Manufacturing Revolutions: Industrial Policy and Industrialization in South Korea*

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Abstract

I study the impact of industrial policy on industrial development through a canonical intervention. Following a political crisis in 1972, South Korea dramatically altered its development strategy with a new sector-specific policy: the Heavy Chemical and Industry (HCI) drive. With newly digitized data, I use the sharp introduction and withdrawal of HCI trade policy and investment incentives to study its impacts. (1) I show HCI successfully promoted the evolution of directly treated industries. Next I provide evidence for two key justifications of industrial policy: network and dynamic externalities. (2) Using variation in exposure to policies through the input-output network, I show HCI indirectly benefited (non-treated) downstream industry. (3) Finally, I show both direct and indirect benefits of HCI persist even after the policy is withdrawn, following the 1979 assassination of President Park. Together, my findings suggest that the temporary drive helped shift the economy into higher value-added activity.

1 Introduction

Miracles by nature are mysterious. The forces behind the East Asian growth miracle are no exception. Industrial policy (IP) has defined Asia's striking postwar transformation (Rodrik, 1995). The ambitious development strategies pursued across the region have shaped interventions across the world, from Southeast Asia to sub-Saharan Africa (Rodrik 2005; Robinson 2010; Lin 2012). Broadly, industrial policies are a consistent feature of industrializing economies. With rare exception, every developing country has pursued some type of IP intervention. While early development economists argued these strategies play a fundamental role in industrialization (Rosenstein-Rodan 1943; Hirschman 1958), others argue they are deleterious (Baldwin 1969; Krueger 1990; Pack 2000). As IP re-enters popular policy discussions, contemporary empirical evidence on their impact is rare.[1]

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[1]See: Lane (2019) for a contemporary review of the current literature.

The Republic of Korea entered the 1960s corrupt, unstable, and dependent on Western aid.[2] By 1980, the nation had undergone an industrial transformation that had taken Western nations over a century to achieve (Nelson and Pack 1998).

How did South Korea evolve from a fledgling light export economy into an industrial powerhouse? This paper explores the nation's use of industrial policy: intentional state action with the goal of shifting the composition of national economic activity. Often, the goal is to shift the economy to a pattern of activity that is growth-enhancing (Lindbeck 1981; Chang 2003; Noland and Pack 2003). My study explores the impact of a pivotal IP intervention—one that sought to transform the industrial trajectory of a small-open, developing economy.

I focus on a definitive postwar intervention: South Korea's Heavy Chemical and Industry (HCI) drive, 1973 to 1979. HCI embodied policies imagined by early developmentalists (Rosenstein-Rodan 1943; Nurkse 1953; Hirschman 1958)—with important caveats. Though HCI was interventionist, its outward orientation resembled similar policies across Asia and distinguished it from those used in Latin American. Japan's experience inspired South Korea's drive, and contemporaries, like Taiwan, pursued comparable IP (Vogel 1991; Cheng 1990, 2001). In turn, Korea's HCI experience influenced strategies across the globe, as middling economies, such as Malaysia, "looked east" for ways to foster industrial development. The mixed record of imitators has fueled HCI's notoriety.[3]

Econometric studies on East Asian industrialization—and industrial policy, broadly—are rare. My study overcomes two obstacles to studying infant industry policies: research design and data. For over a century, economists have discussed the difficulties of empirically examining IP (Meredith 1906; Grubel 1966). Theoretically, optimal policies are often temporary, and justifications rely on assisting sectors with either dynamic comparative advantage (Greenwald and Stiglitz 2006) or abundant spillovers (e.g. inter-industry linkages) (Hirschman 1958; Grossman 1990). Tests of theoretical justifications, however, are moot against the litany of unobserved political realities (Rodrik 2005, 2012). These political factors mean that IP often goes to underperforming, politically-sensitive, and incoherent sectors (or lone firms). Such political forces also mean that IP is seldom temporary (see: Head 1994; Juhasz 2018).

My research design uses the unique context of South Korea's HCI drive to study the impact of purposeful IP interventions: a mix of trade policy and investment incentives. External politics precipitated HCI's launch in 1973—and its termination in 1979. President Nixon's promise to withdraw U.S. forces from the Asia-Pacific area shook regional allies. Like Southern Vietnam, the Republic of Korea (ROK) long-relied on this support against the Communist-backed North. The abrupt U.S. policy shift catalyzed the ROK to build a domestic heavy industrial complex. HCI was thus born. Rigorously implemented under the duress of crisis, the drive targeted strategically important infant industries industries (Stern et al. 1995; B.-k. Kim and Vogel 2011). Importantly, policies were actually deployed. They were proved to be temporary, when the 1979 assassination of the president ended his cornerstone project.

[2]Per capita GDP figures, see: Werlin (1991). According to the Penn World Tables, in 1960 South Korea's per capita national income lagged behind Cameroon, the Central African Republic, Haiti, Madagascar, Morocco, Niger, and Tanzania (Feenstra, Inklaar, and Timmer 2015).

[3]For global experience of HCI-style policies, see Kim et al. (2013); Moreira (1994); Lall (1995); Lall (1996). Examples of similar policies include Algeria, Brazil, and Philippines.

Studying the HCI experiment entails constructing a rich dataset on industrial, trade, and, importantly, policy outcomes. I do so by harmonizing material from archival sources; digitized industrial surveys; and vintage machine-readable datasets into a rich panel dataset. Using newly constructed crosswalks, I merge industrial statistics with historical input-output accounts and detailed trade policy measures. The result is a dataset spanning a key episode of postwar development.

My historical setting suggests an intuitive estimation strategy. I study the impact of IP by comparing changes in outcomes between targeted versus non-targeted manufacturing industries for each year, before and after the HCI announcement. This "flexible" differences-in-differences (DD) strategy captures the impact of HCI policies (investment incentives and trade policy). Pre-trends represent Korea's counterfactual sectoral structure, where, absent these interventions, industries would have evolved according to their pre-1973 specialization—or *static* comparative advantage. Post-1973 differences reveal the efficacy of IP in fostering sectors in which South Korea had unrealized potential—or *latent* comparative advantage.

This estimation strategy allows me to examine two key justifications of industrial policy (See: Krueger and Tuncer 1982). First, by comparing the evolution of treated versus non-treated industries *after* Park's assassination, I confirm whether infant industry interventions were durable. In doing so, I test for the dynamic impacts of IP. Another canonical motivation for IP is that benefits accrue to industries external to targeted sectors. To see whether this was the case, I estimate the impacts of IP on sectors differentially exposed to targeted industries through industrial linkages. Using measures constructed from historical input-output accounts, I compare the evolution of (non-targeted) industries with weak links to those with strong links to HCI industries.

I make four empirical contributions. First, I show that *de facto* policy aligned with *de jure* policy during the HCI drive. Contrary to popular narratives, I do not observe overt protectionism of output markets through trade policies, but rather show evidence that HCI promoted intermediate imports and capital formation. Second, I find a significant, positive impact of IP across industrial development outcomes in treated industries. HCI industries see an 80 percent increase in output over non-treated sectors, with output prices falling 11 percent. Third, these direct impacts of HCI are durable. After 1979, development outcomes are significantly higher in treated sectors, compatible with dynamic justifications for IP. Fourth, HCI policies positively impacted the development of forward-linked (downstream) industry, with mixed impacts on backward-linked (upstream) industries. My estimates suggest that the development of HCI sectors is associated with the development of downstream industries, where trade allowed HCI sectors to cheaply import inputs. This trade policy, however, exposed upstream suppliers to import competition. Together, these patterns indicate IP moved Korea into more advanced industrial production.

My study joins a small but growing empirical literature on IP (Nunn and Trefler 2010; Aghion et al. 2015; Criscuolo et al. 2019). I contribute directly to recent scholarship studying industrial interventions through historical natural experiments. Juhasz (2018) uses the Napoleonic blockade as a protectionist shock to French textiles, testing a key from of infant industry policy. Though her work—as well studies by Inwood and Keay (2013) and Harris, Keay, and Lewis (2015)—focus on temporary output market protection, I find qualitatively similar patterns of development in a modern setting through different levers. My results touch on related work on dynamic comparative advantage and temporary interventions, notably Hanlon (2018) and Mitrunen (2019).[4] While many studies use shocks mimicking policy, my results broadly support their findings. I do so. however, by examining *in situ* a purposeful, targeted intervention in a recent context. By analyzing intentionally targeted policies, I speak to a growing body of work evaluating place-based policies. Notably, Criscuolo et al. (2019), who study the impact of supports targeted at lagging (UK) geographies (also see Becker, Egger, and Ehrlich (2010) for the EU). Though I show the impact of policies guided toward industries, rather than geographical units.

My study also reconciles competing views on IP and postwar development. Influential qualitative work emphasized the role of IP in newly industrializing economies (NICs).[5] Notably, Wade (1990) and Amsden (1992) argue IP was a vital element of Taiwan and South Korea's ascent. Economists, however, have largely been skeptical. A sizable literature argues infant industry interventions are flawed—theoretically and practically (Baldwin 1969; Krueger 1990; Lal 1983).[6] Many challenge the lessons gleaned from East Asia, specifically IP (Weinstein 1995; Beason and Weinstein 1996; Lawrence and Weinstein 1999). Krueger (1995) and Pack (2000) contend NICs developed *despite* IP, a conclusion Yoo (1990) makes for HCI.

Early regression studies reify critiques of IP (Krueger and Tuncer 1982). Correlation studies of Asia show *1)* a negative relationship between interventions and industry development, and *2)* argue that IP did not target high-externality sectors (Lee 1996; Beason and Weinstein 1996; Noland 2004).[7] My findings corroborate some arguments of IP advocates, but highlight conventional policy levers. With Liu (2019), I suggest Korean targeting may not have been incoherent. I argue prior econometric work may not distinguish between rational, technocratic policy and those driven by other motives (see: Harrison 1994).

Finally, I contribute broadly to a literature on the role of the state institutions and development (Besley and Persson 2010, 2011; Dell, Lane, and Querubin 2018; Acemoglu et al. 2015)—especially their role in promoting industrial change (Kohli 2004).[8] Industrial policy is state action. Accordingly, I emphasize that the efficacy of these policies is intertwined with the state's ability to deploy them (Rodrik 1997). By studying IP that was rigorously deployed, I distinguish between the impact of policy *per se* and common political confounders. The context of my study only highlights that successful IP depends on bureaucratic capabilities (Johnson 1982; Evans 1995; Fukuyama 2014) and political incentive compatibility (Haggard 1990; Chibber 2002; Robinson 2010; Vu 2010). Such conditions may be rarely satisfied (Krueger 1990), indicating the importance of future work on the political economy of IP.

[4] Hanlon (2018) studies the initial cost advantages of early steel shipbuilders, while Mitrunen (2019) examines the impact of Stalin's export reparations policy on Finnish industry. For temporary government procurement policy and managerial training, see Jaworski and Smyth (2018) and Giorcelli (2019), respectively. Alternatively, see structural I-O work on shipbuilding by Kalouptsidi (2018).

[5] The literature is vast. See seminal work by Johnson (1982); Wade (1990); Vogel (1991); Amsden (1992); Evans (1995); Chibber (2002); and Kohli (2004).

[6] See: extensive critical discussions by Pack and Saggi (2006) and Noland and Pack (2003).

[7] For Korea, Lee (1996) reveals a negative relationship between postwar IP interventions and industry-level outcomes. In Japan, thoughtful work by Beason and Weinstein (1996) argues IP was not positively related to industry development, and was not directed to sectors with high returns to scale. Noland (2004) similarly argues Korean policy did not target sectors with high spillovers (linkages). Also see: Pack (2000).

[8] Using Vietnamese history as a case study, my work with Melissa Dell and Pablo Querubin (2018) explores the effect of the Weberian state and its capacity to implement successful policy in East versus Southeast Asia.

My study is organized as follows. Section 2 discusses the institutional and historical setting of the HCI drive. Section 3 describes this study's data construction effort. Section 4 provides simple general equilibrium model for motivating empirical results. Accordingly, section 5 presents estimates of the direct impact of industrial policies on targeted industries. Section 6 reports estimates of HCI's spillovers into external sectors via input-output linkages. Finally, section 7 concludes with a discussion and summary of my results.

2 Institutional Context

This section describes the historical setting of the HCI drive. First, I describe the political economy behind HCI intervention, including the external factors behind its adoption. Second, I describe how these forces shaped the industry selection of HCI industries. Third, I describe the drive's policy mix—trade policy and investment incentives—and describe its withdrawal. These details motivate my empirical strategy in section 5.

External Political Drivers Political crisis drove South Korea's HCI drive (Im 2011; H.-A. Kim 2011; Moon and Jun 2011).[9] Two events were at the heart of this impasse: 1) the sudden change in U.S. foreign policy in Asia; 2) North Korea's militarization (Kim 1997, 2004; Moon and Lee 2009). In 1969, facing fallout from the Vietnam War, President Nixon announced the end of direct U.S. military support for Asian allies. This "Nixon Doctrine" effectively ended the Vietnam War and decades of large-scale military presence in the region. South Korea, an anti-Communist stalwart, was shocked. The US' pivot introduced the risk of *full* U.S. troop withdrawal from the peninsula (Kim 1970; Kwak 2003). Like their Vietnamese allies, South Korea believed they would need to defend against a militarized, Communist-backed neighbor.

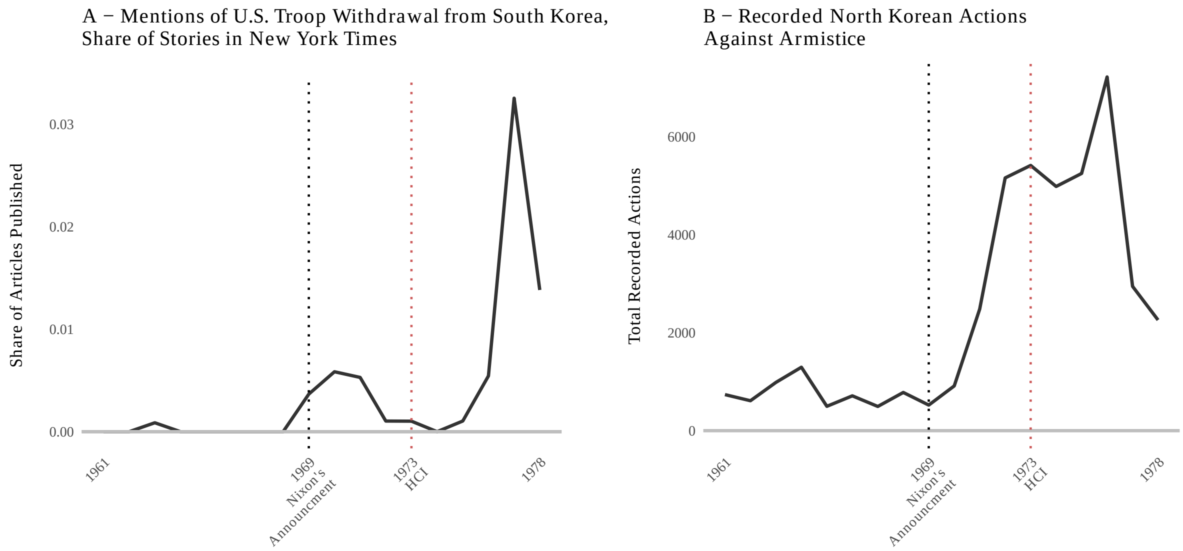
The threat of U.S. withdrawal hung through the 1970s. Figure 1 Panel A plots the occurrences of Korean troop withdrawal stories, measured as the share of New York Times articles containing the terms "South Korea" and "troop withdrawal." The first hump corresponds to 1970 and 1972. Confirmation of the U.S. withdrawal from the peninsula came in 1970 and "profoundly" shocking Park, who had expected exemptions from Nixon's doctrine [Rogers (1970); Nixon (1970); Kwak (2003); p.34]. The pullout of 24,000 troops and three air force battalions from the peninsula in 1971 were seen as only the beginning. The second jump in articles corresponds to the 1976 U.S. presidential campaign. Democratic candidate, Jimmy Carter, campaigned on ending U.S. assistance to Park, including total withdrawal, reaffirming these commitments upon his election (Han 1978; Taylor, Smith, and Mazarr 1990; Lee 2011).[10].

Sea change in U.S. foreign policy followed a period of intense militarization by the North, as well as increased provocations. Figure 1, panel B plots the escalation of "actions again the amnesty treaty" (the post-Korean War treaty) (Choi and Lee 1989).[11] In the late 1960s,

[9]There is no ambiguity as to the security pretext for the HCI drive. For a summary of HCI in the context of building a domestic defense, see (H.-A. Kim (2011)). "When President Richard M. Nixon declared his Guam Doctrine in 1969 to initiate U.S. military disengagement from Asia, Park's fear of the Americans' departure pushed him to initiate an aggressive HCI drive to develop a defense industry by 1973" (Moon and Jun (2011), p.119).

[10]Kim, Shim, and Kim (1995) notes the political motivations for HCI were "*magnified by the Carter administration's plan to completely withdraw U.S. ground forces.* [emphasis my own]" (ibid, p.186). Park's eventual assassination, however, complicated Carter's ambitions

[11]Actions against the amnesty treaty include border crossings, military exercises, and other acts of antagonism.



Search terms: South Korea+Troop Withdrawal.

Figure 1: Political Events Behind the Heavy Chemical and Industry Drive

the DPRK launched a wave of attacks and the South experienced a number of high-profile security emergencies (Scobell and Sanford 2007). By 1971, U.S. officials warned, "our front-line is a half step before crisis" [Kim (2001); p.55]. In the early 1970s, the North rivaled the South Korea—militarily, and perhaps even economically.[12] The North had emerged from the Korean War with an industrial advantage. And since the 1960s, aided by Communist allies, they pursued a total military-industrialization campaign (Hamm 1999). South Korea had not kept pace. Upon Nixon's pullout, the ROK had no domestic arms industry, nor the scale of industry to support it. Without U.S. troops, the ROK relied wholly on vintage arms and stocks incapable of absorbing a DPRK blitz (Cushman 1979; Eberstadt 1999). These military-industrial deficiencies catalyzed HCI, shaping the scope of IP, which I describe next.

Sectoral Choice The HCI drive was announced on January 12, 1973, after a period of covert planning.[13] Using trade policy and investment incentives, HCI targeted six classes of "strategic" industry: steel, non-ferrous metals, shipbuilding, machinery, electronics, and petrochemicals (Lee 1991; Stern et al. 1995). Table A1 lists nearly 100, 5-digit industries that fell under HCI.

The choice of sectors were driven by two forces: strategic goals and feasibility (H.-A. Kim 2011). First, HCI sectors were necessary for military-industrial modernization, as the South prepared for a future without military assistance. Heavy industries were a linchpin for future defense production. For Park and his regime, steel embodied just one such critical ingredient (Rhyu and Lew 2011). Before 1973, the economy lacked the inputs to develop a military-

[12]The exact growth rate of North Korea is mysterious. Some North Korea scholars contend that, conservatively, Northern growth dominated the Republic's at least in the early 1970s [Eberstadt (2007); p.xi]. According to Noland *et al.* "conventional wisdom is that per capita income in North Korea exceeded that of South Korea well into the 1970s" [Noland, Robinson, and Wang (2000); p.1769].

[13]The HCI plan is often conflated with Korea's Third Five Year Economic Development Plan (1972-1976), which the HCI announcement effectively interrupted (Lee 1991).

industrial base comparable to the North, which inherited heavy industry following the war. Early attempts at arms manufacturing were undermined by "inadequate materials and the lack of precision production. Koreans realized the critical importance of creating a more advanced industrial base" (ibid, p.375).

Second, the 1970s crisis compelled Korea to choose wisely. Technocratic planning and history limited IP to a set of feasible projects. As they had done with earlier development planning, HCI engineers and technocrats used feasibility studies to winnow the scope of policies (Stern et al. 1995; Adelman 1969).[14] Jet engines and missiles, for example, were rejected as beyond their capability. Importantly, however, the regime carefully studied the industrial projects and IP of other countries (Perkins 2013). Korean planners, in particular, saw their economy as akin to Japan—lagged. Japan's experience gave Korea a template of sectors for which they had potential (Kong 2000; Moon and Jun 2011).[15] The New Long-Range Economic Plan of Japan (1958–68) was used as a near literal blueprint for HCI.

Policy Mix and Liberalization HCI deviated from South Korea's earlier strategy. Before 1973, Korea pursued blanket export promotion over industry-specific incentives (Krueger 1979; Westphal and Kim 1982; Westphal 1990).[16] In contrast, HCI-era IP was decidedly targeted. This section describes HCI's two main policy levers: 1) investment incentives and 2) trade policy.

First, investment incentives were a vital ingredient in the HCI policy mix, notably directed credit (see: Woo 1991). In 1974, the National Investment Fund (NIF) promoted long-term investment (e.g. machine equipment and factory construction) with subsidized loans to HCI sectors (Koo 1984; Kim 2005).[17] These "policy-oriented" loans were allocated to commercial banks and, in particular, state-run development banks (Koo 1984). Figure A1 shows the clear pattern—and volume—of lending by a principal NIF lender, the Korea Development Bank (KDB), during the period. The plot conveys the differential pattern of lending across sectors (2-digit). Red indicates targeted sectors, while gray indicates non-targeted sectors. The divergence in post-1973 lending is clear.

Post-1973 tax policies were reformed to drive investment in HCI sectors over general export activity (Kwack 1984; Kim 1990).[18] Figure A2 illustrates the sectoral pattern of incentives before, during, and after HCI. Plot displays the average effective tax rate (percentage) on the returns of capital, accounting for changes in industry-specific subsidies. Thick lines show the

[14] *Planning* in the South Korea context refers to a type of policy-making distinct from centralized state planning in Communist regimes. Instead, the ROK's Economic Planning Board utilized *indicative planning* used by Western Germany, France, and Japan.

[15] Beyond steel and metals, shipbuilding is an example of using Japan to justify sectoral choice. "Korea found in Japan's shipbuilding industry a cynosure" argues Woo (1991), were "the Korean strategy to promote shipbuilding was very simply a carbon copy of Japan's" (p.137). Government documents from 1973 "dutifully note Japan's export performance in 1955-71 and its composition of manufactures" [Kim and Leipziger (1993); p.18-19].

[16] Export incentives "were administered uniformly across all industries" [Westphal and Kim (1982); p.217-218]. For example, the main role of credit policies "was to support export 'activity' rather than specific industries" [Cho (1989); p.93].

[17] The NIF was largely funded through bond sales financial institutions. According to Byung-kook Kim, "NIF was an outright forced savings program," selling bonds on public non-banking institutions and then requiring 8 percent of wage income to be levied into pensions [B.-k. Kim and Vogel (2011); p.226].

[18] Prior Export tax incentives "no longer played a central role compared to that played by [the] industry incentive scheme," which aimed to concentrate investment in "a relatively small number of industries" [Trela and Whalley (1990); p.19]. "Special Tax Treatment for Key Industries" under the *Tax Exemption and Reduction Control Law* was one such example of HCI investment incentives.

average rates by HCI and non-HCI sectors, where thin lines show rates by 2-digit industry. Figure A2 clearly shows the sharp divergence in sectoral incentives between 1973 and 1979, during which Korean law granted generous credits and depreciation allowances for HCI investments. Importantly, A2 also conveys the convergence of policies before 1973 and after 1979.

Second, trade policy was reoriented to HCI. Pre-1973 trade policy was akin to "a virtual free trade regime" for exporters, who were exempted from import controls (Nam 1980; Westphal 1990). 1973 marked the end of the earlier regime, eliminating the allowances and import subsidies granted, broadly, exporters.[19]. After 1973, however, HCI industries enjoyed the 1960s-style import assistance (Woo 1991; Cho and Kim 1995). For example, through the 1970s, HCI producers were exempted from up to 100 percent of duties and tariffs on imports.[20]

HCI policies were ephemeral. I use 1979 as the *de facto* end date of the drive. On October 26 of that year, President Park was assassinated by Korean Central Intelligence Agency director, Kim Jae-kyu. The murder marked the termination of the Park regime's core policy agenda (Cho and Kim 1995; Lee 2011).[21] A new, emergent rejected the *dirigism* of the Park era with repeated rounds of liberalization. Between 1979 and 1980, the South pursued "investment adjustment" for targeted sectors, as trade liberalization progressed in earnest (Kim 1988, 1994; Kim and Leipziger 1993). The import liberalization ratio climbed from 68.6 in 1979 to 76.6 by 1982. That same year, maximum import exemptions were reduced.[22] The banking sector was also liberalized, notably with reforms in 1981 and 1983. Accordingly, the share of government loans to industry shrank, as interest rates between strategic and non-strategic sectors converged (Cho and Cole 1986; Nam 1992). Public finance reforms also limited special tax treatment for key industries. By 1982, the gap in effective corporate tax rates between strategic and non-strategic industries closed (Kwack and Lee 1992), also show by A2.

3 Data

Though East Asian modernization was a relatively recent event, detailed machine-readable data is rare. This study has entailed creating a new dataset on South Korean manufacturing and trade. The following section describes this effort, including the digitization process. I leave the details of data harmonization, especially the crosswalk process, to Data Appendix C.

The main sources of industrial data were digitized from records published in the Economic Planning Board's (EPB, the predecessor to the modern South Korean statistical authority)

[19]Wastage allowances for exporters were eliminated that year, followed by exemptions on capital good imports and raw material imports (Hong 1992; Nam 1995)

[20]According to Park (1977) "key industries," on average, enjoyed 80 percent tariff exemptions across industries (with the exception of petrochemicals) (ibid, p.212). Similarly, HCI exporters were allowed to purchase inputs from foreign investors and licensors (Castley (1997)).

[21]On the politics of the assassination, see Lee (1980). Earlier in 1979, the government had announced the "Comprehensive Stabilization Program," in efforts to address the apparent macroeconomic instability brought on by turbulent world economic conditions and HCI's imbalances. Nonetheless, the death of Park truly opened the door for wide-scale liberalization—economic and political.

[22]Major reductions in maximum exemptions occurred in 1982 and 1984. Though average import liberalization ratios gradually climbed through the HCI period 1973–1979, full import liberalization was only seriously discussed in 1978, but economic instability in 1979–1980 postponed it until the post-Yushin era [Kim (1988); pg.1].

Mining and Manufacturing Surveys and Census (MMS) from 1970 to 1986. The industrial census records were published approximately every five years from 1970 onward, with intercensal statistics published each non-census year as individual survey volumes. Most core variables are consistent across MMS publications, allowing me to construct a panel dataset from digitized materials.

The digitized MMS dataset reports statistics at the lowest level of aggregation, the 5-digit industry level'; The South Korean MMS is enumerated at the establishment-level, with statistics aggregated to the industry-level for anonymization.[23] Since the HCI policy was an industry-level policy, MMS industrial data is suitable for empirical evaluation, capturing (as opposed to firm-level) outcomes at a reasonable level of disaggregation. A second source of MMS data comes from tape data sold by the EPB in the 1980s. These machine-readable statistics span the period 1977–1986. Like the digitized statistics, tape data reports annual industrial statistics at the 5-digit level. Both digitized volumes and the machine readable data were harmonized into a single, consistent panel dataset for 1970-1986.

Table 1 reports pre-1973 averages and standard deviations for major industrial variables used in this study. Two data transformations are used for both dependent and independent variables: log normalization (with a small constant) and inverse hyperbolic sine (IHS) normalization. Since many variables, such as capital acquisition variables, have many 0s, the IHS transformation is preferred. While IHS approximates log, estimated coefficients are not as readily interpretable. Since in almost all cases log and IHS estimates are nearly equivalent, log-normalized interpretations appear in the text. IHS estimates are reported in the tables.

Data on intersectoral linkages come from the Bank of Korea's 1970 "basic" input-output tables.[24] Hard copies were translated from to English and then digitized.[25] These tables encompass around 320 sectors. Price statistics were also digitized from Bank of Korea publications, in particular historic export and import price indices.

Statistics from the BOK and EPB are use different industrial codes. Combing data from these bodies required constructing crosswalk schemas from historic publications. The Data Appendix describes the harmonization of industry, price, and I-O data require harmonization,

Trade data comes from both conventional and unconventional historical sources. Statistics on bilateral trade are at the 4-digit (ISIC, Revision 2) level, extracted from the World Bank's World Integrated Trade Solution (WITS) database. This data includes values and quantities of exports and imports for the study period.

Trade policy statistics were extracted from hard copy publications. Product level (Customs Commodity Code Number or CCCN) measures of quantitative restrictions (QRs) and tariffs come from Luedde-Neurath (1986). While my study uses mostly annual data, trade policy measures are only available for 1968, 1974, 1976, 1978, 1980, and 1982. Nevertheless, broadly

[23] To illustrate this level of aggregation consider two sectors: 35291, *Manufactures of adhesives and gelatin products*, and 35292, *Manufactures of explosives and pyrotechnic products*. As of the time of this study, micro data from the period is not available. Note that because the census is enumerated at the establishment-level, as opposed to the firm, this precludes analysis of firm competition.

[24] 1970 tables report *total* values of inter-industry flows and do not differentiate between *domestic* and *imported* activity.

[25] At the time of this study, machine readable I-O tables for 1970, were not available from the Bank of Korea.

this data is the most detailed for the period (Westphal 1990).[26] This data is also notable in that it contains measures for non-tariff barriers, notably QRs (Goldberg and Pavcnik 2016). I describe Luedde-Neurath (1986)'s coding of QRs in the Data Appendix.

Trade policy and trade flow data were mapped to my core industry dataset (1970-1986). For each 5-digit industry, I created separate protection measures for (nominal) output *and* input protection.[27] Output protection for industry i is simply the average tariff or QR score for that sector: output-tariff$_i$.

Since HCI used import exemptions, I calculate measures of input protection. The input tariff face by i (or QRs) are calculated as the weighted sum of tariffs (QR) exposure for each input into industry production, with weights taken from the 1970 I-O accounts (See: Amiti and Konings 2007). Input tariff (QR) exposure is calculated as input-tariff$_i = \sum_j \alpha_{ji} \times$ output-tariff$_j$, where α_{ji} are input cost-shares for industry i.

4 Theoretical Framework

I frame my empirical analysis using a stylized general equilibrium model of a network economy. I do this for two reasons. First. I specify how HCI-style industrial policy should (directly) impact targeted sectors. Beyond emphasizing with outcomes associated with temporary policy, doing so highlights where political economy factors may inhibit the application of policy. I test for this empirically. Second, I provide a simple way of showing the impacts of HCI policies on forward-linked and backward-linked sectors. I distill his discussion into three simple predictions that guide my empirical analysis.[28]

Consider a basic multi-sectoral economy populated by N industries (Jones 2008; Acemoglu, Akcigit, and Kerr 2016). Each sector, or industry, produces a single good, i in a competitive market. A representative consumer has Cobb-Douglass preferences these goods. Industries are either treated or non-treated types: $i \in \{\text{HCI}, \text{Non-HCI}\}$.

Each good is produced with a Cobb-Douglass technology: $y_i = A_i k_i^{\alpha_i^k} l_i^{\alpha_i^l} \prod_{j=1}^N x_{ji}^{a_{ji}} \prod_{j=1}^N m_{ji}^{b_{ji}}$, where y_i is output from industry i. As usual, I denote A_i as productivity, k_i is capital, l_i is labor. Subscript, ji demarcates the direction of transactions from industry j to industry i. Thus, a_{ji} is the cost share of input j used by industry i. With Cobb-Douglas production and perfect competition, a_{ji} are entries in the *domestic*)* input-output matrix, capturing the share of good j used in the total input bundle of industry i. *Imported* intermediates cost-shares, similarly, are captured by b_{ji}.

These industrial policies are modeled in the following way. Our environment is populated by distortions, or wedges. For each industry i, these distortions act as taxes on capital $(1 + \tau_i^R)$ and on imported intermediates $(1 + \tau_i^M)$. Targeting is tantamount to removing these

[26] Archival administrative data has been collected as of this study. Most empirical studies of Korean trade policy use highly aggregated data.

[27] For simplicity, this study follows the contemporary practice of using nominal rather than effective rates of protection.

[28] A full derivation of this model is presented in my Theoretical Appendix.

wedges for an HCI industry. Consider the impacts of investment subsidies and trade policy (exemptions from customs),

> **Prediction 1:** Removing import restrictions and increasing capital subsidies promotes real output growth in targeted industries.

> **Prediction 2:** Moreover, both levers should decrease output prices in targeted industries.

There are good reasons to suspect neither may happen in reality. First, in a world devoid of political frictions, Prediction 1 and 2 are straightforward. While in practice, *de jure* targeting may not translate into the implementation of IP. For example, if capital subsidies flow to inappropriate sectors, we may not observe investment and related outcomes. Development banks may lend to connected firms over priority industries (Lazzarini et al. 2015; Musacchio, Lazzarini, and Aguilera 2015) and weak bureaucracies may not enforce trade policy (Panchamukhi 1978). More fundamental reasons mean Prediction 2 may not materialize, as Schmitz Jr (2001) shows for IP and state owned firms, and Blonigen (2016) for global steel IP.

This framework shows how HCI policies can impact non-targeted industries through forward and backward-linkages. In this stylized setting, Cobb-Douglas preferences and technology guarantee that IP policy propagates in simple ways through input-output links.

First, consider a targeted industry j and a forward-linked sector i, which is non-targeted. Above we showed IP promotes an increase in j's output and a decrease in price. In our setting, it is straight forward to show that these movements correspond to similar changes in the downstream industry: a rise in y_j translates into higher y_i, and lower p_j leads to a decline in p_i. Intuitively, the strength of these impacts depend on the extent to which j is used by i.[29] By promoting the expansion of treated industries, IP benefits buyers through forward linkages.

Second, the expansion of targeted sectors also effects backward-linked industries (e.g. domestic industries supplying goods to HCI sectors). Consider an industry i that sells its output to HCI industry j. In a closed economy, IP that promotes the expansion of j also expands the demand for i through backward linkages.[30] In an open economy, HCI sectors often use *imported* inputs (m_{ij}) that compete directly with i. In which case, IP that promotes the expansion of j may harm local industry i through trade competition. Specifically, by lowering the price of imported inputs for targeted sectors, HCI trade policy can increase imports m_{ij} thereby reducing the output of domestic competitors.

Summarizing these two predictions:

> **Prediction 3:** Successful industrial policy confers benefits to forward-linked (downstream) industries. Output increases in industries purchasing targeted industry products. Prices in downstream suppliers decline;

[29] These effects are derived easily firm's optimization problem and price index, respective. Details are provided in the theoretical appendix. For similar downstream impacts of IP in a richer theoretical setting, see Forslid and Midelfart (2005).

[30] Given the assumptions of the model, this demand shock does not impact prices in this environment, as prices are wholly determined by the supply side of the economy.

Prediction 4: For targeted sectors, the trade industrial policy lowers the cost of importing intermediate inputs. If intermediate imports compete with domestic suppliers operating in the same market, then industrial policy creates a negative (demand) shock for backward-linked industries. Thus, suppliers exposed to import competition should contract.

The following empirical exercises are organized around these simple predictions, which structure the following analysis.

5 Direct Impacts of Industrial Policy

I start my analysis by focusing on the implementation and impact of HCI policy on (directly) targeted industry. I first describe my empirical framework: describing the issues of estimating industrial policy and describing my research design. I then turn to results. Before considering development outcomes, I provide evidence that *de jure* IP was truly implemented, then show results for developmental outcomes.

5.1 Empirical Framework

HCI as Quasi-Experiment The HCI context provides a natural experiment for analyzing the impact of infant industry policy. Since IP is state action, the allocation of policy is often governed by sub-optimal political forces. These confounders are both unobserved by the econometrician and negatively correlated with industry fundamentals. Prior empirical work shows a negative relationship between the effect of protection on development outcomes (Harrison 1994; Harrison and Rodriguez-Clare 2009; Rodriguez et al. 2001). Political also mean that temporary policy episodes are also rare. Subsidies and interventions create constituencies, many of which can lobby for permanent policy. Precisely because IP is purposeful—intended for specific industries and activity—empirical designs that utilize randomization are both rare and hard to interpret (Rodrik 2004).

My context is advantageous for estimating the impacts of an industrial intervention. First and foremost, the introduction and withdrawal of HCI introduces a useful variation in policy—through time and across industries. HCI was book ended by two external political factors that created this variation (see 2). International political crisis catalyzed HCI in 1973, breaking from the earlier industry-agnostic policy regime in favor of industry-specific incentives. President Park's assassination in 1979, introduced another policy break, liberalizing industry-specific incentives.[31] Importantly, the termination of HCI allows me to study a temporary policy episode.

[31]Importantly, while the post-Park regime pursued economic and not political liberalization (which occurred later in 1987).

Industries selected by HCI were infant industries, as opposed to sunset, industries. Those such as shipbuilding and chemicals were small and not-entrenched[32] As often is the case with external threat, the regional crisis behind HCI meant policy was guided by strategic criteria by a willing regime. An insulated planning apparatus reduced the potential of choosing sectors that contradicted notions of comparative advantage (shown in 2).[33]

Second, the details of the Korean context address shortcomings of earlier IP work. Responsive governments are motivated to support declining ("sunset," sectors.[34] At the same time that South Korea supported the "sunrise" shipbuilding industry, the Social Democratic Sweden government supported their sunsetting ship sector to ease their exit from the market. Similar examples are found across the OECD[35]

Poor institutions confound evaluation of interventions. Industrial policy has long been viewed as a core vehicle for rent-seeking (Krueger 1974). For thus reason *de jure* industrial policy treatment cannot be taken at face value. Clientalism, capacity constraints, and political forces mean interventions are targeted to industries that contradict comparative advantage (Rodrik 2005; Lin and Chang 2009; Lin 2012).[36] Where *du jure* policy is coherent, its implementation can be undermined by similar forces.[37] Incentives may not translate into capital formation, as development banks may lend to connected firms over priority industries (Lazzarini et al. 2015; Musacchio, Lazzarini, and Aguilera 2015) and administrators may not implement trade policy (Panchamukhi 1978).

Estimation Framework The first estimating equation explores the relationship between industrial targeting and industrial development during the big push. This framework estimates the year-specific differences between targeted and non-targeted industries relative to a 1972 baseline, the year before the announcement of the industrial policy drive. Concretely, I estimate the following specification,

$$\begin{aligned} Y_{it} = & \sum_{j=1970}^{1986} \beta_j \cdot \left(\text{Targeted}_i \times \text{Year}_t^j\right) + \\ & \sum_{i=n} \alpha_n \cdot \text{I}_i^n + \sum_{j=1970}^{1986} \lambda_j \cdot \text{Year}_t^j + \sum_{j=1970}^{1986} X_i' \text{Year}_t^j \Omega_j + \epsilon_{it} \end{aligned} \tag{1}$$

[32]Woo-Cummings notes that during HCI, "[t]he chemical industry in Korea was built on practically nothing, unlike other industries that had some vested enterprises to start from. Korean dependence on imports of fertilizers from 1955-1961 was an amazing 100 percent" [Woo (1991); p.139].

[33]Park's consolidation of power allowed for the creation of a technocratic Heavy Chemical and Industry Planning Board that superseded competing political actors.

[34]For discussion of optimal sunset IP: (Gray 1973; Hillman 1982; Flam, Persson, and Svensson 1983).

[35]Japan's Ministry of International Trade and Industry (MITI) notably intervened in troubled manufacturing sectors, as did the U.K.'s National Enterprise Board (Hindley and Richardson 1983; Sawyer 1992). Long before Obama's bailout of GM in the US, Reagan defended embattled U.S. automakers using trade interventions.

[36]For example: Tommy Suharto, son of Indonesia's General Suharto, received gracious subsidies to develop a national automobile industry—without any prior experience or competence in manufacturing (Eklof 2002; Fisman and Miguel 2010).

[37]The Philippines' Ferdinand Marcos, Park's contemporary, used ambitious industrial projects as a vehicle for cronyism rather over industrial development, using technocratic planning as a facade for competency (Boyce 1993; Kang 2002; White 2009).

where Y is an outcome, i indexes 5-digit industries, and t indexes the years 1970–1986. The treatment variable *Targeted* is an indicator equal to one if a sector is targeted by the Heavy Chemical and Industry committee, zero otherwise. Specification 1 includes both industry-level fixed effects $\sum_n \mathrm{I}_n$ and time period effects $\sum_j \mathrm{Year}_j$.

Preferred specifications include a set of pre-treatment variables that capture unobserved productivity that may correlate with policy. These include pre-1973 measures of plant size, wage bill, raw material costs, employment, fixed capital investment, and labor. Controls (trend) are interacted with time period indicators: $\sum_{j=1970}^{1986} \mathrm{X}_i' \mathrm{Year}_t^j \Omega_j$, as time time-invariant controls are absorbed by industry fixed effects.

The coefficient of interest in equation 1, β_j, gives the estimated difference between targeted and untargeted sectors in year j relative to 1972, the year prior to the policy. Together, the set of estimated coefficients reveal the differential evolution of targeted industries through time. Before the policy, I expect no difference between targeted and untargeted sectors: $\hat{\beta}_{1970} \approx \hat{\beta}_{1971} \approx \hat{\beta}_{1972} \approx 0$. After the 1973 policy announcement, I expect increasing differences between the two types of sectors, $\hat{\beta}_{1974} \leq \hat{\beta}_{1975} \leq ... \leq \hat{\beta}_{1979}$, until 1979, when Park Chung-hee was assassinated and the dissolution of HCI was binding. For years after 1979, we may expect that the estimated coefficients decline after subsidies are removed: $\hat{\beta}_{1979} \geq \hat{\beta}_{1980} \geq \hat{\beta}_{1981} ... \geq \hat{\beta}_{1986}$.

While estimates from the flexible specification in 1 convey the dynamic impacts of the policy, the *average* impact of industrial targeting before and after 1972 is also useful. In this case, I estimate the average impact of HCI on by interacting the $Targeted$ sector indicator with a post-announcement indicator:

$$
\begin{aligned}
Y_{it} = & \beta \cdot \left(\mathrm{Targeted}_i \times \mathrm{Post}_t\right) + \\
& \sum_{i=n} \alpha_n \cdot \mathrm{I}_i^n + \sum_{j=1970}^{1986} \lambda_j \cdot \mathrm{Year}_t^j + \sum_{j=1970}^{1986} \mathrm{X}_i' \mathrm{Year}_t^j \Omega_j + \epsilon_{it}
\end{aligned}
\tag{2}
$$

where the estimated coefficient of interest, β, captures the average growth in treated industries before-after the policy announcement. The $\mathrm{Targeted}_i \times \mathrm{Post}_t$ interaction is the only substantive difference between specification ((2)) and the previous "flexible" specification ((1)).

5.2 Policy Results: Did Policy Bite?

I now confirm that industrial policy packages significantly changed for targeted relative to non-targeted sectors. First, I study the impact of subsidies by examining whether investment activity in targeted industries changed significantly over the HCI period (1973–1979), relative to non-targeted industries. How did the relaxation of credit constraints affect fixed and variable costs? Given that many subsidies were intended for capital accumulation, I examine measures of gross fixed capital formation. I then turn to the effects of HCI on (real) capital investment across different assets. Credit also financed the purchase of other advanced intermediates. Thus, I also examine changes in (real) materials expenditure, following Banerjee and Duflo (2014) and Manova, Wei, and Zhang (2015).

Next, I turn to protectionism. HCI policies were long associated with trade policy in the form of output protection and import protection. Exemptions from tariffs and non-tariff barriers (quantitative restrictions) were given to the purchasers of imported inputs and protective measures (purportedly) sheltered domestic industry from international competition. Thus, in addition to subsidy variables, I analyze changes in trade policies over the planning period.

Responses to Targeted Subsidies Figure 2 conveys the relative changes in (gross) fixed investment measures and materials investment for the period 1970–1986, relative to a 1972 baseline. Panels A and B plot the flexible coefficient estimates of equation (1) for each year. Figure 2 Panels C and D examine differences in targeted versus non-targeted industry capital acquisitions for two types of assets: equipment and buildings, respectively; Because state lending, especially from Korea's National Investment Fund (see Section 2), emphasized the financing of equipment purchases and factory expansions for HCI firms. All specifications include both 5-digit industry fixed effects, period effects, and include baseline covariates (interacted with period effects). Data for disaggregated capital acquisitions is only available until 1982 and does not include acquisitions for the census year 1973. Light gray bands represent standard errors for each coefficient, clustered at the 5-digit industry level.

Figure 2 gives four insights. First, targeted and non-targeted sector outcomes are not significantly different before the policy announcement. Second, there is a conspicuous divergence in purchases of total intermediate inputs and fixed capital—both in aggregate capital and across all asset classes. Third, this divergence wanes after Park's 1979 assassination and the subsequent liberalization of the economy. Across outcomes, sectoral differences decline relative to their 1979 peak, corresponding to the winding down of lending in the early 1980s.[38] Fourth, plots for disaggregated capital investment are consistent with the investment pattern incentivized by state-lending policy, which favored equipment and construction investment (Yoo 1990; p.39-41; World Bank 1987).[39]

This last point is worth highlighting. Yang (1993) shows that preferential investment subsidies in Taiwan (late-1980s) did not actually contribute to capital formation. Echoing a common criticism of industrial policy, he provides survey evidence that investment would have occurred in the absence of investment incentives. Lazzarini et al. (2015) show that for Brazil, capital from the BNDES development bank did not increase investment, and instead was allocated to politically connected firms where investments would have otherwise have taken place. Rent-seeking and clientalism surrounding industrial policy may mean *de jure* policy does not translate into actual policy.[40]

[38] The second oil crisis also corresponds to the year 1979. While the oil crisis should negatively impact HCI industry, the plots reveal a sustained dip in differences through the 1980s. Moreover, the first global oil shock (1973–1974) coincided with the beginning of the policy, and a commensurate dip does not appear in the estimates for the period.

[39] The pattern also indicates the source of worries of growing excess capacity prior to the early 1980s (Kim 1994).

[40] For example, Marcos forced U.S. auto parts manufacturers out of the Philippine market, granting monopoly rights and industrial subsidies to crony Ricardo Silverio, who promptly mismanaged nearly a billion pesos in liabilities before bankruptcy in 1984 (Kang 2002; p.140; White 2009).

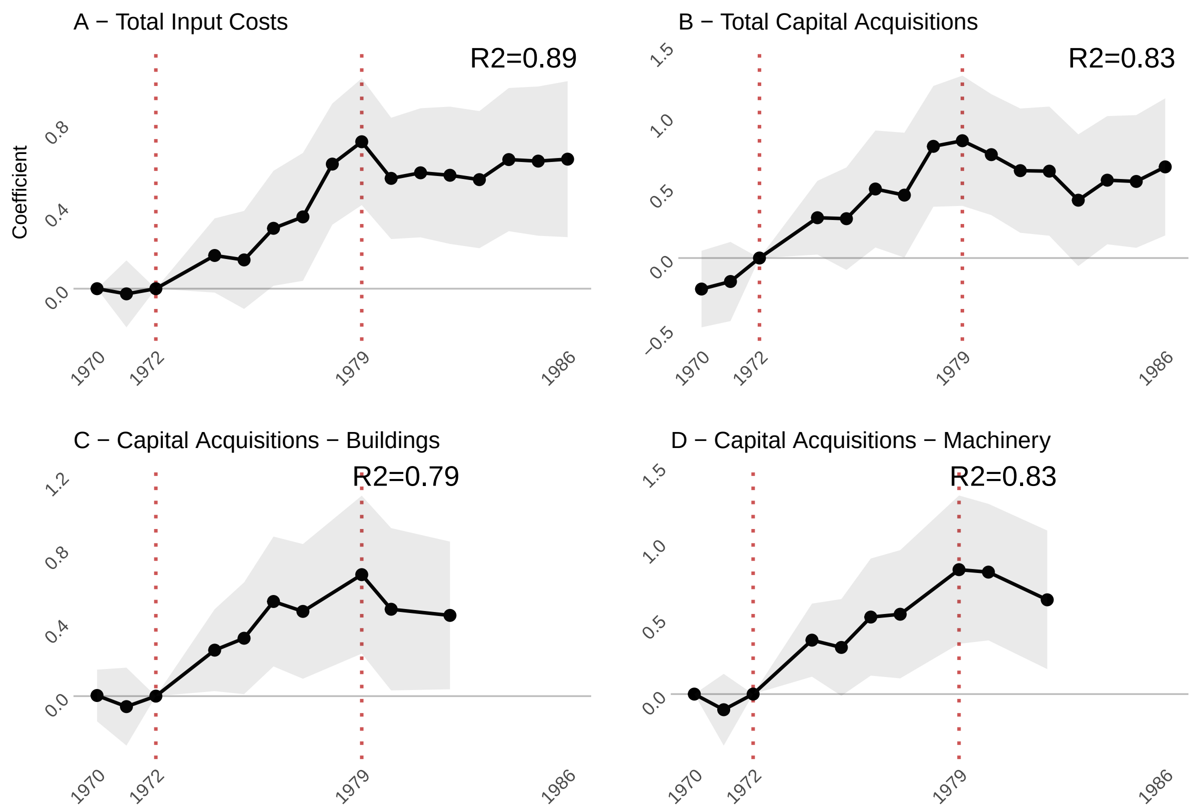


Figure 2: Industry Responses to Targeted Subsidies, Estimated Differences in Total Costs, Total Gross Capital Formation, and Capital Formation Across Asset Classes, 1970-1986, Relative to 1972

While Figure 2 shows the *temporal* pattern of estimates, it also is informative to present the total average estimates for the policy period. Table 2 presents the average impact of HCI on total value of (real) gross capital formation and total (real) value of intermediate input purchases. Columns (1)–(3) report estimates for capital acquisitions, and (4)–(6), material costs outcomes. Columns (1) and (4) show estimates exclusively include two-way fixed effects. Columns (2) and (5) add baseline controls. Preferred estimate appear in (3) and (6), which include linear pre-trends in baseline controls (interacted with a period effects).

Estimates for average total capital investment in Table 2, column (3) indicate the average difference in total gross fixed capital investment is .689 (1 percent level of significance)—nearly a 99 percent increase in acquisitions for targeted sectors over non-targeted industries, relative to 1972 levels. Similar estimates for total materials costs (column 6) suggest a 61 percent increase in relative input use (.479 at a 5 percent level of significance).

Table 3 presents the average estimates capital assets classes: value of building and structure acquisitions (column 1); machinery (2); land (3); and transportation equipment (4). Estimates for machinery acquisitions are the strongest, indicating an 85 percent growth (1 percent level of significance) in machinery acquisitions, followed by building and land acquisitions are the next largest. Transportation investment shows the smallest and least precisely estimated effects: 28 percent (10 percent).

Trade Policy Differential responses of trade policy are more ambiguous than the subsidy estimates above. Input protection significantly changes (declines) for targeted industries. However, *output* protection does not change.

Figure A5 reports flexible regression estimates for tariffs and quantitative restrictions for the periods 1974, 1978, 1980, and 1982, relative to 1970, the earliest year in the sample. The plotted estimates correspond to specifications that include year and industry fixed effects, as well as full baseline controls and pre-trends interacted with time periods. The input-output table weighted exposure of HCI industries to input tariffs and input QRs is significantly decreasing over the same period.

A well-recorded fact of South Korean trade policy is that few import restrictions were actually binding, thus nominal (legal) protection measures are noisy indicators of trade restrictiveness (Mason 1980; Nam 1995). While the HCI period is associated with highly interventionist policy, in fact South Korea was actively liberalizing its trade policy from the late 1960s. From 1970 to 1980, import controls dropped. However, after the post-1979 liberalization episode, some of the import controls for targeted industries remained, as is evident from the output tariff/QR panels of Figure A5, and liberalization of trade policy occurred mostly after 1982, the end of the sample (Yoo 1993). Moreover, import controls are significantly lower for only a few periods for tariffs and QR estimates, since import restrictions were generally falling over the period.

Table 4 simplifies the flexible regression analysis, showing average estimated changes in trade outcomes after 1973. Columns (1)–(6) report estimates for average output protection; columns (7)–(12), average input measures. Columns (1), (4), (7), and (10) include only time and industry fixed effects. Columns (2), (5), (8), and (11) include baseline control averages (with period interaction). Columns (3), (6), (9), and (12) add pre-trend controls. Importantly, differences in average output protection for targeted industry is insignificant and the estimates straddle zero.

Input protection measures, however, decline significantly for targeted industries and results are robust across specifications. Point estimates for QRs for preferred specifications are -.045 (5 percent level). Estimates for average import tariffs are more negative: -.192 (1 percent level), translating into an average of 21 percent lower input tariff exposures for targeted industries relative to non-targeted after 1973.

5.3 Main Results: Manufacturing Growth and Industrialization.

Having shown that industrial policies vary as expected over the big push period, I now turn to exploring the impact of policy on industrial development outcomes.

Growth (Prediction 1) Figure 3, Panel A plots estimates from equation (1) for industrial output (real value shipped). Estimated coefficients include time and year fixed effects, as well as time-varying baseline controls and associated pre-trends. The estimates illustrate a distinct

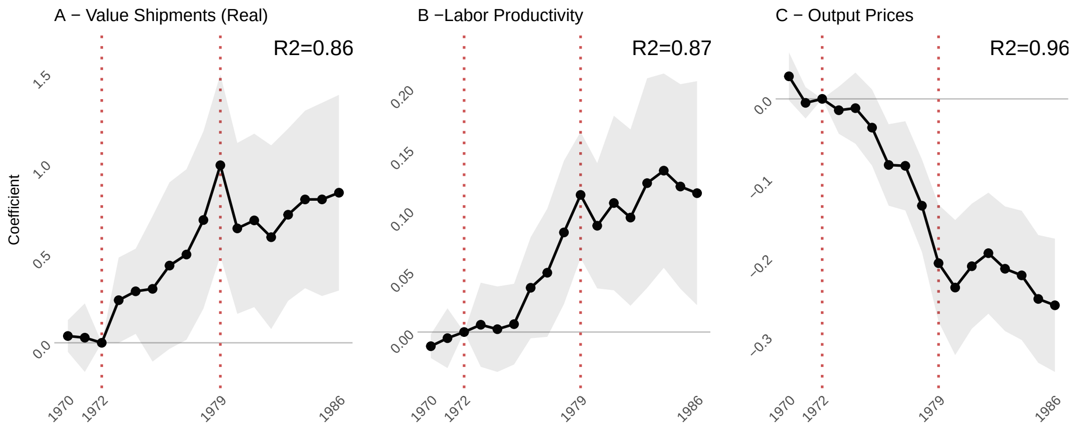


Figure 3: Estimated Differences in Value of Output, Labor Productivity, and Output Prices, Relative to 1972 Baseline, 1970-1986

pattern similar to that of the industrial policy plots in Section 5.2, in particular the results for capital subsidies.

The industrial growth results in Figure 3, Panel A convey three key insights. First, conditional on controls, the plots show no pre-treatment differences between targeted and non-targeted industries prior to the 1973 policy announcement. Second, after 1973, estimated differences between treated and non-treated industries widen markedly. Finally, following Park Chung-hee's assassination and the retrenchment of interventions in 1979, estimated differences in output decline a bit but nonetheless remain significantly higher than their 1972 level relative to non-targeted sectors.

For completeness, Table A2 column (3) shows the estimates associated with Figure 3 Panel A, along with two other measures of output: gross output (4)–(6); and value added (7)–(9). Models in columns (3), (6), (9) report estimates for models with the full set of controls. Columns (2), (5), and (8) exclude pretrends. Specifications with only year and industry fixed effects correspond to columns (1), (4), and (7). The table confirms that the plotted coefficients presented in Figure 3, Panel A are robust across various measures of output and controls.

Table 5 presents estimates of the average effect of targeting on industrial growth for periods after 1973. Preferred estimates for (real) value shipped in column (3) indicate average changes of 0.614 at the 1 percent level of significance. These estimates translate into a nearly 85 percent difference in industrial growth between treated and untreated industries. Similar estimates for gross output (6) and value added outcomes (9) show an 81 percent (5 percent significance) and 77 percent (1 percent significance) difference, respectively, in growth between the targeted and non-targeted sectors for the same period.

Factor Productivity and Prices (Prediction 2) Figure 3, Panel B visualizes the pattern of coefficient estimates for labor productivity, measured as (real) gross output per worker. The pattern for labor productivity reveals the same pattern for the levels of output in Panel A.

Table 6 reports average estimates for labor productivity. Columns (1)–(3) show estimates for value added labor productivity; columns (4)–(6), gross output labor productivity. The preferred specifications for estimates of industrial productivity appear in columns (3) and (6) and correspond to an average relative growth in labor productivity of 3 percent (5 percent significance) and 9 percent (1 percent significance), respectively, for value added and gross output-based measures.

Figure 3, Panel C reveals the relative fall in output prices for targeted sectors. While labor productivity (Panel B) is an incomplete measure of productivity, the strong relative decline in prices during and after the HCI planning period are telling, as well as highly significant. Table 7, column (3) suggests output prices fell 11 percent more in targeted relative to non-targeted sectors (1 percent level of significance). Estimates for price outcomes results are robust across specifications.

Entry, Labor, and Industrialization The big push aimed to reallocate manufacturing activity from low value added, light industries to HCI sectors. Figure **??** reports standard structural change outcomes: Panel A, share of manufacturing output; and Panel B, share of manufacturing employment. The figures reveal that HCI effectively reallocated manufacturing activity to strategic industries. Furthermore, even after the retrenchment of HCI policies starting in 1979, the average share of activity in strategic sectors continued to grow more than other manufacturing sectors, relative to 1972 levels. In other words, Figure **??** makes the case that HCI policy induced structural change toward strategic industry.

Table 7 reports the average relative rise in share of manufacturing employment (Column 15) and share of manufacturing output (Column 18). These estimates suggest that the share of manufacturing employment for HCI industries rose over 40 percent (10 percent significance). The change in average share of manufacturing output is nearly identical (39 percent higher, 10 percent significance).

Figure A4 reports estimates for entry (Panel A), as measured by number of establishments, and total employment (Panel B). Column 9 reports a 30 percent rise in entry (new establishments); column 12 indicates an over 50 percent rise in employment, though estimates are insignificant at a 10 percent level. Importantly, there is no evidence of any significant rise in the average wages paid by targeted and non-targeted sectors, which is undoubtedly the result of Park's notoriously repressive labor regime and policies (Choi 1990; Kim 2003).[41]

Trade Outcomes The big push aimed to create internationally competitive HCI sectors and expand HCI exports. Generally, South Korean manufacturing exports continued to increase through the period: the share of exports to output rose from 13.0 in 1970 to 19.1 by 1980 (Hong 1987).

Table 8 column (6) confirms that the value of exports grew enormously relative to non-HCI sectors—by over 150 percent after the HCI announcement, significant at a 10 percent level when controlling for pre-trends and pre-treatment levels of exports and imports. While

[41] Itskhoki and Moll (2016) suggests wage suppression was an implicit industrial policy used by NICs.

insignificant, there was a decline in the relative value of imports of 25 percent (column 3). In other words, the massive increase in exports was not met with a proportional decline in imports, emphasizing that the HCI drive was not a traditional import substitution strategy.

Discussion In summary, the results above indicate that industrial targeting corresponded to significant rises in output, labor productivity, and measures related to productivity (such as increased exports and falling prices). In particular, the relative industrial growth and declining output prices in treated sectors are consistent with the predictions of my theoretical framework.

Nonetheless, the empirical relationship between industrial policies and industrial development is not obvious. In an important study on Japan's postwar industrial targeting, Beason and Weinstein (1996) find that low growth and declining sectors were targeted by Japanese industrial policies. As well, the authors find a negative relationship between productivity and targeting. In an empirical study of Japanese steel subsidies, Ohashi (2005) finds that industrial policies, while having contributed to learning-by-doing externalities, had statistically small contributions to growth. The relationship between trade policies and growth are often negative [Rodriguez et al. (2001); Harrison and Rodriguez-Clare (2009); p.4092].

The impact on prices are notable. Surprisingly, it appears that South Korean heavy industrial policy successfully decreased the price of domestically produced goods. The success of Korean IP in decreasing input prices contrasts with the policy experience of Egypt, India, and Turkey, whose heavy industrial policies may have effectively *increased* the relative price of capital and intermediate goods (Schmitz Jr 2001). These results are likely the norm rather than the exception with industrial policy. Blonigen (2016) shows global evidence that where steel IP raises the price of goods, this may harm downstream producers. With this in mind, I now turn to the downstream and upstream impacts of HCI in the following section.

6 Indirect Impacts of Industrial Policy

The case for industrial policy has frequently been motivated by the existence of positive spillovers beyond treated sectors (Krueger and Tuncer 1982; Pack and Westphal 1986; Grossman 1990; Krugman 1993). A classic literature in development highlighted the importance of linkages in justifying industrial interventions: notably Scitovsky (1954), Rasmussen (1956), and Hirschman (1958). Having shown the sudden growth of HCI sectors (Section 5.3), I examine how this growth impacted non-targeted sectors through the input-output network.

I use the traditional language of development economics (*linkages*) to explore network externalities from the policy. The impacts of HCI interventions propagates through *backward linkages*—to upstream firms selling goods to targeted sectors—or through *forward linkages*. That is, to downstream firms purchasing goods from targeted sectors.

The network plot in Figures 4 and A6 show the pre-treatment variation in linkages for the South Korean economy. They do so using input-output accounts for 1970, including both

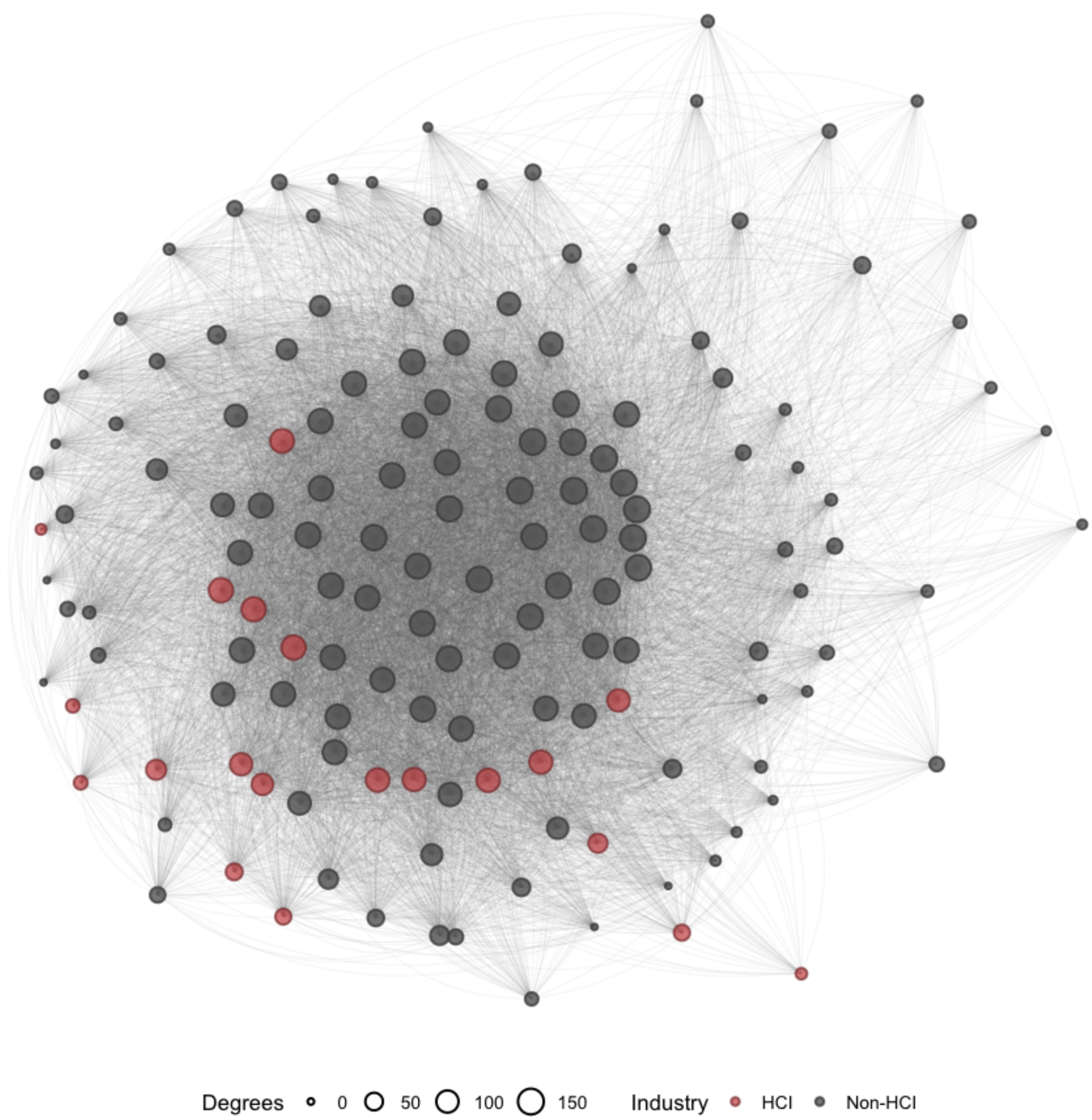


Figure 4: Targeted Sectors in the Korean Industrial Network, 1970 - Weighted by Number of Forward Links (Out Degrees)

tradable and non-tradable sectors.[42] Red nodes correspond to targeted industries; gray nodes, non-targeted. The size of each node is weighted by the total number of connections (or "degrees").

Figure 4 gives a sense of the distribution of forward links ("out degrees") from IO sectors; A6 shows the distribution of backward links ("in degrees") to IO sectors. I use the Kamada-Kawai algorithm (1989) to determine the graph layout, and nodes for industries with more links appear closer to one another. The targeted nodes vary considerably in terms of inward links and outward links. Moreover, targeted industries are not the most central nodes, nor are they weakly connected nodes on the periphery.

6.1 Measures of Network Exposure

To estimate the impact of industrial policy through intersectoral linkages, I construct measures of network exposure to industrial policy. First, I focus on the direct exposure to policy by using the total weighted share of sales (purchases) to (from) targeted sectors. However, sectors two degrees away from a targeted sector may also be exposed indirectly to the policy. Thus, I introduce a second measure of network exposure that captures *total exposure* to targeted sectors. To do so, I utilize a measure based on the famous *Leontief inverse*. As is well known, the Leontief inverse measure captures not only first-degree linkage effects between sectors, but also second, third, fourth, etc., degree relationships to (from) targeted sectors.

Direct Linkages Direct (first-degree) measures of network exposure are calculated in the following way. Consider industrial policy propagates through backward linkages. Let i be non-targeted industry. A single backward link is defined as a connection between industry i and industries purchasing their output, indexed by j. This relationship is denoted by the subscript ij.

Backward linkages are defined as the weighted sum of links between industry i and their direct buyers, j,

$$\text{Backward Linkage}_i = \sum_j \alpha_{ij} \quad , \text{with} \;\; \alpha_{ij} = \frac{\text{Sales}_{ij}}{\sum_{j'} \text{Sales}_{ij'}}. \tag{3}$$

Linkage weight α_{ij} is the value of i's sales to j, divided by the total sales of i to all purchasing industries j'.[43] Following traditional input-output analysis, the denominator of the weight in 3 is equivalent to summing over industry $i's$ total sales across all industries. This includes i's sales to tradable and non-tradable industries, as well as output sold as final products. Notice that α_{ij} is the very weight used in j's Cobb-Douglass production functions (Section 4).

[42] The main study uses the 320 × 320 sectors, while the network plots use the "medium" 153 × 153 input-output accounts for visual clarity. Summary "sectors," such as employee remuneration, and scrap sectors are excluded.

[43] For simplicity, I do not count i's sales to itself. Substantively, this means amounts to excluding diagonals α_{ii} in the input-output matrix.

We are interested in how industry i may be exposed to HCI policy vis-a-vis its total collection of backward (forward) linkages to (from) *targeted industries only*. Equation 4 captures the policy exposure by summing the share of sales (α_{ij}) to targeted industries only. Thus,

$$\text{Backward HCI Linkages}_i = \sum_{j \in \text{HCI}} \alpha_{ij} \tag{4}$$

In other words, (4) measures only linkages between i and targeted sectors $j \in$ HCI, where HCI is the set of targeted industries.

The preceding calculations were shown for *backward linkages*. The *forward linkage* versions of equation 4 are calculated in a similar manner. Measure Forward Linkages$_i$ is equal to $\sum_j \alpha_{ji}$ and Forward HCI Linkages$_i$ is equal to $\sum_{j \in \text{HCI}} \alpha_{ji}$. Similarly, a Forward non-HCI Linkages$_i$ captures these forward linkages to non-HCI manufacturing sectors. In other words, this forward linkage measure reflects the extent to which industry i's intermediate inputs are purchased from (as opposed to sold to) targeted industries $j \in$ HCI.

Total Linkages The measures calculated in equation 4 capture only direct spillovers from industrial policy. By appealing to the Leontief inverse, however, I construct a complete linkage measure that accounts for the n-degree effects of industrial policy through backward and forward linkages.

Define the technical coefficient matrix $\boldsymbol{A}$ as a matrix of the weights defined in equation 3, much like the traditional input-output matrix. The Leontief inverse is calculated by inverting the identity minus the technical coefficient matrix, $\boldsymbol{L} \equiv (I - \boldsymbol{A})^{-1}$.

$$\boldsymbol{A} \equiv \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1j} \\ a_{21} & a_{22} & \dots & a_{2j} \\ \vdots & \vdots & \ddots & \vdots \\ a_{j1} & a_{j2} & \dots & a_{jj} \end{bmatrix} \tag{5}$$

$$\boldsymbol{L} \equiv \begin{bmatrix} \ell_{11} & \ell_{12} & \dots & \ell_{1j} \\ \ell_{21} & \ell_{22} & \dots & \ell_{2j} \\ \vdots & \vdots & \ddots & \vdots \\ \ell_{j1} & \ell_{j2} & \dots & \ell_{jj} \end{bmatrix} \tag{6}$$

An entry ℓ_{ij} from the Leontief matrix $\boldsymbol{L}$ (6), captures how much a one percent increase in sector j's output raises sector i's output—accounting for not only the direct effects of j, but the totality of second, third, and n-th order effects.[44] If $\ell_{ij} = 1.2$, a one percent rise in industry k is associated with a 1.2 percent rise in i, accounting for *all* j's knock-on effects on i.

The total backward linkage effects of industrial policy are calculated as follows

$$\text{Total Backward HCI Linkage}_i = \sum_{j \in \text{HCI}} \ell_{ij}. \tag{7}$$

[44]In this method of input-output economics, more precisely, the entry refers to a rise in i's final demand.

The measure in equation 7 adds industry i's Leontief coefficients for purchasing sectors, j, but only for j's targeted by the HCI big push.[45] In other words, for an industry row i, I add together column-wise entries j for j's in the set of targeted industries.

One can think of Total Backward HCI Linkage$_i$ as being the n-degree analogue of the direct backward linkage measure (equation 4). Substantively, Total Backward HCI Linkage$_i$ captures the total exposure of industry i vis-a-vis targeted industries purchasing i's output.

The preceding calculations focused on total backward linkage exposure to industrial policy. The Total Forward HCI Linkage$_i$ measure is calculated in a similar way. However, instead of summing across columns for each row i, I sum across rows, indexed by j, for each column i. Row-wise sums are restricted only to suppliers in the set of targeted industries.

It is helpful to get an intuition for the types of sectors with strong connections to treated industries. Figure 5 lists non-targeted sectors with the highest *direct connections* to targeted sectors—measured by Backward HCI Linkages$_i$ and Forward HCI Linkages$_i$, Equation (4).[46] The left-hand side shows the top twenty 5-digit manufacturing industries with the highest share of inputs sourced from targeted sectors. These sectors include *Jewelry & related articles* and *Plastic products*, with over 60 percent of intermediate inputs coming from targeted industries. Qualitatively, many of the products with high forward linkages from HCI sectors are further downstream.

On the right-hand side, I list the top 20 industries with the highest direct, backward links to targeted sectors. Unsurprisingly, many of the sectors supplying a large share of output to targeted industries are raw material sectors, such as processed ores and various non-metallic mineral products. Many of these industries send over 50 percent of output to HCI industries.

6.2 Network Economies: Empirical Strategy

The proceeding analysis focuses on spillovers from targeted industries to external ones. Figure 6 shows the simple bivariate relationship between log growth (1972–1982) and the strength of (first-degree) 1970 linkages (Equation 4) from/to treated sectors. Grey dots represent non-targeted industries; red, targeted. Regression slopes are shown for non-targeted and targeted observations, though neither are significantly different.

The empirical pattern displayed in Figure 6 encapsulates the patterns I will explore below. The left-hand panel shows a positive relationship between the strength of forward-linkages from targeted sectors and (real) growth in the value of output shipped (1972–1982). The coefficient for the combined regression is $\hat{\beta} = 1.8350$ ($t = 3.110$). Panel A indicates a potentially strong positive relationship between output growth and the strength of forward connections from targeted sectors. On the other hand, the right-hand panel of Figure 6 shows a weakly

[45] As with the direct linkage calculations, I do not count on-diagonal Leontief coefficients. E.g.: ℓ_{ii}.

[46] Names of the sectors reflect both the harmonization of industry names through time, as well as the matching of input-output tables to 5-digit industry codes. Industry names may not be literally interpretable and are meant to convey a general, qualitative pattern to the reader. Measures Backward HCI Linkages$_i$ and Forward HCI Linkages$_i$ are presented in raw formats.

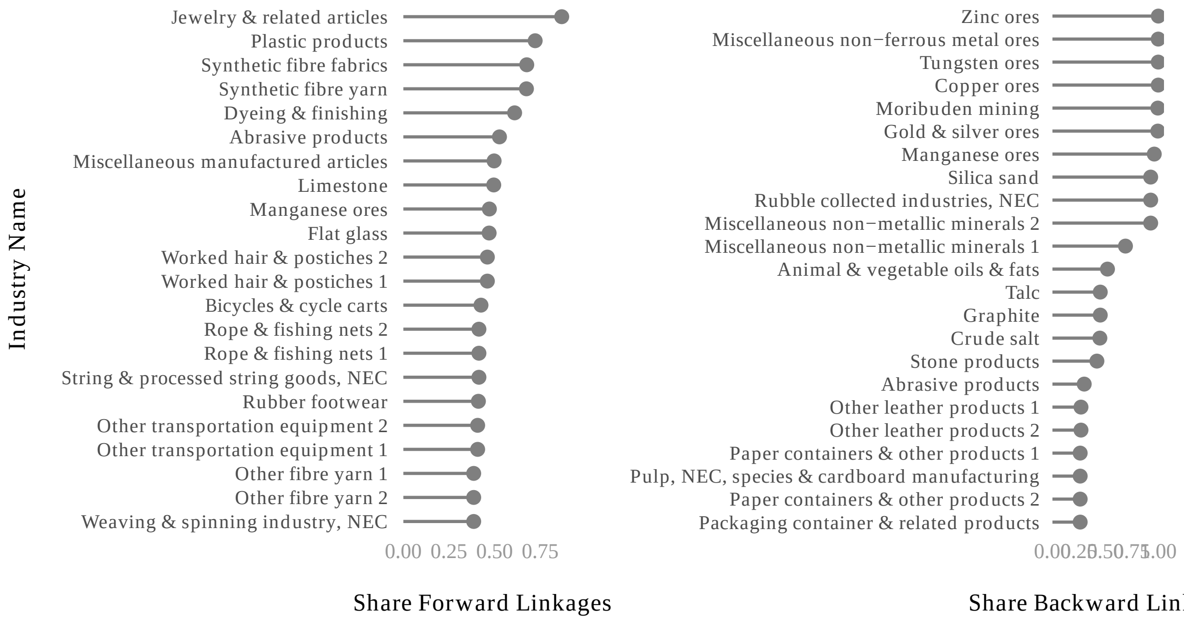


Figure 5: Top 20 Non-HCI Sectors with Highest Forward and Backward (Direct) Linkages to Targeted Industry, 1970.

negative relationship between backward linkages and industrial growth over the same period: $\hat{\beta} = -0.9871$ ($t = -1.63$).

Next I estimate the impact of the HCI industrial policy on backward (forward) linked industries, regressing industrial development outcomes on the linkages measures. These continuous measures are interacted with time period indicators to convey the dynamic pattern of changes for backward and forward-linked industries.

Specifically, I estimate the following specification

$$
\begin{aligned}
Y_{it} = &\sum_{j=1970}^{1986} \gamma_j \cdot \left(\text{Backward HCI Linkages}_i \times \text{Year}_t^j\right) + \\
&\sum_{j=1970}^{1986} \beta_j \cdot \left(\text{Targeted}_i \times \text{Year}_t^j\right) + \\
&\sum_{i=n} \alpha_n \cdot \mathrm{I}_i^n + \sum_{j=1970}^{1986} \lambda_j \cdot \text{Year}_t^j + \epsilon_{it}.
\end{aligned} \tag{8}
$$

The parameters of interest are γ_js, which convey the growth of linked sectors versus non-linked sectors, relative to pre-treatment (1972) levels. Prior to 1972, the estimated effect ought to be 0, indicating no anticipatory effect of the policy on linked industries. Estimates after 1972 should increase until at least the 1979–1982 period, when HCI policies were withdrawn. Estimates for the post-liberalization period indicate long-run effects of the policy (if coefficients continue to be greater than or equal to earlier estimates) or temporary-policy effects (if coefficients decline for periods after the policy).

I control for the direct effects of targeting using the time-varying interaction term: Targeted $\times$ Year. As in the direct effect analysis, I include industry controls $\sum_n \mathrm{I}^n$ time period fixed, $\sum_j \text{Year}^j$. Standard errors are clustered at the 5-digit industry level.

The identifying assumption is that, conditional on aforementioned controls, differences in industrial development between backward (forward) linked and non-linked industries would have changed similarly in the absence of the HCI industrial policy. Section 5.1 explained the HCI interventions were orthogonal to conventional sources of bias. For the current empirical exercise, I take the pre-determined input-output network (1970) to be exogenous to the differential development of targeted sectors.

6.3 Network Economies: Results.

Forward Linkages and Growth (Prediction 3) Section 5 documented the rapid development of targeted sectors. The growth of treated industries and, specifically, the rapid decline in output prices, ought to generate pecuniary externalities for external sectors. My theoretical framework predicts (*Prediction 3*) that an expansion of the supply from targeted sectors is beneficial to forward-linked sectors—that is, to sectors purchasing the output from targeted sectors.

Figure 7 presents flexible estimates of the coefficient of interest from equation 8. In the following results, growth is measured by the (real) value of output shipped.[47] Panel A shows results using the direct measure of forward linkages. Similarly, Figure 7, Panel B plots estimates from the same model, but using the total (Leontief) forward linkage measure. Each estimated model includes time and industry fixed effects, and controls flexibly for targeted and non-targeted sectors.

Figure 7 illustrates the estimated correlation between industrial growth and the strength of (pre-treatment) forward linkages from targeted sectors. Panels A (direct forward linkage effects) and B (total forward linkage effects) indicate industries that purchased larger shares of input from treated sectors grow more than other industries, relative to pre-treatment levels. Estimates for both models indicate industries with strong upstream connections benefited from the policy during the 1973–1979 period. Moreover, estimated differences using the direct linkage measure diminish after 1979 (Panel A). However, the post-1979 effects are stronger when accounting for total forward linkage exposure (Panel B).

Similarities between the two measures indicate that the major effect occurs for industries most directly connected to targeted sectors and rapidly dissipates.[48] These findings are consistent with *Prediction 3* of the multi-sectoral model.

Table 9 reports average effects for direct, forward linkages before and after the policy announcement. These estimates correspond to a simple differences-in-differences version of the dynamic specification, Equation 8. Column (1) shows estimated spillover effects using the

[47] As before, results are robust to using measures of gross output and value added. In fact, results are usually strongest for value added measures.

[48] For example, estimates for second-degree effects (not shown) are about half the size of direct effects and insignificant.

entire sample of industries. The estimates are substantial and significant, 1.15 (10 percent). Column (2) estimates the model using only non-targeted industries, and column (3) estimates spillovers for only targeted sectors. The results for the restricted sample are similarly positive and similar in magnitude, though only significant for the model restricted to targeted sectors.

Table 10 presents estimates from a similar differences-in-differences specification to Table 9 but using a total (Leontief) forward linkage measure. Forward linkage effects (columns 1–3) are much stronger than the direct effects of Table 9. In particular, the estimated effect of total forward linkages (column 1) is stronger, 1.354 (5 percent level significance), than direct linkage effects. When restricting the model to only non-targeted sectors, the effect is much stronger and highly significant: 3.742 (1 percent significance), compared to the much weaker effect of direct linkages on non-targeted sectors.

Table 11 reports estimates for other industrial growth outcomes, such as employment and entry. Column (1) shows that strong forward linkages are significantly tied to the entry of new establishments: 1.203 at the 1 percent level of significance. Column (3) shows a corresponding 1.694 estimate (1 percent significance) for employment.

Forward-Linkages, Prices, and Mechanisms *Prediction 3* also suggests that a supply shock in targeted industries also decreases the output price of downstream sectors. Table 12 shows the relative output prices of forward-linked industry fall significantly during the HCI period. Column (1) shows conventional differences-in-difference estimates for the effect of forward linkages from targeted sectors. Sectors with strong forward linkages experience a significant decline in the price of their output, relative to sectors with weak linkages: a point estimate of -.43 (1 percent significance). Estimates are stronger and significant if I use a total forward linkage measure.

If HCI policy positively affected downstream industries, it should have done so by providing cheaper domestic intermediate inputs. One indication of this effect, would be to see increased purchases of intermediate goods by forward-link industries.

Accordingly, Table 12, columns (3) and (4) corroborate the mechanisms behind the positive downstream spillovers. Indeed, forward linked sectors appear to purchase more intermediate materials and capital goods than sectors less reliant on HCI intermediates. Point estimates for material cost growth and capital investment growth are both 1.2 and highly significant (1 percent level). Inventory investments, both for semi-finished products (column 5) and raw materials (column 6) also increase significantly more for forward-link sectors.

Together, the preliminary analysis of mechanisms hints to the potential pecuniary externalities highlighted by Murphy, Shleifer, and Vishny (1989) and Ciccone (2002), as well as big push scholars (Hirschman 1958). The relationship between equipment investment and growth is one of the strongest relationships in the cross-country growth literature (Sala-I-Martin 1997). Specifically, DeLong and Summers (1991), DeLong and Summers (1993), and Bond, Leblebicioglu, and Schiantarelli (2010) point to the role of equipment investment and growth. Focusing on relative prices, complementary studies by Jones (1994), Jovanovic and Rob (1997), and Restuccia and Urrutia (2001) show a negative relationship between equipment prices and growth.

Backward-Linkages and Growth (Prediction 4) Since Hirschman (1958), proponents of industrial policy suggest interventions promote spillovers through backward linkages. I show that in the context of a small open economy like South Korea, this is not necessarily the case.

Theoretically, the expansion of targeted sectors can produce mixed effects on backward-linked sectors. On one hand, growth in targeted sectors increases demand for some domestic inputs and benefits domestic suppliers. However, since targeted sectors imported intermediate goods and raw materials, domestic suppliers were subjected to import competition. In other words, my model shows (*Prediction 4*) there may be both positive and negative demand shocks to backward-linked sectors.

Figure 8 illustrates the ambiguous, perhaps negative, impact of HCI on domestic suppliers. Panel A shows that industries with strong backward linkages to targeted industries contracted compared to those with weak links, relative to 1972 levels. Panel B shows, when accounting for *total* backward linkages, the effect is zero or slightly negative. Accounting for second-order effects, third-order effects, etc., may counter the first-order negative effects of the policy. Nonetheless, in both Panels A and B there is some evidence of negative spillovers to domestic suppliers, particularly for the periods of liberalization following the 1979 assassination of President Park.

Table 9 columns (4)–(6) indicates the potential negative effect of HCI policy on direct upstream suppliers. As before, these tables present the average linkage effect from a standard differences-in-differences version of the dynamic specification in Equation (8). Column (6) reports a strong negative average effect of backward linkages using the full sample of industries (and controlling for targeted and non-targeted sectors): -1.322 (10 percent). While the estimate is stable when restricting the sample to non-targeted industries (columns 8), the spillover effect is positive and insignificant for targeted industries (column 9).

Accounting for total backward linkages, Table 10 columns (4)–(6) also reports a negative effect of HCI on sectors with strong backward linkages, relative to sectors with weak links. All estimates are insignificant. Point estimates using the entire sample (column (4)) are much weaker, but nonetheless negative: -0.245. Restricting the sample to non-targeted industry only, the effect of backward linkages is stronger (-0.486), though insignificant.

The negative effects of HCI on domestic suppliers is also reflected in differences-in-differences estimates using other industrial development outcomes. For instance, Table 11 column (2) shows a large relative decline in employment, -0.975, though the effect is insignificant.

Backward Linkages and Import Competition The preceding results present evidence that domestic suppliers with strong connections to targeted sectors shrank relative to those with weak connections. One possible reason suggested by the HCI policy context and my model is that the big push allowed targeted sectors to import inputs, which may have negatively affected domestic industry.

Figure 9 illustrates why HCI may have negatively impacted backward-linked producers. For 1962–1973 and 1973–1986, I show the simple bivariate relationship between the value of imports and the strength of backward connections from non-targeted to targeted industry. Before 1973, there is no relationship between manufacturing industries with backward linkages and the value of imports. The estimated coefficient is slightly negative and insignificant $\hat{\beta} = -1.8619$ ($t = -1.161$). After 1973, however, there is a positive, significant relationship $\hat{\beta} = 4.828$ ($t = 4.118$). That is, post-1973, codes used intensely by HCI industries tend are imported extensively. This patter is consistent with targeted industries increasing intermediate imports over the policy period.

I now consider the relationship between backward-links and import competition more formally. Table 13 presents the differences-in-differences estimates of this relationship. Columns (1)–(2) show the impacts of direct backward linkages on the value of exports; Columns (3)–(4) show the value of imports. Column (4) confirms there is a significant rise in the relative value of imported inputs used in HCI industries. Accordingly, column 2 shows that the relative growth in the value of imports used by HCI sectors coincides with a commensurate decline in the export performance of domestic industry (2.9, 1 percent significance).

Notably, Table 13, column (1) also shows that sectors with strong forward linkages increased exports relative to unconnected sectors. This evidence is notable in light of Blonigen (2016), who shows that while steel industrial policies, on average, hurt export performance of downstream industries, the results are heterogeneous: East Asian and Northern European economies being exceptions.

A priori, negative results for backward-linked industry seems counter-intuitive. Scholars like Albert Hirschman stressed the importance of backward linkages in industrial development.[49] In the HCI context, however, targeted industries benefited from a policy regime that allowed freer, even subsidized, importation of inputs. In the small open economy, instead of receiving a positive demand shock from targeted industries, upstream sectors were subjected to increased import competition, as the expansion of targeted sectors drove demand for imported materials.

Direct Effects with Linkages Section 5.3 showed that HCI sectors directly targeted by the big push grew significantly more than other sectors, relative to pre-policy levels. Does accounting for either forward or backward spillovers alter estimates of the direct effects—e.g. estimates from specification 4?[50]

The grey points (grey confidence bands) in Figure A7 plot estimates of Targeted $\times$ Time from the main flexible differences-in-differences specification for direct effects; the red points (pink bands) plot this same model, but including both the Forward HCI Linkage and the Backward HCI Linkage measures in specification 4.

Side by side, Figure A7 shows estimates from the two models are strikingly similar. The implication: accounting for first-order linkage effects does not significantly change the pattern

[49] See *Backward Linkages at Work* [Hirschman (1958); p.109-113].

[50] The existence of either forward or backward spillovers from the industrial policy may alter the differences-in-differences assumption: that the targeted treatment is contained only to treated sectors.

of the direct effects. Estimates from the specification with linkages are only slightly lower for most years and generally less precise. Nonetheless, accounting for first-degree linkage effects—the dominant spillover—does not fundamentally modify the results for the direct effect of HCI on industrial growth.

One reason for the similarity may be that the (positive) forward linkage effects and (negative) backward linkage effects cancel out, in which case the control group direct effect estimate is not polluted by spillovers from the treated sector.

7 Conclusion

In this paper, I study a seminal event in postwar economic development, South Korea's rapid industrialization. Specifically, I explore Park Chung-hee's Heavy Chemical and Industry big push (HCI, 1973–1979), a large-scale industrial policy that attempted to shift Korea from a light exporting economy to a modernized industrial power capable of domestic arms production. This paper shows that the ambitious intervention promoted industrial development in manufacturing sectors targeted by the policy. In addition, I show the industrial intervention had wide ramifications. First, the big push created positive effects in treated industries long after major elements of the policy were retrenched. Moreover, the regime's policy mix created winners and losers in sectors differentially linked to treated industries.

The role of industrial policy in the East Asian growth miracle has long been debated by economists (Rodrik 1995; Lal 1983; Krueger 1995). My study provides some of the first estimates on the impact of infant industry policy on industrial development. In doing so, I add to a nascent literature using natural experiments to understand the foundations of industrial development (Juhasz 2018; Hanlon 2018; Giorcelli 2019; Mitrunen 2019). I show real output in treated industries grew 80 percent more relative to non-targeted manufacturing industries during the policy period, while also fostering growth in export activity and significant drops in output price. My study shows, that unlike IP in many places, realized HCI policies correspond to *de jure* industrial policy. In doing so, I also confirm Korea IP relied on investment incentives and the availability of imported intermediates, rather than the overt protection of output markets.

I use the HCI context to study two important justifications for industrial policy: dynamic comparative advantage and spillovers. Using the assassination of President Park, which liberalized trade and capital markets, I show that the direct impact of industrial policy persisted long after the *de facto* end date of the policy. Importantly, my study provides evidence that targeted industries impacted external industries through the input-output network. I show the relative decline in the output price of treated sectors benefited forward-linked, or downstream, sectors. Specifically, downstream buyers with strong links to treated sectors grow relatively more (in terms of output, establishment entry, and employment) than downstream industries with weak links. The relative price of output in downstream sectors also decreased significantly for linked versus unlinked sectors. I also provide evidence that these forward-linked sectors invested more in capital and increased their purchases of intermediate goods.

Development scholars, such as Albert Hirschman, have long highlighted the role of external economies in promoting industrialization, emphasizing the role of backward linkages in producing demand for upstream producers. I find, however, that HCI industrial policies had mixed impacts on backward-linked sectors. For example, direct suppliers with exposure to targeted industry decline relative to those with weak links. I thus provide evidence that the negative effects that HCI had on upstream industry resulted from increased import competition, indicated by a marked rise in imports of intermediate goods used by treated sectors. In other words, South Korean IP sacrificed more upstream sectors for the benefit of downstream sectors.

This study provides a valuable glimpse into a canonical industrial intervention: South Korea's influential heavy industrial push. My findings correspond to qualitative arguments posed by Wade (1990) and Amsden (1992). The impacts of my study are nonetheless related to more conventional policy levers, such as investment incentives and the promotion of import intermediate inputs. While the later likely benefited targeted industries, it also subjected upstream suppliers to new trade competition. These results update earlier work by Hirschman (1958) and others, indicating that the impacts of traditional policy prescriptions may be complex in a highly globalized economy.

While my study highlights the impacts of industrial policy on industrial development outcomes, I have not delved into issues of total factor productivity, which I investigate deeper in an upcoming analysis. A next step for future research would be to fully account for the effects of industrial policy on the aggregate economy.

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Figures (Remaining)

Figure 6: The Relationship Between Linkages from Targeted Sectors and Growth, 1972-1982.

Notes: Red dots (line) correspond to *targeted* industries; gray, *non-targeted*. The y-axis corresponds to ΔValue Shipments between 1970 and 1982 (IHS normalized). The x-axis represents the total share of pre-treatment (1970) linkages to or from targeted industries, as captured by the input-output accounts. Forward linkages to HCI sectors represent the sum of weighted connections between sector i and all targeted selling sectors. Backward linkages to HCI sectors represent the sum of weighted connections between sector i and all targeted purchasing sectors. Specification: an industry-level regression, $\Delta \text{Value Shipments}_{i1970-1982} = \alpha + \beta \times \left(\text{Forward (Backward) Linkages HCI}_{i1970}\right) + \epsilon_i$. Each bivariate regression is estimated separately for HCI sectors and non-HCI sectors to illustrate that the relationship between linkages and growth holds for sectors targeted and non-targeted by the big push.

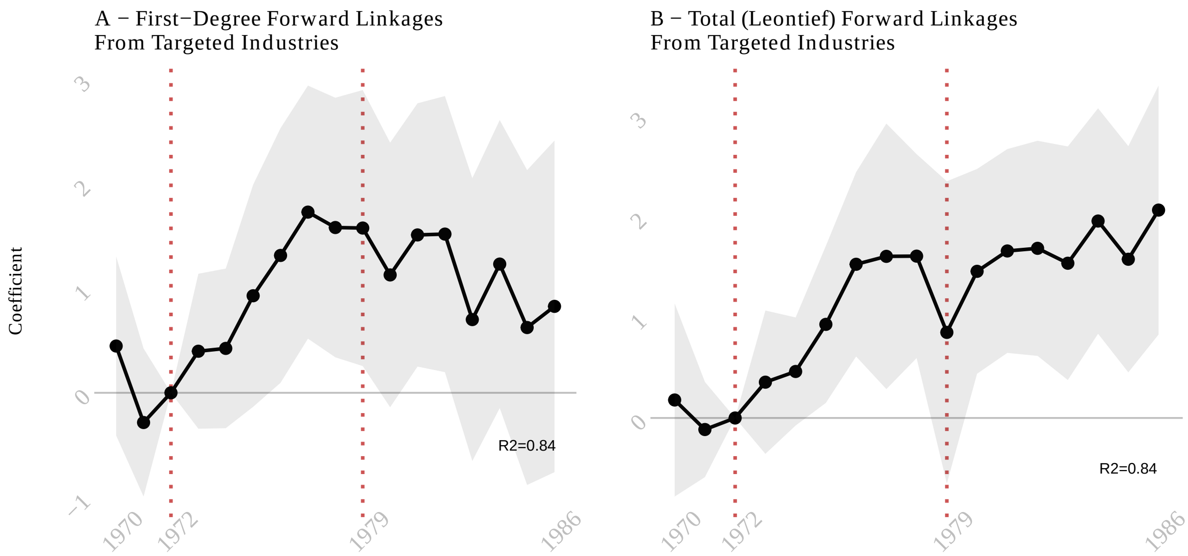

Figure 7: The Impact of First-Degree and Total Forward Linkages on Output, Relative to 1972 Baseline, 1970-1986.

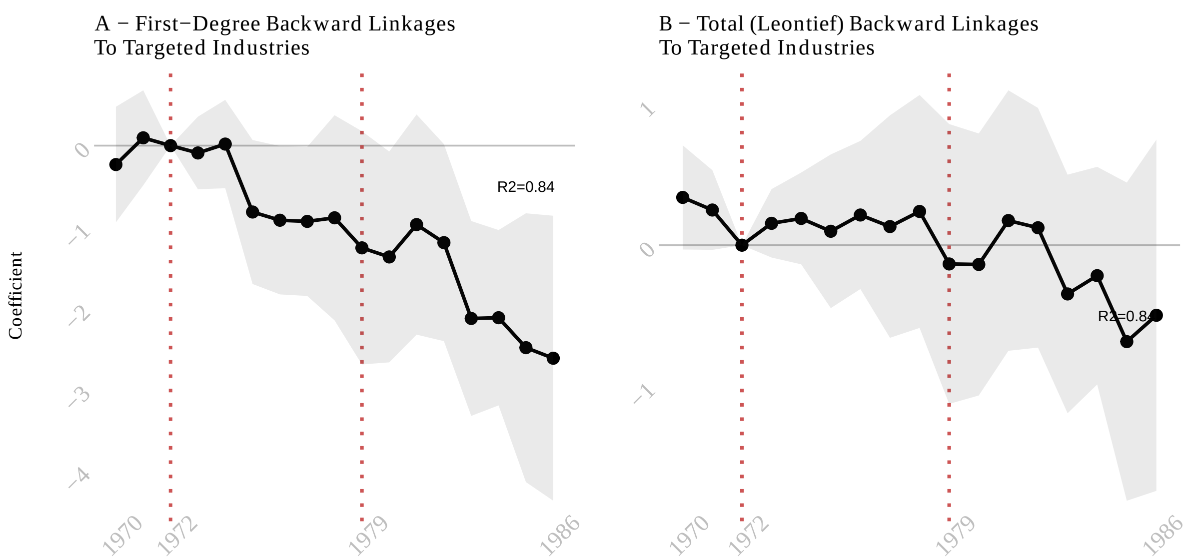

Figure 8: The Impact of First-Degree and Total Backward Linkages on Output, Relative to 1972 Baseline, 1970-1986

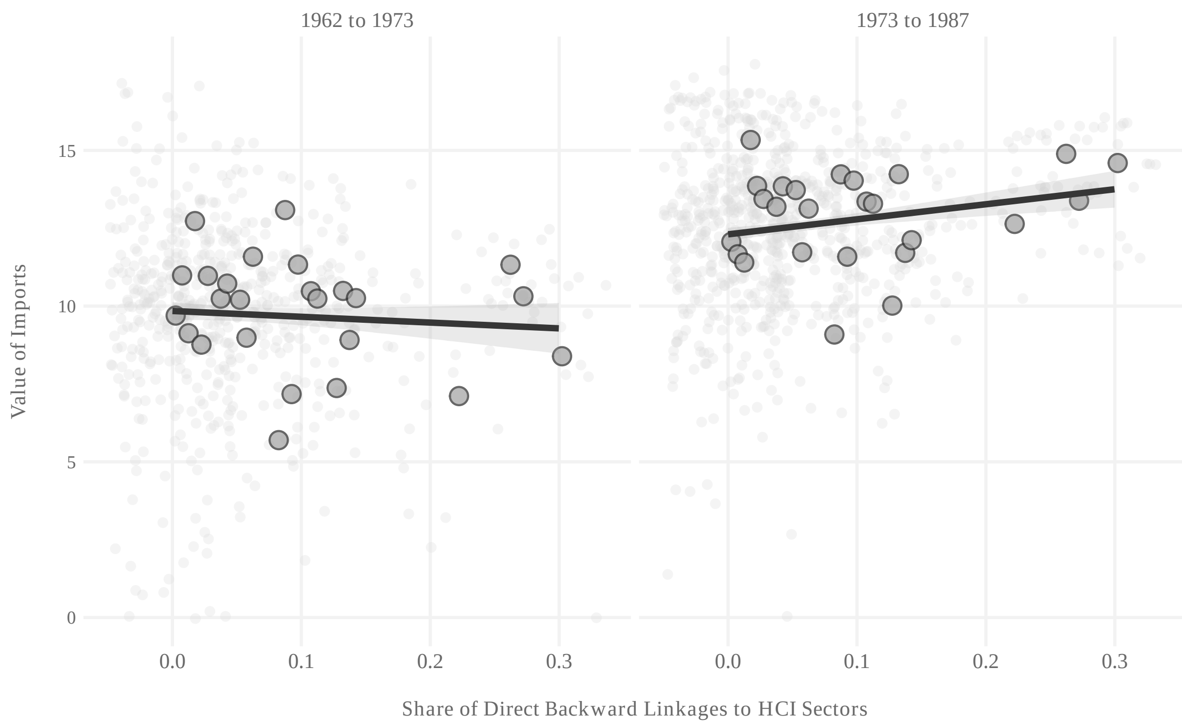

Figure 9: Relationship Between Import Competition and Backward Linkages, Pre- and Post-1973

Notes: This figure shows the relationship between the value of imports and the strength of backward connections to HCI sectors for two periods: 1962-1972 and 1973-1986. The x-axis is the weighted sum of sales to targeted sectors, or backward HCI linkages. The y-axis is the (IHS) import value.

Tables

Table 1: Pre-1973 Industry Statistics, Non-HCI v. HCI

HCI	Variable	Mean	St.dev.	Min	Max	Obs.
A. Industrial Statistics (Ln)						
Non-Targeted	Costs	2.37	1.75	0.00	7.81	3009
Targeted	Costs	2.59	1.84	0.00	8.73	1547
Non-Targeted	Establishments	3.52	1.78	0.00	8.37	3009
Targeted	Establishments	3.41	1.66	0.00	7.48	1547
Non-Targeted	Gross Output	5.59	2.65	0.00	10.80	3009
Targeted	Gross Output	5.76	2.80	0.00	12.60	1547
Non-Targeted	Prices	3.36	0.67	1.10	5.33	3009
Targeted	Prices	3.60	0.81	1.01	5.88	1547
Non-Targeted	Labor Productivity	0.12	0.14	-0.03	1.50	3009
Targeted	Labor Productivity	0.15	0.25	0.00	2.45	1547
Non-Targeted	Inventory	2.31	3.36	0.00	11.89	3009
Targeted	Inventory	2.51	3.61	0.00	12.82	1547
Non-Targeted	Average Size	0.03	0.03	0.00	0.61	3009
Targeted	Average Size	0.02	0.02	0.00	0.14	1547
Non-Targeted	Shipments	5.55	2.67	0.00	10.79	3009
Targeted	Shipments	5.73	2.81	0.00	12.60	1547
Non-Targeted	Investment	2.47	2.05	0.00	7.84	3009
Targeted	Investment	2.89	2.24	0.00	9.71	1547
Non-Targeted	Value Added	4.85	2.44	0.00	10.55	3009
Targeted	Value Added	4.96	2.52	0.00	10.95	1547
Non-Targeted	Average Wages	0.00	0.01	0.00	0.37	3009
Targeted	Average Wages	0.00	0.01	0.00	0.18	1547
Non-Targeted	Workers	6.97	2.76	0.00	12.39	3009
Targeted	Workers	6.96	2.77	0.00	12.36	1547
B. Linkages						
Non-Targeted	Backward Linkage, From Targeted	0.80	0.17	0.13	1.01	3009
Targeted	Backward Linkage, From Targeted	0.45	0.20	0.22	0.98	1547
Non-Targeted	Backward Linkage, From Targeted	0.17	0.14	0.00	0.87	3009
Targeted	Backward Linkage, From Targeted	0.49	0.21	0.02	0.76	1547
Non-Targeted	Forward Linkage, To Targeted	0.84	0.24	0.00	1.00	3009
Targeted	Forward Linkage, To Targeted	0.74	0.23	0.00	1.00	1547
Non-Targeted	Forward Linkage, To Targeted	0.09	0.20	0.00	1.00	3009
Targeted	Forward Linkage, To Targeted	0.19	0.21	0.00	0.92	1547
C. Trade Statistics (Ln)						
Non-Targeted	Value Exports (Sitc4 Products)	7.03	2.82	0.69	14.49	10738
Non-Targeted	Value Imports (Sitc4 Products)	7.43	2.58	0.69	15.67	10787
Targeted	Value Exports (Sitc4 Products)	6.48	2.34	0.69	12.64	468
Targeted	Value Imports (Sitc4 Products)	7.73	2.55	0.69	13.05	463
Non-Targeted	Quantitative Restrictions Output	0.51	0.37	0.00	1.10	3009
Targeted	Quantitative Restrictions Output	0.37	0.25	0.00	1.10	1547
Non-Targeted	Tariff Output	3.81	0.54	2.40	5.02	3009
Targeted	Tariff Output	3.33	0.45	1.52	4.45	1547

Table 2: Differences in Total Gross Capital Investment & Costs, Before-After 1973, 1970-1986

	Dependent Variable (IHS) :					
	Total Capital Formation	Total Capital Formation	Total Capital Formation	Total Input Costs	Total Input Costs	Total Input Costs
	(1)	(2)	(3)	(4)	(5)	(6)
Targeted X Post	0.594***	0.667***	0.683***	0.568***	0.496***	0.493***
	(0.164)	(0.162)	(0.164)	(0.141)	(0.137)	(0.136)
Constant	1.741	2.154	2.119	2.646	2.008	2.004
	(0.071)	(0.338)	(0.351)	(0.058)	(0.261)	(0.270)
Industry Fixed Effects	X	X	X	X	X	X
Year Fixed Effects	X	X	X	X	X	X
Baseline Controls		X	X		X	X
Trends Baseline			X			X
R-Squared	0.814	0.821	0.827	0.871	0.882	0.890
Observations	4288	4288	4288	4288	4288	4288
Clusters	268	268	268	268	268	268

Note: Differences-in-Differences estimates of the effect of Heavy Chemical and Industry industrial targeting on total value of gross capital formation and total value of intermediate materials purchases. All capital outcomes are deflated using their respective wholesale price index. Columns (1)-(3) report estimates for capital acquisitions; columns (4)-(6), material costs. All specifications include industry and year fixed effects. Columns (1) and (4) correspond to estimates from specifications without additional. Columns (2) and (5) include baseline controls: pre-1973 averages for (IHS) employment, labor productivity, average wage, average cost, average establishment size, and average fixed investment, each interacted flexibly with period effects. In addition, columns (3) and (6), include pre-trends in baseline control variables, each interaction with a period effects. Year effects absorb the post period indicator; individual industry fixed affects absorb the *Targeted* dummy variable. Regression log specifications are nearly identical and are included in the Appendix. Robust standard errors are clustered on the 5-digit industry-level. Standard errors in parentheses: *p<0.05, ** p<0.01, *** p<0.001.

Source: Mining and Manufacturing Survey & Mining and Manufacturing Census: 1970-1987.

Table 3: Differences in Gross Capital Investment Across Asset Classes, Before and After 1973, 1970-1986

	Dependent Variable (IHS) :			
	Acquisitions Building	Acquisitions Machinery	Acquisitions Land	Acquisitions Vehicle
	(1)	(2)	(3)	(4)
Targeted X Post	0.485***	0.631***	0.335**	0.244*
	(0.141)	(0.152)	(0.116)	(0.106)
Constant	1.855	2.274	1.326	1.283
	(0.210)	(0.275)	(0.147)	(0.175)
Industry Fixed Effects	X	X	X	X
Year Fixed Effects	X	X	X	X
Baseline Controls	X	X	X	X
Trends Baseline	X	X	X	X
R-Squared	0.776	0.809	0.679	0.786
Observations	2680	2680	2680	2680
Clusters	268	268	268	268

Note: Differences-in-Differences estimates of the impact of Heavy Chemical and Industry industrial targeting on different capital asset acquisitions. All variables and controls use an IHS transformation. Column (1) report estimates for building and structural acquisitions; columns (2), equipment and machinery acquisitions; (3) land acquisitions; and (4) vehicle acquisitions. Each have been deflated using a capital goods price index (2010 baseline values). All regressions include period and 5-digit industry fixed effects. In additions all regression include the standard baseline pre-treatment averages and pretrends interacted with time period effects. Regression log specifications are essentially identical and are included in the Appendix. Robust standard errors are clustered on the 5-digit industry-level. Standard errors in parentheses: *p<0.05, ** p<0.01, *** p<0.001.

Source: Mining & Manufacturing Survey and Mining & Manufacturing Census: 1970-1987. National Input-Output Accounts, Bank of Korea, 1970.

Table 4: Differences in Protection Policy, Before-After 1973, 1970-1982

	Dependent Variable (IHS) :											
	QR Output	QR Output	QR Output	Tariff Output	Tariff Output	Tariff Output	QR Input	QR Input	QR Input	Tariff Input	Tariff Input	Tariff Input
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Targeted X Post	0.039	0.029	0.034	0.028	0.017	0.010	-0.045**	-0.044**	-0.041**	-0.216***	-0.203***	-0.201***
	(0.047)	(0.047)	(0.048)	(0.028)	(0.027)	(0.027)	(0.014)	(0.014)	(0.014)	(0.043)	(0.041)	(0.040)
Constant	0.701	0.650	0.660	4.536	4.520	4.548	0.391	0.360	0.362	3.719	3.659	3.660
	(0.019)	(0.083)	(0.085)	(0.010)	(0.037)	(0.036)	(0.006)	(0.024)	(0.024)	(0.012)	(0.024)	(0.024)
Industry Fixed Effects	X	X	X	X	X	X	X	X	X	X	X	X
Year Fixed Effects	X	X	X	X	X	X	X	X	X	X	X	X
Baseline Controls		X	X		X	X		X	X		X	X
Trends Baseline			X			X			X			X
R-Squared	0.774	0.781	0.786	0.959	0.961	0.963	0.881	0.885	0.893	0.974	0.977	0.978
Observations	1340	1340	1340	1340	1340	1340	1340	1340	1340	1340	1340	1340
Clusters	268	268	268	268	268	268	268	268	268	268	268	268

Note: Differences-in-Differences estimates of the impact of Heavy Chemical and Industry industrial targeting on industrial output. All outcomes are daflected by industry-level price indices and reflect real values. Columns (1)-(3) report results for value of shipments; columns (4)-(6), for gross output; columns (7)-(9), for value added. All specifications include industry and year fixed effects; the year effects absorbs the post period indicator. Columns (2), (5), and (8) include pre-1973 averages for (IHS) employment, labor productivity, average wage, average cost, average establishment size, and average fixed investment, each interacted flexibly with period effects. Columns (3), (6), and (9) include pre-trends in the aforementioned baseline control variables, each interaction with a period dummy. Regression log specifications are essentially identical and are included in the Appendix. Robust standard errors are clustered on the 5-digit industry-level. Standard errors in parentheses: *p<0.05, ** p<0.01, *** p<0.001.

Source: Mining & Manufacturing Survey and Mining & Manufacturing Census: 1970-1987. Tariffs and Protection, Luedde-Neurath, 1986.

Table 5: Differences in Industrial Growth, Before-After 1973, 1970-1986

	Dependent Variable (IHS) :								
	Value Shipments	Value Shipments	Value Shipments	Gross Output	Gross Output	Gross Output	Value Added	Value Added	Value Added
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Targeted X Post	0.710***	0.603***	0.596**	0.673***	0.562**	0.551**	0.593**	0.530**	0.504**
	(0.191)	(0.180)	(0.183)	(0.197)	(0.185)	(0.187)	(0.179)	(0.173)	(0.173)
Constant	4.680	3.068	2.966	4.662	3.040	2.984	3.949	2.760	2.721
	(0.086)	(0.446)	(0.456)	(0.093)	(0.472)	(0.485)	(0.085)	(0.419)	(0.431)
Industry Fixed Effects	X	X	X	X	X	X	X	X	X
Year Fixed Effects	X	X	X	X	X	X	X	X	X
Baseline Controls		X	X		X	X		X	X
Trends Baseline			X			X			X
R-Squared	0.839	0.858	0.865	0.827	0.847	0.854	0.829	0.849	0.856
Observations	4556	4556	4556	4556	4556	4556	4556	4556	4556
Clusters	268	268	268	268	268	268	268	268	268

Note: Differences-in-Differences estimates of the impact of Heavy Chemical and Industry industrial targeting on industrial output. All outcomes are deflated by industry-level price indices and reflect real values. Columns (1)-(3) report results for value of shipments; columns (4)-(6), for gross output; columns (7)-(9), for value added. All specifications include industry and year fixed effects; the year effects absorbs the post period indicator. Columns (2), (5), and (8) include pre-1973 averages for (IHS) employment, labor productivity, average wage, average cost, average establishment size, and average fixed investment, each interacted flexibly with period dummy. Columns (3), (6), and (9) include pre-trends in the aforementioned baseline control variables, each interacted with a period dummy. Regression log specifications are essentially identical and are included in the Appendix. Robust standard errors are clustered on the 5-digit industry-level. Standard errors in parentheses: *p<0.05, ** p<0.01, *** p<0.001.

Source: Mining and Manufacturing Survey & Mining and Manufacturing Census: 1970-1987.

Table 6: Differences in Labor Productivity, Before-After 1973, 1970-1986

	Dependent Variable (IHS) :					
	Labor Prod. (Value Added)	Labor Prod. (Value Added)	Labor Prod. (Value Added)	Labor Prod. (Gross)	Labor Prod. (Gross)	Labor Prod. (Gross)
	(1)	(2)	(3)	(4)	(5)	(6)
Targeted X Post	0.025	0.029*	0.028*	0.092**	0.084**	0.084***
	(0.015)	(0.014)	(0.012)	(0.031)	(0.028)	(0.025)
Constant	0.081	0.080	0.095	0.170	0.177	0.207
	(0.007)	(0.022)	(0.020)	(0.012)	(0.053)	(0.049)
Industry Fixed Effects	X	X	X	X	X	X
Year Fixed Effects	X	X	X	X	X	X
Baseline Controls		X	X		X	X
Trends Baseline			X			X
R-Squared	0.808	0.836	0.856	0.825	0.854	0.866
Observations	4556	4556	4556	4556	4556	4556
Clusters	268	268	268	268	268	268

Note: Differences-in-Differences estimates of the impact of Heavy Chemical and Industry industrial targeting on industrial labor productivity. All outcomes are daflected by industry-level price indices and reflect real values. Columns (1)-(3) report estimates for value added labor productivity. Alternatively, columns (4)-(6) report gross output labor productivity. All specifications include industry and year fixed effects; the year effects absorbs the post period indicator. Columns (2), (5), and (8) include baseline controls. Columns (3), (6), and (9) include pre-trends in the aforementioned baseline control variables, each interacted with a period dummy. Regression log specifications are essentially identical and are included in the Appendix. Robust standard errors are clustered on the 5-digit industry-level. Standard errors in parentheses: *p<0.05, ** p<0.01, *** p<0.001.

Source: Mining and Manufacturing Survey & Mining and Manufacturing Census: 1970-1987.

Table 7: Differences in Industrial Outcomes, Before-After 1973, 1970-1986

	Dependent Variable (IHS) :																	
	Prices	Prices	Prices	Avg. Wages	Avg. Wages	Avg. Wages	Entry	Entry	Entry	Employment	Employment	Employment	Labor Share	Labor Share	Labor Share	Share of Output	Share of Output	Share of Output
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Targeted X Post	-0.1726***	-0.1681***	-0.1667***	0.0008	0.0001	0.0002	0.3241*	0.1861	0.1897	0.5800*	0.3783	0.3786	0.0758*	0.0675*	0.0632*	0.0916**	0.0839**	0.0803*
	(0.0389)	(0.0335)	(0.0329)	(0.0024)	(0.0002)	(0.0002)	(0.1502)	(0.1306)	(0.1316)	(0.2530)	(0.2151)	(0.2201)	(0.0301)	(0.0293)	(0.0297)	(0.0316)	(0.0318)	(0.0312)
Constant	3.3223	3.4422	3.4315	0.0057	0.0004	0.0007	3.6454	2.2696	2.2978	6.7478	4.4773	4.4653	0.2929	0.1650	0.1653	0.2145	0.1274	0.1314
	(0.0153)	(0.0447)	(0.0443)	(0.0016)	(0.0006)	(0.0002)	(0.0586)	(0.1966)	(0.1982)	(0.1020)	(0.3718)	(0.3747)	(0.0122)	(0.0282)	(0.0286)	(0.0121)	(0.0402)	(0.0407)
Industry Fixed Effects	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Year Fixed Effects	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Baseline Controls		X	X		X	X		X	X		X	X		X	X		X	X
Trends Baseline			X			X			X			X			X			X
R-Squared	0.944	0.953	0.957	0.271	0.901	0.945	0.857	0.884	0.887	0.792	0.825	0.829	0.897	0.905	0.908	0.893	0.901	0.907
Observations	4552	4552	4552	4556	4556	4556	4556	4556	4556	4556	4556	4556	4556	4556	4556	4556	4556	4556
Clusters	268	268	268	268	268	268	268	268	268	268	268	268	268	268	268	268	268	268

Note: Differences-in-Differences estimates of the impact of Heavy Chemical and Industry industrial targeting on industrial labor productivity. All outcomes are daflected by industry-level price indices and reflect real values. Columns (1)-(3) report estimates for output prices. Columns (4)-(6) report average wages, or the total (real) wagebill divided by industry employment. Columns (7)-(9) are for entry, as measured by establishment entry. Columns (10)-(12) are total industry employment estimates. Columns (13)-(15) reflect labor structural change: the industry employment as a share of total manufacturing employment. Similarly, columns (16)-(18) reflect output structural change, reflected as real gross industry output as share of total manufacturing output. All specifications include industry and year fixed effects. Regression log specifications are essentially identical and are included in the Appendix. Robust standard errors are clustered on the 5-digit industry-level. Standard errors in parentheses: *p<0.05, ** p<0.01, *** p<0.001.

Source: Mining and Manufacturing Survey & Mining and Manufacturing Census: 1970-1987.

Table 8: Differences in Exports and Imports, Before-After 1973, 1970-1986

	Dependent Variable (IHS) :					
	Import Value	Import Value	Import Value	Export Value	Export Value	Export Value
	(1)	(2)	(3)	(4)	(5)	(6)
Targeted X Broadpost	-0.4832	-0.2089	-0.2284	0.8070	1.0416*	1.0604*
	(0.2706)	(0.3350)	(0.3327)	(0.4420)	(0.4954)	(0.5017)
Constant	11.8400	8.9995	9.3343	11.3009	7.0224	6.6820
	(0.0859)	(0.6243)	(0.7368)	(0.1291)	(1.2135)	(1.6588)
Industry Fixed Effects	X	X	X	X	X	X
Year Fixed Effects	X	X	X	X	X	X
Baseline Controls		X	X		X	X
Trends Baseline			X			X
R-Squared	0.891	0.900	0.901	0.856	0.878	0.880
Observations	2044	2044	2044	2044	2044	2044
Clusters	85	85	85	85	85	85

Note: Differences-in-Differences estimates of the impact of Heavy Chemical and Industry industrial targeting on industrial labor productivity. All outcomes are daflected by industry-level price indices and reflect real values. Columns (1)-(3) report estimates for value added labor productivity. Alternatively, columns (4)-(6) report gross output labor productivity. All specifications include industry and year fixed effects; the year effects absorbs the post period indicator. Columns (2), (5), and (8) include baseline controls. Columns (3), (6), and (9) include pre-trends in the aforementioned baseline control variables, each interacted with a period dummy. Regression log specifications are essentially identical and are included in the Appendix. Robust standard errors are clustered on the 5-digit industry-level. Standard errors in parentheses: *p<0.05, ** p<0.01, *** p<0.001.

Source: Mining and Manufacturing Survey & Mining and Manufacturing Census: 1970-1987.

Table 9: Impact of Direct Linkages on Industrial Growth, 1970-1986

	Dependent Variable (IHS) Shipments :					
	(1)	(2)	(3)	(4)	(5)	(6)
Post X Forward HCI Linkage	1.051*	0.895	1.315*			
	(0.507)	(0.736)	(0.582)			
Post X Backward HCI Linkage				-1.224*	-1.553*	-0.492
				(0.479)	(0.611)	(0.648)
Constant	4.989	4.833	4.381	4.989	4.833	4.381
	(0.081)	(0.111)	(0.135)	(0.080)	(0.109)	(0.135)
Industry Fixed Effects	X	X	X	X	X	X
Year Fixed Effects	X	X	X	X	X	X
Sample	Full Sample	Non-Targeted	Targeted	Full Sample	Non-Targeted	Targeted
R-Squared	0.841	0.826	0.868	0.842	0.828	0.867
Observations	4556	3009	1547	4556	3009	1547
Clusters	268	177	91	268	177	91

Note: Shipments are the (real) value of shipments for each industry in a census year. Columns (1) and (4) estimate the spillover effects on the entire sample–including but treated and non-treated sectors. Columns (2) and (5), examine spillover effects for only non-targeted industries. Likewise, columns (3) and (6), do so for only targeted industries. All specification include year and 5-digit industry fixed effects. Linkage measures are from pre-treatment (1970) input-output accounts. The *Forward HCI Linkage* variable measures the total weighted share of intermediate inputs purchased *from* treated sectors; *Forward HCI Linkage*, similarly captures the total weighted share of intermediates sourced *from* non-treated sectors. *Backward HCI Linkage* measures the total weighted share of output sold *to* treated sectors; *Forward Non-HCI Linkage*, similarly captures the total weighted share of intermediates sold *to* non-treated sectors. Regression log specifications are essentially identical and are included in the Appendix. Robust standard errors are clustered on the 5-digit industry-level. Standard errors in parentheses: *p<0.05, ** p<0.01, *** p<0.001.

Source: Mining and Manufacturing Survey & Mining and Manufacturing Census: 1970-1987. Bank of Korea, Input-Output Accounts, 1970.

Table 10: Impact of Total (Leontief) Linkages to Policy on Industrial Growth, 1970-1986

	Dependent Variable (IHS) Shipments :					
	(1)	(2)	(3)	(4)	(5)	(6)
Post X Leontief HCI Forward Linkage	1.354**	3.742***	0.410			
	(0.417)	(0.930)	(0.389)			
Post X Leontief HCI Backward Linkage				-0.245	-0.486	0.302
				(0.365)	(0.504)	(0.383)
Constant	4.989	4.833	4.381	4.989	4.833	4.381
	(0.080)	(0.107)	(0.135)	(0.081)	(0.110)	(0.134)
Industry Fixed Effects	X	X	X	X	X	X
Year Fixed Effects	X	X	X	X	X	X
Sample	Full Sample	Non-Targeted	Targeted	Full Sample	Non-Targeted	Targeted
R-Squared	0.842	0.829	0.867	0.841	0.826	0.867
Observations	4556	3009	1547	4556	3009	1547
Clusters	268	177	91	268	177	91

Note: Shipments are the (real) value of shipments for each industry in a census year. Each model is estimated using the full sample of 5-digit industries.Total linkages measures are calculated from pre-treatment (1970) input-output accounts. The Leontief-based linkage measures capture the *total* linkage effect of targeted or non-targeted sector output shifts on the output of other sectors, accounting for N-order effects. The *Leontief Forward HCI Linkage* for an industry refers to row sums of the Leontief inverse matrix, excluding non-targeted linkages. *Leontief Forward Non-HCI Linkage* refers to row sums of the Leontief inverse matrix, but only for non-targeted industries. *Leontief Backward HCI Linkage* refers to column sums of the Leontief matrix, excluding non-targeted linkages; *Leontief Forward Non-HCI Linkage*, includes only non-targeted industries. Regression log specifications are essentially identical and are included in the Appendix. Robust standard errors are clustered on the 5-digit industry-level. Standard errors in parentheses: *p<0.05, ** p<0.01, *** p<0.001.

Source: Mining and Manufacturing Survey & Mining and Manufacturing Census: 1970-1987. Bank of Korea, Input-Output Accounts, 1970.

Table 11: Impact of Direct Linkages on Industrial Development Outcomes, 1970-1986

	Dependent Variable (IHS) :							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Entry	Entry	Employment	Employment	Avg Wages	Avg Wages	Avg Size	Avg Size
Post X Forward HCI Linkage	1.327***		1.514*		0.015		0.005	
	(0.363)		(0.592)		(0.011)		(0.008)	
Post X Backward HCI Linkage		-0.382		-1.184*		-0.006		0.013*
		(0.305)		(0.594)		(0.004)		(0.006)
Constant	3.619	3.619	6.807	6.807	0.004	0.004	0.031	0.031
	(0.062)	(0.062)	(0.102)	(0.101)	(0.001)	(0.001)	(0.001)	(0.001)
Industry Fixed Effects	X	X	X	X	X	X	X	X
Year Fixed Effects	X	X	X	X	X	X	X	X
Subsample	Full Sample	Full Sample	Full Sample	Full Sample	Full Sample	Full Sample	Full Sample	Full Sample
R-Squared	0.859	0.858	0.793	0.793	0.279	0.274	0.525	0.526
Observations	4556	4556	4556	4556	4556	4556	4556	4556
Clusters	268	268	268	268	268	268	268	268

Note: The entry variable is equal the number of establishments operating in an industry. Employment is simply the number of employees. Average (real) wages are calculated from the Mining and Manufacturing census, dividing the total wage bill by number of employees, deflated using the industry price index. Average Size reflects employment divided by the number of establishments. Each model is estimated using the full sample of 5-digit industries.Linkage measures are from pre-treatment, 1970 input-output accounts. The *Forward HCI Linkage* variable measures the total weighted share of input purchased from targeted sectors; the *Backward HCI Linkage* variables, the share of total weights sales to targeted sectors. Regression log specifications are essentially identical and are included in the Appendix. Robust standard errors are clustered on the 5-digit industry-level. Standard errors in parentheses: *p<0.05, ** p<0.01, *** p<0.001.

Source: Mining and Manufacturing Survey & Mining and Manufacturing Census: 1970-1987. Bank of Korea, Input-Output Accounts, 1970.

Table 12: Linkages and (More) Industrial Development, Before-After 1973, 1970-1986

	Dependent Variable (IHS) :									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Prices	Prices	Costs	Costs	Capital Acquisitions	Capital Acquisitions	Inventory Output	Inventory Output	Inventory Inputs	Inventory Inputs
Post X Forward HCI Linkage	-0.310*		0.717		0.5		1.332*		1.730**	
	(0.131)		(0.369)		(0.443)		(0.611)		(0.602)	
Post X Backward HCI Linkage		0.517***		-0.7**		-0.826*		-0.627		-0.244
		(0.071)		(0.285)		(0.331)		(0.495)		(0.336)
Constant	3.183	3.184	2.460	2.460	1.655	1.655	3.191	3.191	2.695	2.695
	(0.014)	(0.014)	(0.064)	(0.064)	(0.072)	(0.072)	(0.106)	(0.106)	(0.089)	(0.090)
Industry Fixed Effects	X	X	X	X	X	X	X	X	X	X
Year Fixed Effects	X	X	X	X	X	X	X	X	X	X
Subsample	Full Sample	Full Sample	Full Sample	Full Sample	Full Sample	Full Sample	Full Sample	Full Sample	Full Sample	Full Sample
R-Squared	0.947	0.949	0.869	0.869	0.802	0.802	0.535	0.535	0.490	0.489
Observations	4552	4552	4556	4556	4556	4556	4556	4556	4556	4556
Clusters	268	268	268	268	268	268	268	268	268	268

Note: Price outcomes are industry-level producer price indices, harmonized to account for historic changes in industry definitions. All variables in these models use an inverse hyperbolic sine (IHS) transformation. The cost outcome reflects the (real) total cost of material inputs. Similarly, (real) total investment reflect the value of value of total capital acquisitions during a census year. All inventory variables are reflect change in inventories. Output inventories are changes in unshipped finished or semi-finished products; likewise, materials inventories correspond changes in intermediate input stock. Each model is estimated using the full sample of 5-digit industries.Linkage measures are from pre-treatment, 1970 input-output accounts. The *Forward HCI Linkage* variable measures the total weighted share of input purchased from targeted sectors; the *Backward HCI Linkage* variables, the share of total weighted sales to targeted sectors. Regression log specifications are essentially identical and are included in the Appendix. Robust standard errors are clustered on the 5-digit industry-level. Standard errors in parentheses: *p<0.05, ** p<0.01, *** p<0.001.

Source: Mining and Manufacturing Survey & Mining and Manufacturing Census: 1970-1987. Bank of Korea, Input-Output Accounts, 1970.

Table 13: Linkages and Trade, Before-After 1973, 1962-1986

	Dependent Variable (IHS) :			
	(1)	(2)	(3)	(4)
	Export Value	Export Value	Import Value	Import Value
Post X Forward HCI Linkage	0.013		0.257	
	(1.095)		(0.715)	
Post X Backward HCI Linkage		-2.911***		2.475***
		(0.592)		(0.689)
Constant	2.313	2.368	8.394	8.373
	(1.111)	(1.025)	(1.094)	(1.016)
Industry Fixed Effects	X	X	X	X
Year Fixed Effects	X	X	X	X
Subsample	Full Sample	Full Sample	Full Sample	Full Sample
R-Squared	0.882	0.886	0.901	0.906
Observations	2044	2044	2044	2044
Clusters	85	85	85	85

Note: Differences-in-differences estimates of backward (forward) linkages from (to) targeted industries. The cost outcome reflects the (real) total cost of material inputs on trade outcomes. Columns (1)-(2) correspond to average estimates of linkages before-after HCI on the (real) value of exports; columns (3) and (4) correspond to (real) value of imports. Columns (1) and (3) estimate average effects of forward linkages to targeted industry; columns (2) and (4), backward linkages from targeted industry.Linkage measures are from pre-treatment, 1970 input-output accounts. The *Forward HCI Linkage* variable measures the total weighted share of input purchased from targeted sectors; the *Backward HCI Linkage* variables, the share of total weights sales to targeted sectors. Regression log specifications are essentially identical and are included in the Appendix. Robust standard errors are clustered on the 5-digit industry-level. Standard errors in parentheses: *p<0.05, ** p<0.01, *** p<0.001.

Source: Mining and Manufacturing Survey & Mining and Manufacturing Census: 1970-1987. Bank of Korea, Input-Output Accounts, 1970.

NA

A Appendix

Sectoral Tables

Table A1: Disaggregated Treated Industries, Using 5-Digit 1970 Industry Codes and Names

Industry Names	(K)SIC	Industry Names	(K)SIC	Industry Names	(K)SIC
Calcium carbide	35111	Photochemical and sensitized materials	35296	Boilers	38212
Caustic soda	35111	Printing inks	35297	Farm machinery	38220
Hydrochloric acid	35111	Miscellaneous chemical products	35299	Machine tools for working metals	38231
Other sodium products	35111	Gasoline	35301	Metal working machinery	38234
Soda ash	35111	Naphtha	35301	Mining and construction machinery	38241
Sulfuric acid	35111	Fuel oil	35302	Textile machinery	38242
Anhydrous ammonia	35112	Lubricating oils and greases	35302	Food products machinery	38243
Other industrial compressed gases	35112	Other petroleum products	35309	Other special industry machinery	38249
Basic petrochemical products	35113	Briquettes	35401	Office and service industry machines	38250
Formalin	35114	Dry distillated coal products	35402	General industrial machinery	38291
Other acyclic intermediates	35114	Ferroalloys	37101	General machinery parts	38292
Cyclic intermediates	35115	Pig iron	37101	Refrigerators and other household appliances	38293
Pigments	35117	Raw steel	37101	Sewing machines	38294
Synthetic dyestuffs	35117	Other steel rolling and drawing	37102	Generators and motors	38311
Other inorganic chemicals	35118	Steel bars	37102	Transformers	38312
Miscellaneous organic chemicals	35119	Steel plates and sheets	37102	Other electric transmission and distribution equipmnet	38313
Processed oils and fats products	35119	Steel shapes and sections	37102	Other electrical industrial apparatus	38319
Nitrogenous fertilizers	35121	Steel tubes and pipes	37102	Communications equipment	38324
Phosphatic fertilizers	35121	Cast iron tubes and pipes	37103	Electronic components	38329
Calcium cyanamide	35122	Iron and steel-castings	37103	Radio and television sets	38329
Agricultural chemicals	35126	Galvanized steel products	37109	Household electric appliances	38330
Other chemical fertilizers	35126	Steel forgings	37109	Insulated wire and cable	38391
Petroleum synthetic resins	35131	Copper	37201	Electric lamps	38392
Polyvinyl chlorides	35131	Gold and silver ingots	37201	Storage and primary batteries	38394
Thermosetting resins	35131	Other non-ferrous metal ingots	37201	Other electrical equipment and supplies	38399
Chemical fibres	35133	Nonferrous rolling and drawing	37203	Ships, NEC	38413
Paints and allied products	35210	Nonferrous castings	37204	Steel ships	38414
Soap and active agents	35232	Household metal products	38111	Railroad transportation equipment	38421
Cosmetics and tooth paste and powder	35233	Tools	38112	Motor vehicles	38431
Perfumes	35233	Metal furniture	38120	Automobile repair	38432
Adhesives	35291	Structural metal products	38130	Motor vehicle parts	38432
Explosives and products	35292	Miscellaneous metal products	38197	Measuring and scientific instruments	38512
Matches	35293	Prime movers	38211		

Source notes:
The table lists sectors using names based on the 1970 Bank of Korea sector names, since they were already translated. The Korea Standard Industry Classification (KSIC) are based on 1970 industry codes. Because of code harmonization through time, the exact number of industries used in the study is slightly different. Heuristically, the term 'heavy chemical and industry' (as well as HCI) is also used to define a specific set of sectors in Korea statistical publications. This more general nomeclature, however, does not encompass the electronics industry. Hence, there is a distinction between HCI as it is used in statistical publications and its specific used in \emph{de jure} HCI policy plans. As Suk-Chae Lee explains, the electronics industry 'was one of the core industries slated for promotion in Korea's HCI Plan [May, 1973]; therefore any analysis of the HCI plan should include the electronics industry'[Lee 1992; p.432].

Subsidized credit lending during the HCI period

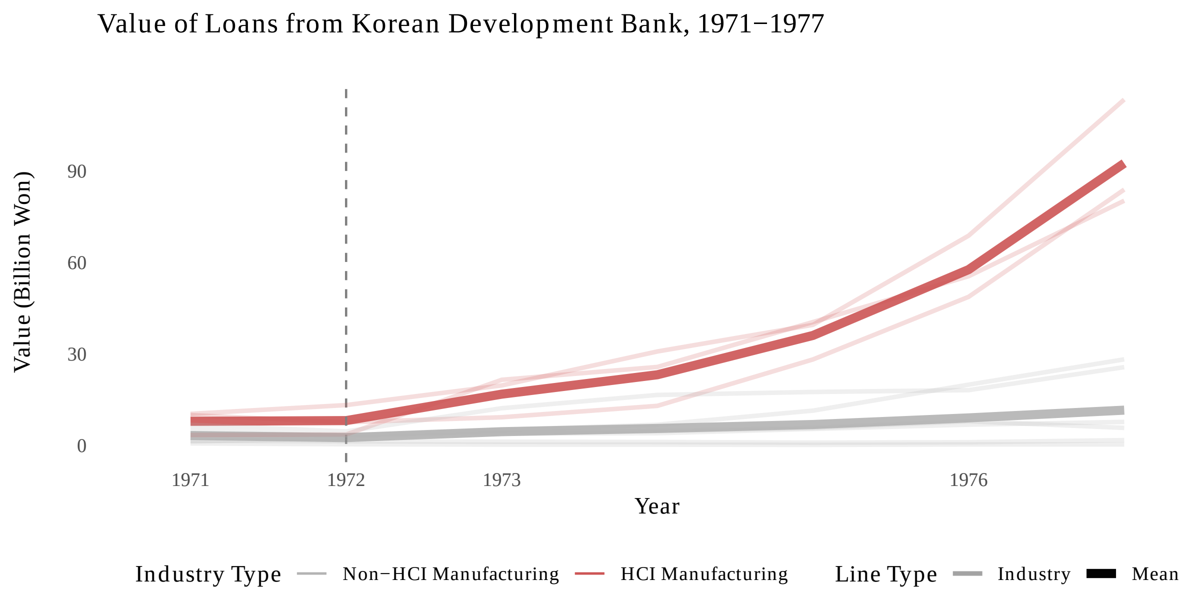

Figure A1: Value of NIF Loans from Korean Development Bank, by 2-digit Manufacturing Industry
Notes: The Korea Development Bank lent 62 percent of all NIF funds through 1981 (OECD 2012)

Investment incentives during the HCI period

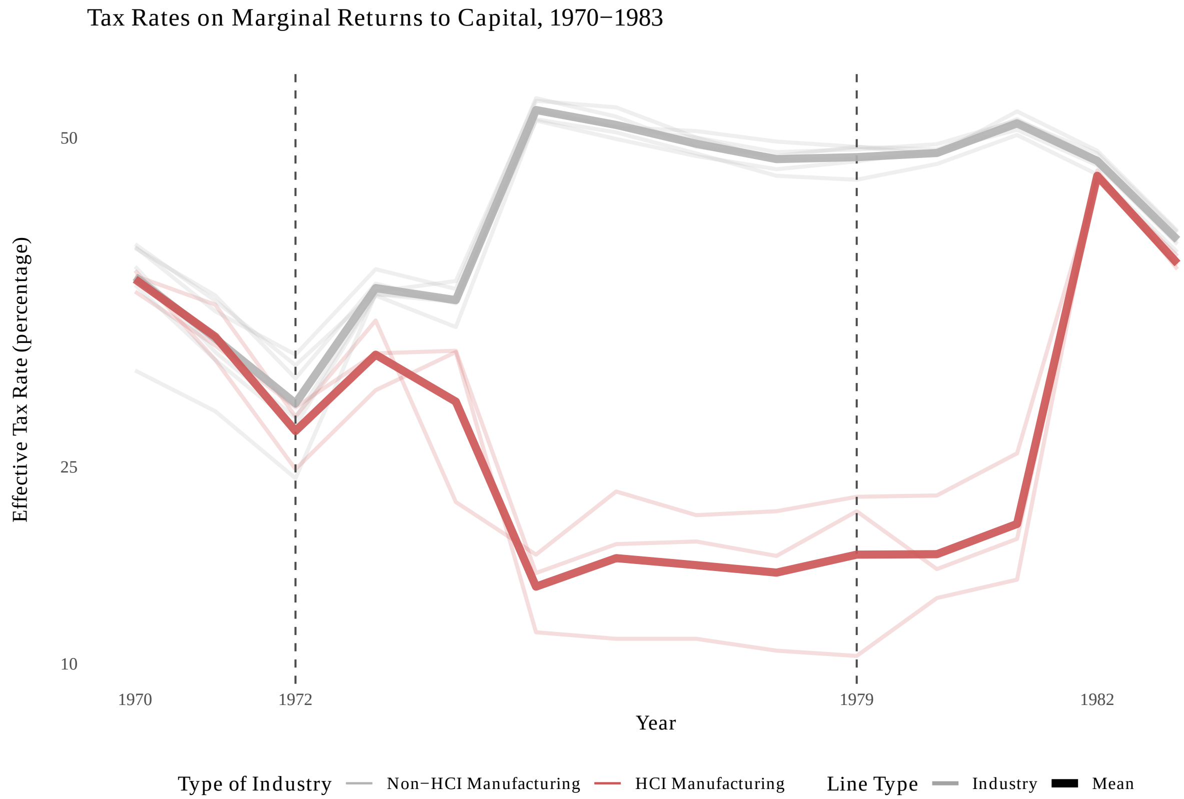

Figure A2: Tax Rates on Marginal Returns to Capital, 1970-1983, by 2-digit Manufacturing Industry.

Structural change plots

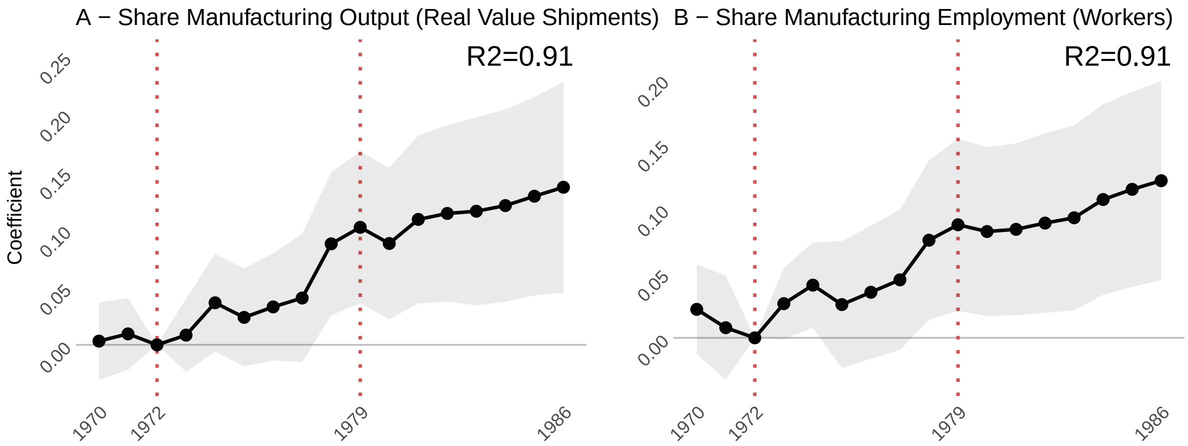

Figure A3: Estimated Reallocation of Industrial Activity, Relative to 1972 Baseline, 1970-1986

Industrial development and stuctural change outcomes

Figure A4: Estimated Differences in Industrial Development, Relative to 1972 Baseline, 1970-1986

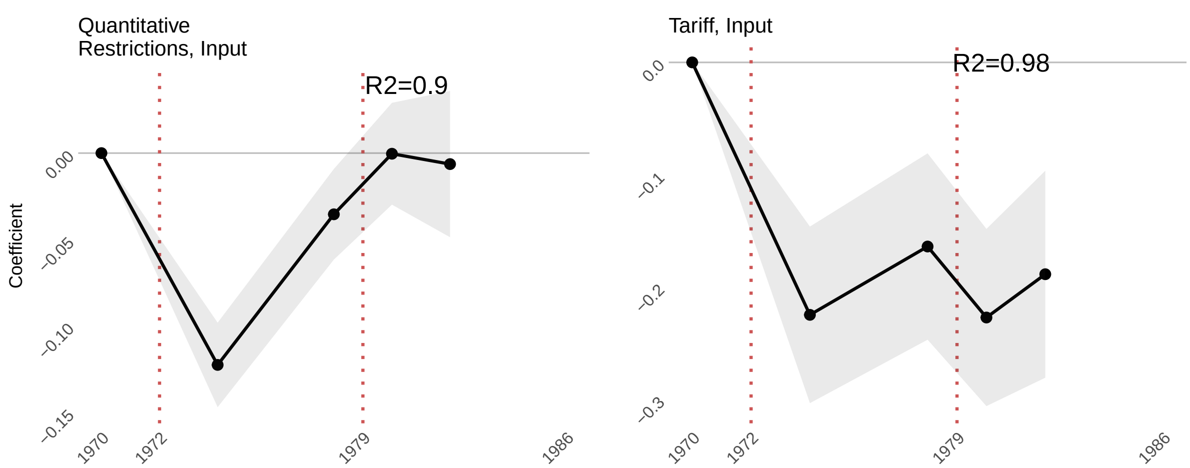

Figure A5: Estimated Differences in Input Protection, Targeted Versus Non-Targeted, Relative to 1972, 1970-1982

Network plot for industries with links *to* HCI sectors

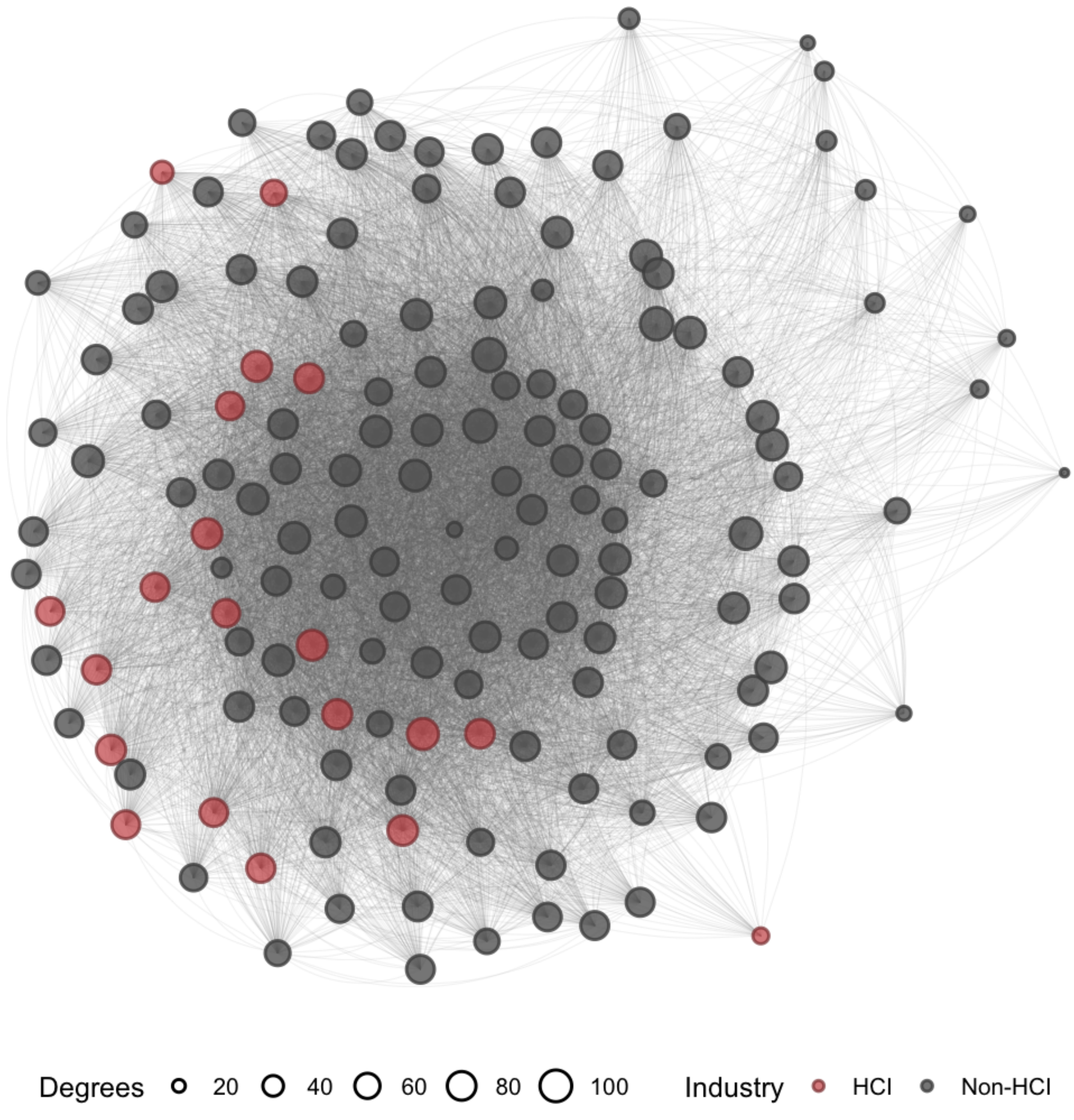

Figure A6: Targeted Sectors in the Korean Industrial Network, 1970 - Weighted by Number of Backward Links (In Degrees)

Dynamic Differences-in-Differences

Table A2: Differences in Industrial Growth Relative to 1972, 1970-1986

	Dependent Variable (IHS) :								
	Value Shipments	Value Shipments	Value Shipments	Gross Output	Gross Output	Gross Output	Value Added	Value Added	Value Added
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Targeted X 1970	-0.041	-0.051	0.038	0.027	0.033	0.114	-0.002	0.005	0.095
	(0.122)	(0.124)	(0.045)	(0.127)	(0.132)	(0.066)	(0.118)	(0.123)	(0.064)
Targeted X 1971	0.046	0.024	0.028	0.117	0.103	0.117	0.059	0.056	0.080
	(0.127)	(0.129)	(0.097)	(0.127)	(0.130)	(0.098)	(0.106)	(0.107)	(0.089)
Targeted X 1972	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)
Targeted X 1973	0.233	0.237	0.237	0.263*	0.268*	0.279*	0.255	0.320**	0.314**
	(0.127)	(0.125)	(0.120)	(0.125)	(0.124)	(0.119)	(0.130)	(0.122)	(0.116)
Targeted X 1974	0.322**	0.327**	0.286*	0.298*	0.302*	0.266*	0.240*	0.243*	0.224
	(0.122)	(0.120)	(0.120)	(0.121)	(0.117)	(0.117)	(0.118)	(0.116)	(0.120)
Targeted X 1975	0.351	0.246	0.300	0.234	0.037	0.063	0.165	0.004	0.018
	(0.200)	(0.196)	(0.205)	(0.233)	(0.212)	(0.213)	(0.204)	(0.191)	(0.194)
Targeted X 1976	0.554*	0.402	0.429	0.576*	0.431	0.461	0.509*	0.395	0.432*
	(0.242)	(0.227)	(0.235)	(0.244)	(0.232)	(0.241)	(0.214)	(0.207)	(0.216)
Targeted X 1977	0.607*	0.441	0.491*	0.630*	0.472*	0.525*	0.491*	0.371	0.427
	(0.248)	(0.227)	(0.241)	(0.247)	(0.228)	(0.242)	(0.217)	(0.204)	(0.218)
Targeted X 1978	0.757**	0.618*	0.682**	0.794**	0.662**	0.730**	0.657**	0.559*	0.624**
	(0.249)	(0.239)	(0.250)	(0.251)	(0.242)	(0.254)	(0.228)	(0.223)	(0.234)
Targeted X 1979	1.108***	0.943***	0.987***	1.131***	0.972***	1.020***	0.926***	0.811***	0.863***
	(0.265)	(0.237)	(0.256)	(0.266)	(0.241)	(0.259)	(0.237)	(0.221)	(0.238)
Targeted X 1980	0.783**	0.619**	0.636**	0.806**	0.649**	0.670**	0.694**	0.578**	0.609**
	(0.254)	(0.238)	(0.241)	(0.252)	(0.238)	(0.242)	(0.228)	(0.220)	(0.224)
Targeted X 1981	0.774**	0.608**	0.680**	0.792**	0.634**	0.707**	0.697**	0.581**	0.648**
	(0.248)	(0.232)	(0.245)	(0.249)	(0.235)	(0.247)	(0.224)	(0.216)	(0.227)
Targeted X 1982	0.695**	0.525*	0.587*	0.721**	0.559*	0.619*	0.603*	0.479*	0.538*
	(0.264)	(0.247)	(0.259)	(0.263)	(0.247)	(0.259)	(0.238)	(0.227)	(0.238)
Targeted X 1983	0.874**	0.726**	0.712**	0.892***	0.751**	0.739**	0.719**	0.619**	0.610**
	(0.264)	(0.244)	(0.243)	(0.267)	(0.251)	(0.250)	(0.241)	(0.232)	(0.232)
Targeted X 1984	0.945***	0.807**	0.797**	0.968***	0.837**	0.829**	0.853***	0.758**	0.755**
	(0.271)	(0.253)	(0.251)	(0.274)	(0.259)	(0.257)	(0.250)	(0.239)	(0.239)
Targeted X 1985	0.983***	0.824**	0.797**	0.997***	0.844**	0.820**	0.870**	0.760**	0.743**
	(0.290)	(0.271)	(0.273)	(0.293)	(0.277)	(0.279)	(0.265)	(0.256)	(0.258)
Targeted X 1986	0.976**	0.816**	0.834**	0.991**	0.839**	0.860**	0.886**	0.776**	0.797**
	(0.296)	(0.275)	(0.276)	(0.299)	(0.281)	(0.282)	(0.272)	(0.260)	(0.262)
Constant	4.989	3.079	3.046	5.011	3.191	3.159	4.278	2.911	2.867
	(0.081)	(0.440)	(0.454)	(0.082)	(0.471)	(0.487)	(0.073)	(0.418)	(0.432)
Industry Fixed Effects	X	X	X	X	X	X	X	X	X
Year Fixed Effects	X	X	X	X	X	X	X	X	X
Baseline Controls		X	X		X	X		X	X
Trends Baseline			X			X			X
R-Squared	0.841	0.858	0.864	0.829	0.848	0.854	0.831	0.849	0.856
Observations	4556	4556	4556	4556	4556	4556	4556	4556	4556
Clusters	268	268	268	268	268	268	268	268	268

Note: 'Fully-flexible' differences-in-differences estimates of the impact of Heavy Chemical and Industry industrial targeting on industrial output, relative to 1972 baseline levels. All outcomes are daflected by industry-level price indices and reflect real values. Columns (1)-(3) report results for value of shipments; columns (4)-(6), for gross output; columns (7)-(9), for value added. All specifications include 5-digit industry and year fixed effects; the industry-level fixed effects absorb the targeted dummy variable. Columns (2), (5), and (8) include pre-1973 averages for (IHS) employment, labor productivity, average wage, average cost, average establishment size, and average fixed investment, each interacted flexibly with period effects. Columns (3), (6), and (9) include pre-trends in the aforementioned baseline control variables, each interaction with a period dummy variabl. These estimates appear in the corresponding visualization figure. Regression log specifications are nearly identical and are included in the Appendix. Robust standard errors are clustered on the 5-digit industry-level. Standard errors in parentheses: *p<0.05, ** p<0.01, *** p<0.001.

Source: Mining and Manufacturing Survey & Mining and Manufacturing Census: 1970-1987.

Main effects: with and without controls

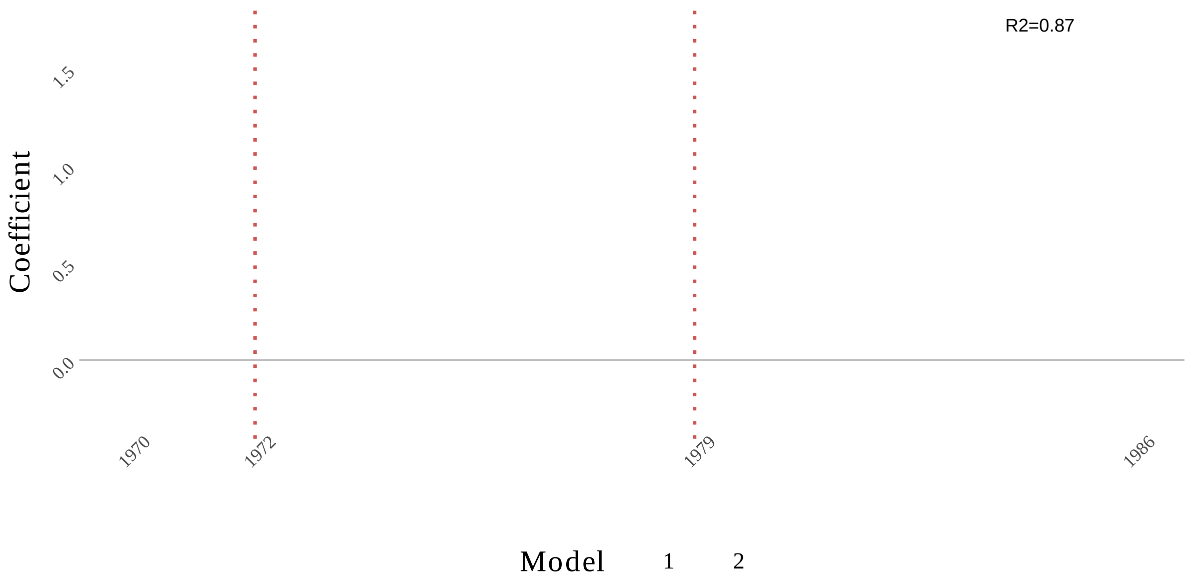

Figure A7: Revisiting the Impact of HCI on (Real) Value Shipped, 1970-1986, Relative to 1972 Baseline. Including versus Not-including First-Order Linkage Effects.

Notes: Each point corresponds to the coefficient Targeted × Year, and estimate the difference in (real IHS) value shipped for each year, relative to the 1972 baseline level. Grey dots and the darker confidence band correspond to the preferred direct effect, flexible differences-in-differences specifications. Red dots and pink confidence bands correspond to the same specification but including *Forward HCI Linkage* and *Backward HCI Linkage*, both interacted with period effects. All specifications include 5-digit industry fixed effects and period effects. Both models also include baseline controls interacted flexibly with period effects: pre-treatment average wage-bill, average establishment size, costs, employment, and total investment. Pretrends of these variables are also included. Standard errors are clustered at the 5-digit industry level.

B Technical Appendix

Section 2 described the details of South Korea's industrial policy, which used capital subsidies and trade policy to shift economic activity toward targeted sectors. In this section, I use a simple multi-sector model (Jones, 2008; Long Jr & Plosser, 1983), to illustrate the general equilibrium effects of the big push through the input-output network. The purpose of this stylized model is twofold. First, I use the framework to specify how HCI-style industrial policy should impacts forward-linked (downstream) and backward-linked (upstream) sectors, respectively. Second, This framework yields four simple predictions which I later use to structure my empirical findings.

I model Korea's industrial policy by considering two forms of market distortions ("wedges"), which planners remove for key industries.[51] The first distortion, $(1+\tau_i^M)$ resembles a tax on imported inputs; the second, $(1+\tau_i^R)$, a tax on investment.[52] Removing $(1+\tau_i^R)$ and $(1+\tau_i^M)$ leads to growth in targeted sectors. This expansion of supply benefits forward-linked sectors, but have ambiguous impacts on backward-linked suppliers, depending on whether targeted sectors face import competition as a result of the industrial policy.

Consider an N industry economy. In each industry i, a representative firm manufactures a single good in a perfectly competitive market with a constant returns to scale technology. The production function of a representative firm has the following Cobb-Douglas form:

$$y_i = A_i k_i^{\alpha_i^k} l_i^{\alpha_i^l} \prod_{j=1}^{N} x_{ji}^{a_{ji}} \prod_{j=1}^{N} m_{ji}^{b_{ji}}. \tag{9}$$

where A_i is productivity, k_i is capital, and l_i is labor. Following the constant returns to scale assumption with $\alpha^l, \alpha^k > 0$, and $a_{ji}, b_{ji} \geq 0$: $\alpha_i^l + \alpha_i^k + \sum_{ß=1}^{N} a_{ji} + \sum_{ß=1}^{N} b_{ji} = 1$. The subscript, ji demarcates the direction of transactions from sector j to sector i, for example a_{ji} is the cost share of input j used by industry i.

In (9), production of good i requires products from other industries, j: x_{ji}. With Cobb-Douglas production and perfect competition, the coefficient a_{ji} corresponds to entries from the (domestic) input-output matrix, capturing the share of good j used in the total intermediate input bundle of industry i. Similarly, b_{ji} corresponds to entries in an input-output matrix for imported intermediates.[53] For now, I assume the two types of inputs are distinct and not substitutable.

The market clearing condition for industry i includes output sold to other industries as intermediates, x_{ij}, and output consumed as final goods, c_i:

$$y_i = c_i + \sum_{j=1}^{N} x_{ij}, \forall i. \tag{10}$$

A representative household has Cobb-Douglas preferences $u(c_1, ..., c_N) = \prod_{i=1}^{N} c_i^{\beta_i}$, where $\beta_i \in (0,1)$ represents the weight of good i in the household's preferences, normalized such that $\sum_i^N \beta_i = 1$. The household finances consumption through capital and labor income, $C = \sum_i^N c_i p_i = rK + wL$. For simplicity, I ignore state transfers and ignore trade balance: $C = Y$. The household's maximization problem yields the conditions, $\frac{p_i c_i}{\beta_i} = \frac{p_j c_j}{\beta_j}, \forall i, j$, and $p_i = \frac{\beta_i}{c_i} Y, \forall i$. In other words, consumption shares are constant, each equal to the coefficient weight in the household's utility function.

[51]In a similar spirit, Cheremukhin, Golosov, Guriev, & Tsyvinski (2013) consider Stalin's structural change policies as the shifting of factor and product market wedges across different sectors. This conceptualization of industrial policy as wedges follows Leal (2016) and Rotemberg (2017).

[52]One could also imagine that industrial policy directly impacts the productivity of targeted industries. Recent work by Itskhoki & Moll (2016) considers industrial policy as interventions promoting the revenue productivity of industries with a latent comparative advantage.

[53]Due to data limitations, the empirical side of this study is restriction to *total* input shares: where Korean input-output matrices combine foreign and domestic input shares.

For each industry i, a representative firm's maximization problem is the following:

$$\max_{\{x_{ji}\}_{j=1}^{n},\{m_{ji}\}_{j=1}^{n},k_i,l_i}\left(p_i y_i - wl_i - (1+\tau_i^R)rk_i - \sum_{j=1}^{N} p_j x_{ji} - \sum_{j=1}^{N}(1+\tau_j^M)\bar{p}_j m_{ji}\right) \tag{11}$$

where $\bar{p}$ are exogenous world prices for imported intermediate inputs, and $(1+\tau_i^R)$ and $(1+\tau_j^M)$ are distortions on investment and imported intermediates, respectively.

The firm's problem (11) yields a competitive supply curve for good i as a function of factor prices and output prices. Accordingly, log-linearized supply is increasing in productivity ($\frac{\partial \ln y_i}{\partial A_i} > 0$), and decreasing in both the domestic price of intermediates and the price of imported intermediates ($\frac{\partial \ln y_i}{\partial p_j}, \frac{\partial \ln y_i}{\partial \bar{p}_j} < 0$). Differentiating the supply curve with respect to changes in capital taxes $(1+\tau_i^R)$ or intermediate input tariffs $(1+\tau_j^M)$ yields:

$$\frac{\partial \ln y_i}{\partial(1+\tau_j^M)} = -b_{ji} \tag{12}$$

$$\frac{\partial \ln y_i}{\partial(1+\tau_i^R)} = -\alpha_i^k. \tag{13}$$

Prediction 1: Removing import restrictions (lowering $(1+\tau_j^M)$) and increasing capital subsidies (lowering investment wedge $(1+\tau_i^R)$) promotes real output growth in targeted industries.

It is also useful to consider the effect of industrial policy on prices. Assuming zero profits, industry i's unit cost function is equal to industry prices. Hence industry i's Cobb-Douglas price index is:

$$p_i = \kappa_i \left[(1+\tau_i^R)r\right]^{\alpha_i^k} w^{\alpha_i^l} \prod_{j=1}^{N} p_j^{a_{ji}} \prod_{j=1}^{N}\left[(1+\tau_j^M)\bar{p}_j\right]^{b_{ji}} \tag{14}$$

where

$$\kappa_i = \left(\frac{1}{\alpha_i^l}\right)^{\alpha_i^l}\left(\frac{1}{\alpha_i^k}\right)^{\alpha_i^k}\prod_{j=1}^{N}\left(\frac{1}{a_{ji}}\right)^{a_{ji}}\prod_{j=1}^{N}\left(\frac{1}{b_{ji}}\right)^{b_{ji}}. \tag{15}$$

In this context, prices are completely pinned down by the supply side of the economy. Prices for good i are increasing in domestic and imported intermediate input prices: $\frac{\partial \ln p_i}{\partial p_j}, \frac{\partial \ln p_i}{\partial \bar{p}_j} > 0$. Importantly, i's prices are also increasing in the size of the intermediate import wedges $\frac{\partial \ln p_i}{\partial(1+\tau_j^M)} = b_{ji}$, as well as the investment wedge $\frac{\partial \ln p_i}{\partial(1+\tau_i^R)} = \alpha_i^k$. In other words, prices for i are decreasing with the industrial policy:

Prediction 2: Industrial policy—removing $(1+\tau^M)$ and $(1+\tau^R)$ for targeted industries—decreases prices in targeted industries.

This framework also illustrates how the expansion of targeted sectors affects forward-linked (downstream) and backward-linked (upstream) industries. The combination of Cobb-Douglas preferences and production guarantees that supply shocks and demand shocks propagate through the input-output network in predictable ways (Acemoglu, Akcigit, & Kerr, 2016).

First, consider the effect of industrial policy on forward-linked sectors. Prediction 1 and Prediction 2 show that industrial policies increase the supply of targeted industry goods. Growth in industry j's output, y_j, and a decline in j's output price, p_j, are beneficial for downstream industries. To see this, consider a manipulation of the (9), plugging in the first order conditions from the firm's optimization problem, and total differentiating after log-linearization: $\ln y_i$ varies positively with $\sum_{j=1}^{N} a_{ji} \ln y_j$.

Moreover, as seen from industry i's price index (14), a decline in the targeted sector's price, p_j, leads to a decline in the output price p_i.[54] Hence, the effect of industrial policy on forward-linked sectors can be summarized as:

> **Prediction 3:** Successful industrial policy confers benefits to forward-linked (downstream) industries: output increases in purchasing industries and prices decline.

The expansion of targeted sectors also affects backward-linked industries—domestic industries that supply goods to targeted sectors. Suppose industry i is an industry selling goods to targeted industry j. Intuitively, growth in targeted sector j translates into increased demand for intermediate products produced by i, x_{ij}. Production in industry i increases to meet higher demand for its output. Moreover, demand shocks do not impact prices, as in this framework prices are wholly determined by the supply side of the economy.

To see how industrial policy creates demand shocks for upstream suppliers, consider the market clearing condition (10) for a backward-linked industry i. Total differentiating (10), inserting the firm's first order conditions, and leveraging that consumption levels do not change, yields $\frac{d(y_i p_i)}{y_i p_i} = \sum_{j=1}^{N} a_{ij} \frac{d(y_j p_j)}{y_i p_i}$. With constant prices, this expression simplifies to $dy_i = \sum_{j=1}^{N} a_{ij} dy_j$. Output of the backward-linked industry, y_i, increases with the output of the targeted sector y_j.

Realistically, however, targeted sectors use imported inputs that may compete with domestic industries, in which case industrial policy has negative effects through backward-linkages (Acemoglu, Autor, Dorn, Hanson, & Price, 2015; Autor, Dorn, & Hanson, 2013). Let m_{ij} be an intermediate import used by targeted sector j; this good competes with a domestically supplied good x_{ij}. Since the policy lowers the price of intermediate imports for treated sectors, j imports more m_{ij}. The detrimental effect of import competition can be incorporated into the model in a reduced form way, incorporating a competing import into industry i's market clearing condition (10): $y_i = c_i + \sum_{j=1}^{N} x_{ij} - m_{ij}$.[55] Thus, an increase in competing import m_{ij} reduces i's output, y_i.

> **Prediction 4:** For targeted sectors, industrial policy lowers the cost of importing intermediate inputs. If intermediate imports compete with domestic suppliers operating in the same market, then industrial policy creates a negative demand shock for backward-linked industries and their output declines.

B.1 Technical Appendix Bibliography.

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Cheremukhin, A., Golosov, M., Guriev, S., & Tsyvinski, A. (2013). Was Stalin Necessary for Russia's Economic Development?

Forslid, R., & Midelfart, K. H. (2005). Internationalisation, industrial policy and clusters. *Journal of International Economics*, *66*(1), 197–213.

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[54] Similar downstream effects of industrial policy (specifically, subsidies), are shown by Forslid & Midelfart (2005).

[55] Acemoglu et al. (2015) similarly examines the reduced form impact of intermediate imports on a competing domestic industry by using the market clearing condition.

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C Data Appendix

C.1 Harmonization and Crosswalk Schemas

My analysis requires two types of harmonization,

1. Making industrial and product definitions that are consistent through time,
2. Combining codes across distinct times of industry coding.

The following text describes the harmonization process.

C.1.1 General Harmonization Heuristics and KSIC Changes Through Time

The main dataset of the project uses the *Mining and Manufacturing Census/Survey* (MMS) published (then) by the Economic Planning Board (EPB). The MMS data used codes a local Korean coding scheme (KSIC) largely based on current International Standard Industrial Classification (ISIC) system. During the span of this study, KSIC codes were updated repeatedly, in 1970, 1975, and 1984, and thus data requires multiple crosswalk schemas to build a harmonized industry panel. The crosswalk schemas—algorithms for harmonizing across many industrial coding schemes—were created with the help of concordance tables digitized from Economic Planning Board publications. These crosswalks allowed me to map sector definition "splits" to time-consistent industry identifiers.

For the main MMS industrial census dataset, the crosswalk schemes were used to map sector "splits" back to their original code format. For example, consider an example from the non-metallic minerals sector. In 1975 the industries (36994) *Manufacture of Asbestos Products* and (36995) *Manufacture of Mineral Wools* were split from the 1970 industry (36996) *Manufacture of Stone Texture*. My crosswalk schema aggregates the two 1975 sector codes back to their original 1970 code.

Conversely, some Korean industry codes were merged through time.[56] For example, the 1975 sector (32163) *Manufacture of Man-made Fibre Fabrics* was merged from two distinct 1970 industry codes: (32172) *Manufacture of Silk Fabrics* and (32176) *Manufacture of Fabrics of Man-made Fibers*. In the case of aggregation of sectors through time, the two 1970 industries are aggregated into a larger synthetic sector, instead of splitting the 1975 industry into two separate industries.

The preceding harmonization process was performed for all Korean industry code changes for revision years 1970, 1975, and 1984. After harmonization, the 1970–1986 industrial panel is a bit more aggregated than each individual cross section, yielding ~268 consistent industry codes for the main MMS panel.

The MMS data used throughout this study are at the 5-digit level, with the exception of series that used pre-1970 MMS data. Prior to 1970, KSIC codes were shorter. Though the short length of pre-1970 codes is quite comsmetic: E.g. for industries that were not merged or split during this period, a 5-digit code in post-1970 KSIC is roughly equivalent to 4-digit KSIC scores. Thus, harmonization codes between pre-1970 and post-1970 periods require more extensive aggregation of industries to accound for this structural change in industrial codes.

[56] Clearly, accounting for simple renaming of sector codes is a trivial problem.

C.1.2 Harmonization Across and Within Other Code Schemes.

Though this study relies heavily on MMS data, my analysis requires combining this data with I-O tables, policy measures, price data, and trade data. Thus, further crosswalk schemas were used to harmonize datasets across coding schemes.[57] Thus, Over a dozen harmonization algorithms were required to create the main 5-digit industrial panel used below.

Generally, data from competing agencies utilize their own coding system. The following types of crosswalks are required for joining data across economic datasets.

- SITC Rev. 2 to KSIC (various revisions)
- Bank of Korea Codes to KSIC (various revisions)
- SITC Rev. 2 to SITC Rev. 1
- CCCN to SITC Rev. 2
- Korean Development Instition input-output codes to Bank of Korean Codes

In addition to KSIC industry data, annual price statistics and 1970 input-output accounts utilize the Bank of Korea's own industrial coding system. Like harmonization across multiple KSIC revisions, BOK data also require a harmonization *within* BOK code revisions. These crosswalks schemas were constructed from appendices of the bank's input-output table publications: for the years 1975, 1980, 1983, and 1985.

[57] Manufacturing data: Korean Standard Industrial Classification; prices: current (as of 2015) Bank of Korea industry classifications; trade data: ISIC (Rev. 2); trade policy data (CCCN); and input-output data: historic Bank of Korea sector codes.