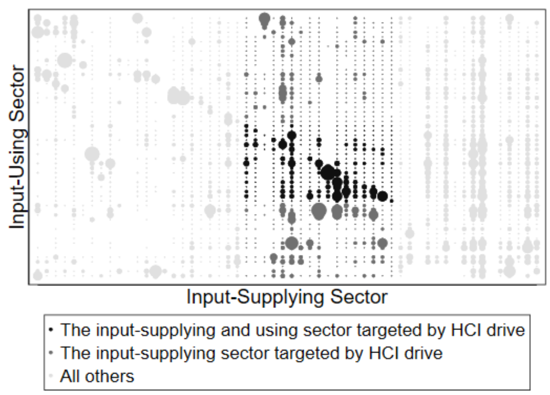
4.4 Change in Input-Output Networks

The analysis so far shows that the targeted industries became a larger part of the economy. The natural next question is how their growth contributed to the overall economy—in particular, whether it also benefited the non-targeted industries.

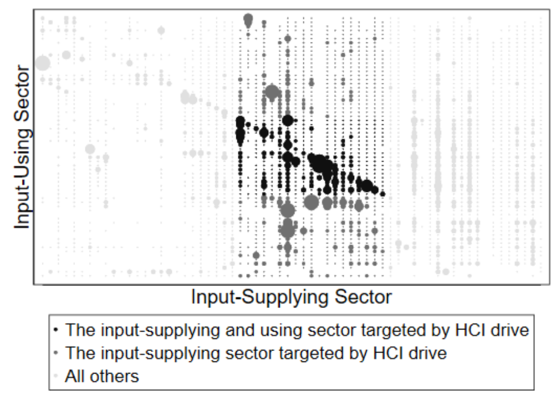
We provide formal evidence in Figure 5. Panels (a) and (b) show the input-output matrix of the Korean economy in 1970 and 1980, respectively. Industries are on the horizontal axis and the vertical axis, and the size of each dot shows the amount of input supplied by an industry on the horizontal axis to one on the vertical axis. Black dots mean that both the input-supplying and the input-using industries were targeted. Dark gray dots represent that the input-supplying industry was targeted but the input-using industry was not. Comparing the two panels, one sees that the input-output matrix after the policy has more and larger black dots and dark gray dots. In other words, both the non-targeted and the targeted industries used more input produced by the targeted industries in 1980 than in 1970. The tables in panels (c) and (d) provide precise numbers. In 1970, of all the

[13] Appendix E discusses additional results from 1990, more than a decade after the end of the policy. The difference in size distribution persisted through 1990, and we confirm that the cohort of plants that entered the targeted industries/regions under the policy was indeed special.

Figure 5: Change in IO Structure



(a) IO Matrix in 1970



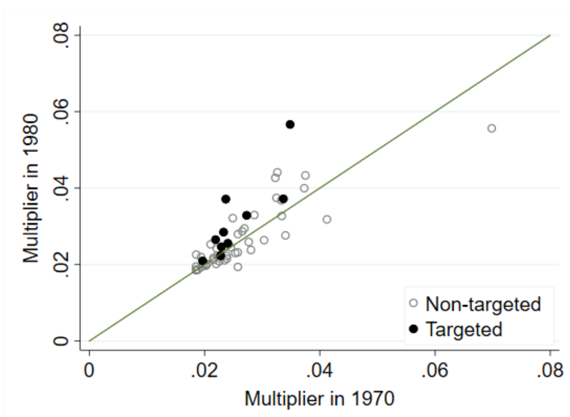
(b) IO Matrix in 1980

		supplying	
		Non-target	Target
using	Non-target	80.38%	10.34%
	Target	4.52%	4.76%

(c) Two-sector IO Matrix in 1970

		supplying	
		Non-target	Target
using	Non-target	64.44%	15.14%
	Target	6.86%	13.57%

(d) Two-sector IO Matrix in 1980



(e) Sectoral IO Multipliers

	Non-target	Target
1970	0.0264	0.0254
1980	0.0266	0.0312

(f) Average Multipliers

Notes: Panel (a) and (b) show the input-output matrix in 1970 and 1980, respectively. The original IO matrices from the Bank of Korea have 64 manufacturing industries in 1970 and 72 in 1980, which we harmonized into 54 industries. Tables in panel (c) and (d) summarize Panel (a) and (b) into a two-sector input-output matrix. Panel (e) plots an industry's multiplier in 1970 (horizontal axis) and 1980 (vertical axis). Panel (f) reports the averages of the multipliers in targeted and non-targeted industries.

intermediate inputs, about 15 percent (10.34+4.76) was produced by the targeted industries. In 1980, this proportion nearly doubled to about 29 percent (15.14+13.57). The intermediate input supplied by the targeted industries to the non-targeted industries accounted for 10 percent of all intermediate inputs in 1970 but 15 percent in 1980. While the increase was more pronounced for the intermediate input supplied by one targeted industry to another, through industrial linkages, the targeted industrial policy contributed to the growth of the non-targeted industries as well.

Another way of representing industries' importance in the input-output context is to compute the vector of sectoral multipliers μ using the Leontief inverse, $[\mathbf{I}-\mathbf{\Gamma}]^{-1}$, and the vector of expenditure shares, β, as in Fadinger et al. (forthcoming):

$$\mu = [\mathbf{I}-\mathbf{\Gamma}]^{-1}\beta. \tag{5}$$

The elements of the multiplier vector μ are the impact of a one-percent increase in the productivity of a given industry on the overall value-added of the economy. These multipliers are related to the notion of how upstream these industries are in the input-output structure.

Panel (e) plots an industry's multiplier in 1970 (horizontal axis) and 1980 (vertical axis), and the straight line is the 45-degree line. The 10 targeted industries are black dots and 44 non-targeted ones are gray dots.[14] The multipliers of nearly all targeted industries increased between 1970 and 1980, while those of the non-targeted industries do not show a clear pattern. The table in panel (f) quantifies this finding by computing the averages across the targeted and the non-targeted industries in 1970 and 1980. One surprise is that, although the policy targeted heavy and chemical industries, which are supposedly more upstream industries, the targeted industries had smaller multipliers than the non-targeted industries in 1970. Consistent with panel (e), the multipliers of the non-targeted industries did not change much between 1970 and 1980, but those of the targeted industries increased on average. The increase of 0.0058 is about 70 percent of the standard deviation of multipliers in the 1970 cross-section, and the increase is statistically significant at the 5 percent level. In addition, even after the policy was reversed after 1980, the multipliers of both the targeted and the non-targeted industries remained stable between 1980 and 1990, underlining the persistence of the policy impact.

What is the economic significance of the larger multipliers? As Fadinger et al. (forthcoming) showed in a model of sectoral linkages, the aggregate TFP in log can be written as $\sum_{i=1}^{n}\mu_i\lambda_i$, where μ_i is sector i's multiplier and λ_i is sector i's TFP in log. Using the multipliers and industrial TFPs we calculate for 1970 and 1980, this formula shows that the

[14]The number of industries is different here because the Bank of Korea used its own industry classification to produce the IO matrices.

TFP of the Korean manufacturing sector grew by 56.4 percent between 1970 and 1980. If we assume that the targeted industries' multipliers had grown only as much as the non-targeted industries' multipliers (1.9 percent instead of the actual 21.6 percent over 10 years), then according to the formula the manufacturing sector TFP would have grown by only 35.7 percent between 1970 and 1980. In other words, the increase in the targeted industry multipliers accounted for more than one-third of the TFP growth of the entire manufacturing sector during this period.

Another relevant fact comes from the trade data. The Korean growth miracle has been widely characterized as export-oriented (Kim and Leipziger, 1997). We find that the export of the targeted and the non-targeted industries respectively grew by 39 and 25 percent per year on average during the policy period of 1973–1979.[15] One possibility is that the targeted industries aided the export growth of the non-targeted industries by providing cheaper intermediate input of production.

5 Concluding Remarks

Korea is often hailed as an example of successful government-led economic growth, but such statements have rarely been backed up by quantitative analysis. We provide the first plant-level view of the heavy industry drive of 1973. During the policy period, the targeted industries/regions grew significantly faster than the non-targeted ones, suggesting the importance of place-based policies as well as industry-specific policies. However, this growth came with more misallocation and concentration within the targeted industries and regions, especially among entrants. Although data limitations preclude a conclusive investigation, the rise in concentration suggests that large plants belonging to large business groups may have been the primary beneficiary of policies favoring specific industries and regions. As more data becomes available, future research will resolve the debates on the efficacy of industrial policy.

[15] Appendix F provides more details.

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APPENDIX (NOT FOR PUBLICATION)

A List of Treated Industries and Regions

Table A.I: List of Treated Industries

Industry Code	Industry Name	Treatment Status
311	Food	N
313	Beverage	N
321	Textiles	N
322	Apparel	N
323	Leather	N
324	Footwear	N
331	Wood	N
332	Wood furniture	N
341	Paper, paper products	N
342	Publishing, printing	N
351	Chemicals	Y*
352	Other Chemical products	N
353	Refined petroleum	Y*
355	Rubber and plastics	N
36	Other non-metallic mineral products, except cement	N
3692	Manufacture of cement, lime and plaster	Y*
371	Manufacture of basic iron and steel	Y
372	Manufacture of basic precious and other non-ferrous metals	Y
381	Manufacture of fabricated metal products, except machinery and equipment	Y
382	Manufacture of machinery and equipment n.e.c.	Y
3825	Manufacture of office, accounting and computing machinery	Y
3831	Manufacture of electrical machinery and apparatus n.e.c.	Y
3832	Manufacture of radio, television and communication equipment and apparatus	Y
384	Other transport equipment	N
3841	Building of ships, boats, and floating structures	Y
3843	Manufacture of motor vehicles and parts	Y
385	Manufacture of medical, precision and optical instruments, watches and clocks	N
390	Manufacturing n.e.c.	N

Note: The table reports 13 treated and 15 untreated industries. * denotes industries that were targeted before 1972.

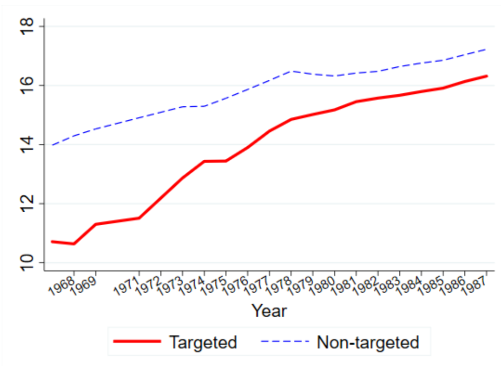
Table A.II: List of Treated Regions

Region Code	Region Name	Treatment Status
11	Seoul	N
21	Busan	N
31	Gyeonggi-do, Incheon	N
32	Gangwon-do	N
33	Chungcheongbuk-do	N
34	Chungcheongnam-do, Daejeon	N
35	Jeollabuk-do	N
36	Jeollanam-do, Gwangju	Y
37	Gyeonngsangbuk-do, Daegu	Y
38	Gyeonngsangnam-do, Ulsan	Y
39	Jeju-do	N

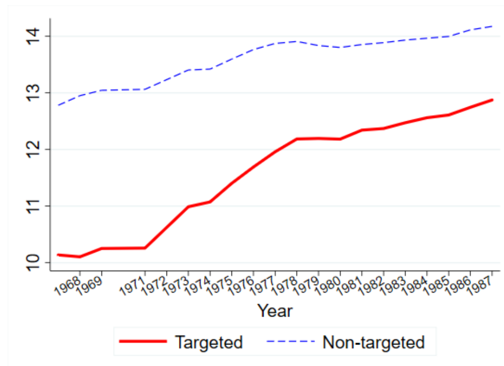
Note: The national industrial complexes were built for heavy chemical industries in the treated region. Regional name with "-do" corresponds to province in Korea.

B Trends in Targeted vs Non-targeted Industries/Regions

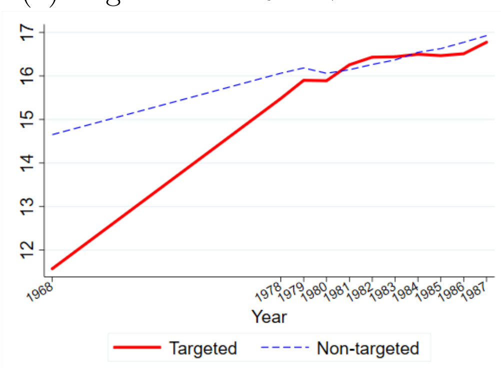
Figure B.1: Output, Input, and Productivity



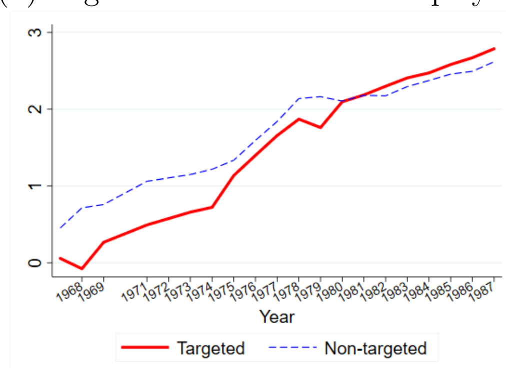
(a) Log of Total Real Value-added



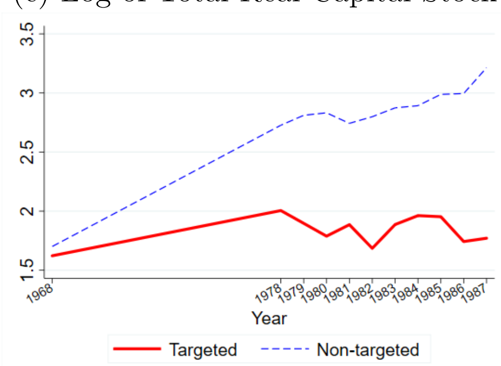
(b) Log of Total Number of Employees



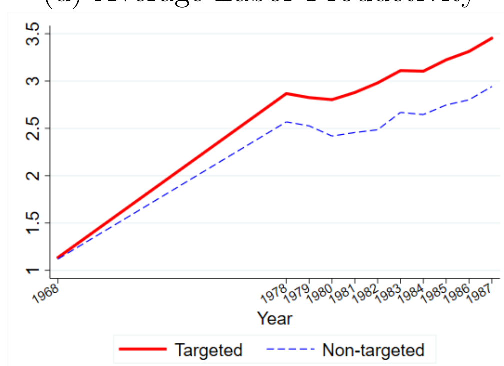
(c) Log of Total Real Capital Stock



(d) Average Labor Productivity



(e) Average Total Factor Productivity

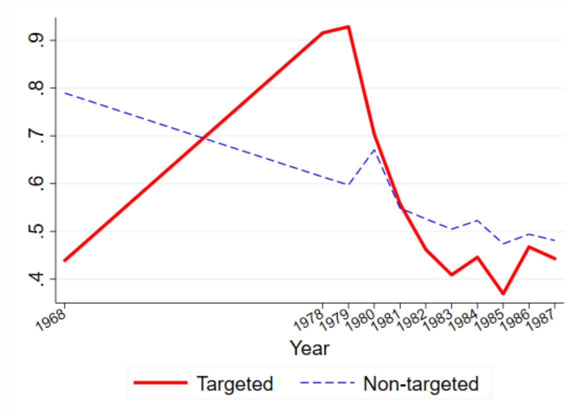


(f) Simple Average of Establishment-level TFP

Notes: Panels (a), (b), and (c) plot logs of sum of variables across targeted and non-targeted industry-region pairs. Panel (d) is an average labor productivity weighted by the number of employees. Panel (e) is an average total factor productivity weighted by real value added. Panel (f) is a simple average of establishment-level TFPs weighted by real value added across industries/regions.

Figure B.2: Allocative Efficiency

(a) Average Standard Deviation of TFPR



(b) Average Correlation b/w TFPR & TFPQ

Notes: Panels (a) to (b) plot the weighted average across targeted and non-targeted industry-region pairs. Weights are real value added.

C TFP Estimation and TFPR Calculation

C.1 TFP Estimation

We estimate total factor productivity (TFP) at the plant-level under the assumption of a Cobb-Douglas production function. We use the value-added specification of the production function as follows.

$$\log VA_{it} = \log A_{it} + \epsilon_s^K \log K_{it} + \epsilon_s^L \log L_{it} + \epsilon_{it} \tag{6}$$

where VA_{it} is the real value-added and A_{it} is the TFP measure. We estimate the elasticities of the log of capital (K_{it}) and labor (L_{it}), which are the coefficients of the equation 6. We apply the estimation method of Wooldridge (2009) to estimate the elasticity parameters for each 28 three-digit industries. Wooldridge (2009) applies a generalized method of moments (GMM) framework to Levinsohn and Petrin (2003), where they use the proxy variables in estimation to control for the simultaneity problem caused by the correlation between unobserved productivity and the production inputs. We used the lag value of labor input as instruments. Since the method requires the use of lagged input variables, we use the unbalanced panel data constructed from MMS between the years 1981 and 1990. Thus, we are implicitly applying the same constant estimated elasticities of inputs for each industry to other periods of analysis. The estimated coefficients are reported in the Appendix Table C.I.

Table C.I: Production Function Estimates

Industry Code	Industry name	Coeff. of capital (s.d.)	Coeff. of labor (s.d.)	No. of obs.	No. of ests.
311	Food	0.16 (0.0066)	0.59 (0.0093)	24973	7126
313	Beverage	0.04 (0.0089)	0.67 (0.0277)	7551	1418
321	Textiles	0.12 (0.0036)	0.71 (0.0049)	45682	18007
322	Apparel	0.1 (0.0034)	0.76 (0.0043)	28555	16088
323	Leather	0.1 (0.0092)	0.74 (0.015)	5612	3458
324	Footwear	0.13 (0.011)	0.76 (0.0149)	3997	3244
331	Wood	0.1 (0.0072)	0.7 (0.013)	12537	4345
332	Wood furniture	0.09 (0.0074)	0.75 (0.0187)	7502	4130
341	Paper, paper products	0.14 (0.0099)	0.49 (0.0145)	10279	4374
342	Publishing, printing	0.09 (0.0051)	0.77 (0.0101)	14881	6652
351	Chemicals	0.18 (0.0148)	0.43 (0.0215)	5446	2567
352	Other Chemical products	0.14 (0.0141)	0.64 (0.0141)	6094	2262
353	Refined petroleum	0.2 (0.0369)	0.19 (0.0564)	728	286
355	Rubber and plastics	0.11 (0.0058)	0.74 (0.0077)	21815	11319
36	Other non-metallic mineral products, except cement	0.16 (0.0073)	0.53 (0.0095)	16867	6826
3692	Cement, lime and plaster	0.18 (0.0648)	0.22 (0.0644)	470	164
371	Basic iron and steel	0.16 (0.0125)	0.52 (0.0155)	5179	2433
372	Basic precious and other non-ferrous metals	0.1 (0.0164)	0.6 (0.0264)	3524	1876
381	Fabricated metal products	0.15 (0.0054)	0.62 (0.0085)	25756	13625
382	Machinery and equipment	0.14 (0.0053)	0.66 (0.0089)	25638	14762
3825	Office, accounting and computing machinery	0.09 (0.0323)	0.64 (0.0351)	975	782
3831	Electrical machinery and apparatus n.e.c.	0.12 (0.0079)	0.59 (0.0111)	11587	6819
3832	Radio, television and communication equipment and apparatus	0.15 (0.0073)	0.62 (0.0081)	13028	7711
384	Other transport equipment	0.15 (0.0245)	0.57 (0.0428)	1385	786
3841	Building of ships, boats, and floating structures	0.05 (0.0151)	0.93 (0.0185)	2839	1173
3843	Motor vehicles and parts	0.16 (0.0112)	0.56 (0.0165)	7327	4328
385	Medical, precision and optical instruments, watches and clocks	0.15 (0.0111)	0.57 (0.0164)	4753	2624
390	Manufacturing n.e.c.	0.09 (0.0057)	0.69 (0.0074)	14680	8238

Note: The table reports the coefficients (and their clustered standard errors) of production function estimation. It also reports both the number of observations and the number of establishments in the unbalanced panel.

C.2 TFPR Calculation

We apply the methodology of Hsieh and Klenow (2009) at the level of industry-region pairs and express the TFP at the industry-region level (indexed by s) as follows.

$$TFP_s = \left(\sum_{i=1}^{N_s} \left(A_{si} \frac{\overline{TFPR}_s}{TFPR_{si}} \right)^{\sigma-1} \right)^{\frac{1}{\sigma-1}} \tag{7}$$

where A_{si} is establishment i's TFPQ defined as $Y_{si}/K_{si}^{\alpha_s}(wL_{si})^{1-\alpha_s}$, $TFPR_{si}$ is defined as $P_{si}A_{si}$, and $\overline{TFPR}$ is the geometric average of the marginal revenue products of capital and labor. Assuming that TFPQ and TFPR follow a joint log-normal distribution, equation (2) gives

$$\log TFP_s = \frac{1}{\sigma - 1} \log \left(\sum_{i=1}^{N_s} A_{si}^{\sigma-1} \right) - \frac{\sigma}{2} \mathrm{var}(\log TFPR_{si}) \ . \tag{8}$$

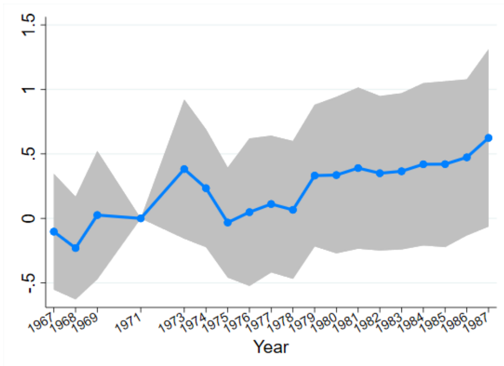
Clearly, the variance of log TFPR adversely affects the aggregate TFP.

We use the parameter values of Kim et al. (2017), who measured the allocative efficiency of the Korean manufacturing sector for the 1982–2007 period.

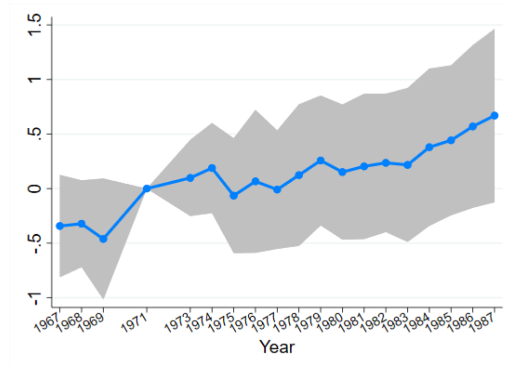
The capital rental rate is set to 0.1 and the elasticity of substitution between plant value-added to 3 following Hsieh and Klenow (2009). We assume the elasticity of output to capital for each industry to be 1 minus its labor share in 2005. The labor share is defined as the share of wages paid to value added for each industry. The mean and the standard deviation of the labor shares across the 28 industries are 0.44 and 0.20. Since the labor shares here are much lower than the labor share in the national input-output table, we scaled up the labor shares by a constant factor, 1.89.

D Results with only industry targets

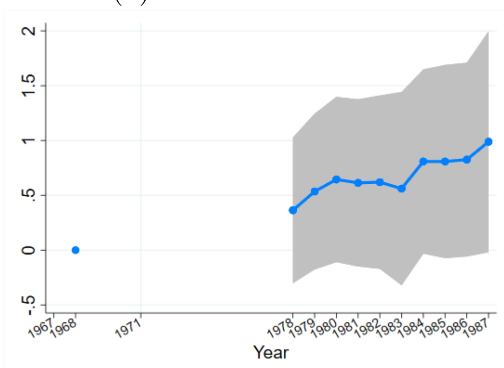
Figure D.1: Output, Input, and Productivity



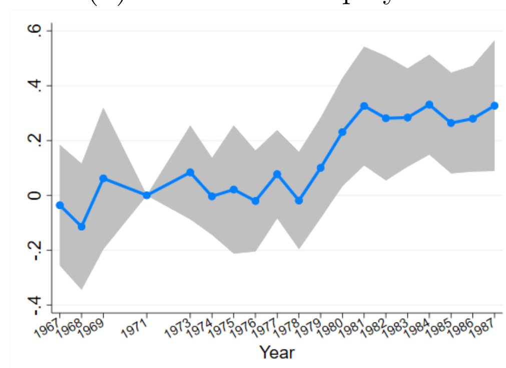
(a) Real Value-added



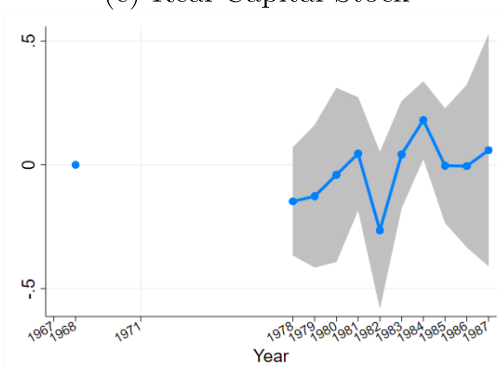
(b) Number of Employees



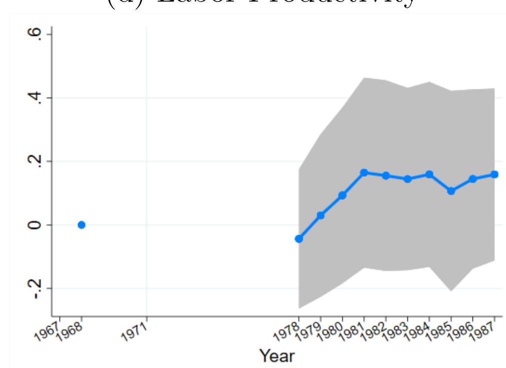
(c) Real Capital Stock



(d) Labor Productivity



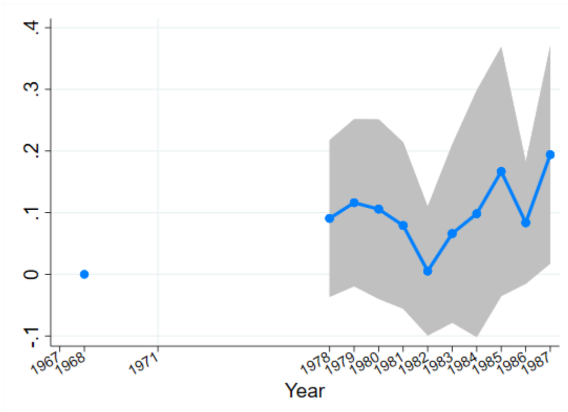
(e) Total Factor Productivity



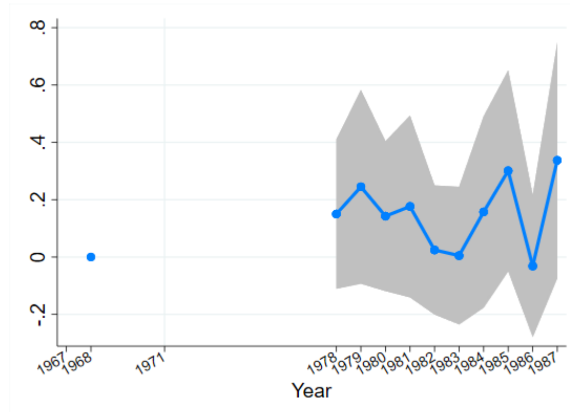
(f) Simple Average of Establishment-level TFPs

Notes: Panels (a) to (f) plot estimated coefficients along with a 95 percent confidence interval. The microdata does not exist in 1970 and 1972, and the year of 1971 is normalized to zero. We adjust standard errors with clustering over industry. Regression weights are dependent variable itself in panels (a), (b), and (c). We use the number of employees as a regression weight for panel (d) and real value added for panels (e) and (f).

Figure D.2: Allocative Efficiency



(a) Standard Deviation of TFPR



(b) Correlation b/w TFPR & TFPQ

Notes: Panels (a) to (b) plot estimated coefficients along with a 95 percent confidence interval. We adjust standard errors with clustering over industry. Regression weights are real value added.

E Establishment size distribution in 1990

Although not shown in main text of the paper, we did a similar exercise using the 1990 establishment size distribution. We find that (i) the size difference between the targeted and the non-targeted industries/regions among the plants that entered during the policy period persisted and got even larger through 1990; (ii) among the young plants (age 0–7) in 1990, even though the policy had ended in 1979, those in the targeted industries/regions are larger on average than those in the non-targeted ones, but the target vs. non-target difference is much smaller than among the young firms in 1980; and (iii) in the targeted industries/regions, the young firms in 1990 are significantly smaller than the old firms in 1990. Fact (i) shows the lasting impact of the policy for the continuing plants, consistent with the findings of Choi and Levchenko (2021). Fact (ii) suggests that, in addition, the policy may have had an effect even on the plants that entered after the policy period. It may capture the effect of the industrial complexes, which continued their operation well after the policy period. Facts (i) and (ii) are consistent to the persistent effect at the industry level in Lane (2021). Fact (iii), when compared to panels (c) and (d) of Figure 4, shows that the plants that entered during the policy period in the targeted industries/regions was a very unusual cohort.

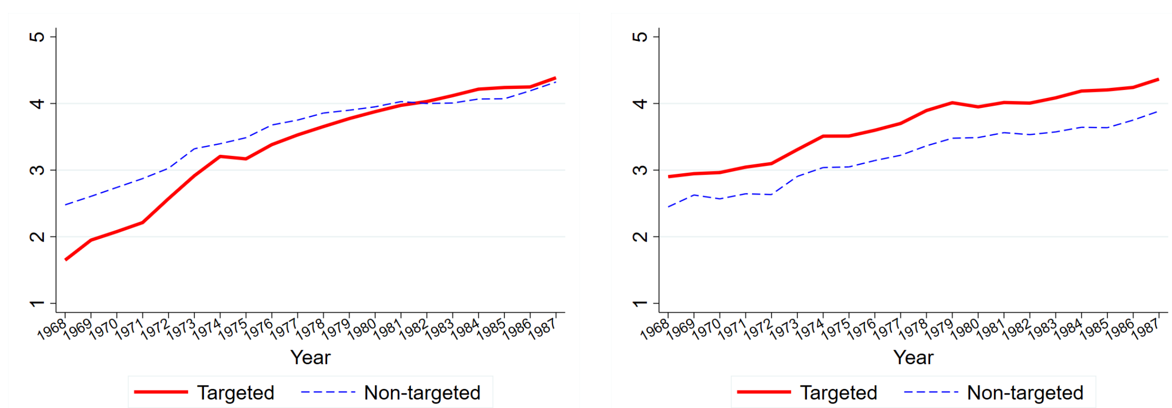
F Trade

The trade data comes from the UN Comtrade Database. We first converted the values of exports and imports reported in SITC Rev. 2 into ISIC Rev. 2 using a concordance table, and second, matched ISIC Rev. 2 to our industry classification.

Figure F.1 shows that both exports and imports grew very rapid between 1968 and 1979. The non-targeted industry export values were much larger in the early period and they were caught up by targeted industry export values in the later period. We find that the export of the targeted industries grew by 39 percent per year on average (in dollar terms) during the policy period of 1973-1979. Over the same period, even the non-targeted industry export grew significantly, by 25 percent per year on average.

The import data confirms that the policy was not import substituting. The import of the targeted industry products grew by 31 percent per year on average during the policy period, while the import of non-targeted industry products grew by 25 percent per year on average.

Figure F.1: Exports and Imports



(a) Exports (b) Imports

Notes: Panels (a) and (b) plot log10 value of total exports and imports in million of dollars by targeted and non-targeted industry.