

Manufacturing Revolutions^{*}

Industrial Policy and Networks in South Korea

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Abstract

This paper uses a historic big push intervention and newly digitized data from South Korea to study the effects of industrial policy on (short- and long-run) industrial development. In 1973 South Korea transitioned to a military dictatorship and drastically changed their development strategy. I find industries targeted by the regime's big push grew significantly more than non-targeted industries along several key dimensions of industrial development. These developmental effects persisted after industrial policies were retrenched, following the 1979 assassination of the president. Furthermore, I estimate the spillovers of the industrial policies using exogenous variation in the exposure to the policy across the input-output network. I find evidence of persistent pecuniary externalities like those posited by big push development theorists, such as Albert Hirschman. In other words, I find that South Korea's controversial industrial policy was successful in producing industrial development, the benefits of which persisted through time and in industries not directly targeted by the policies.

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1 Introduction

Miracles by nature are mysterious. The forces behind the East Asian growth miracle are no exception. Industrial policy, however, has defined Asia's striking postwar transformation (Rodrik, 1995). The ambitious development strategies pursued by Korea, Singapore, and Taiwan now shape interventions across the world, from Southeast Asia to Sub-Saharan Africa (Rodrik, 2005; Robinson, 2010; Lin, 2012). Arguably, industrial policies have since become a ubiquitous feature of modern economic development; with rare exception, every developing country has pursued industrial policy. While early development economists argued these policies were key to structural transformation (Rosenstein-Rodan, 1943; Hirschman, 1958), many others warned of their deleterious consequences (Baldwin, 1969; Krueger, 1990). Nonetheless, few empirical studies have explored the effects of industrial policy on development—and none have addressed their role in Asia's postwar transformation.

In 1957, Ghana and South Korea had identical national incomes, and South Korea entered the 1960s, corrupt, unstable, and dependent on Western aid.¹ By 1980, the Republic of Korea 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 an impoverished, agrarian economy into a modern industrial power? This paper explores Korea's use of industrial policy: interventions intended to shift a nation's industrial composition to one more favorable for growth than if the economy evolved according to static comparative advantage [Lindbeck (1981); Chang (2003); Noland and Pack (2003); p.10].

I consider a definitive postwar policy, South Korea's Heavy Chemical and Industry (HCI) drive, 1973-1979. HCI embodied the big push-style policies imagined by development scholars, such as Rosenstein-Rodan (1943), Nurkse (1953) and Hirschman (1958). Moreover, HCI was an infant industry policy: a temporary (six year) intervention meant to incubate Korea's strategic industries. Korea's drive was broadly representative of industrial policies used across East Asian economies—and beyond (Vogel, 1991; Young, 1992). Korea copied their policy from Japan, while contemporaries, such as Taiwan, pursued comparable strategies (Cheng, 1990; Cheng,

¹I refer to per capita GDP (Werlin, 1991). According to the Penn World Tables, in 1960 South Korea's per capita national income lagged behind Cameroon, Central African Republic, Haiti, Madagascar, Morocco, Niger, and Tanzania (Feenstra et al., 2015).

2001). Meanwhile, Korea's big push inspired similar interventions in countries like Algeria, Brazil, Malaysia, and Philippines (Kim et al., 2013; Moreira, 1994; Lall, 1995; Lall, 1996). The mixed results of these policies have only made Korea's big push more controversial [Kim and Leipziger (1993); p.24].

In studying the consequences of South Korea's big push, I make three contributions. First, I estimate the effect of industrial policy on short-run industrial development outcomes. I do so by comparing the evolution of targeted and non-targeted manufacturing industries before and after the policy's announcement.² Second, I evaluate the spillovers of the intervention, tracing how the policy propagates through the input-output network. I disentangle the effects through forwards and backward linkages, motivating my results using a multi-sector general equilibrium model. Finally, I test whether the effects of the drive persisted after the planning period, both in sectors directly targeted by policy and in those exposed to the policy through linkages.

For the purpose of this study I construct a rich industrial dataset, combining digitized material from archival sources with vintage machine-readable data. I harmonize this panel with network measures from reconstructed input-output accounts and rare trade policy data. The result is an extensive dataset spanning South Korea's big push episode.

External politics drove the big push in 1973 and its demise in 1979. President Richard Nixon's sudden withdrawal of U.S. forces from Asia (the so-called Nixon Doctrine) had thrown Eastern allies into a security crisis. Since World War II, South Korea relied on the U.S. to maintain military balance against the North. With U.S. support in doubt, the South was forced to develop their own military-industrial capacity. Strictly speaking, the U.S. pullout prompted a big push by executive decree, shifting the country's policy regime from a general export promotion strategy to one promoting a limited set of strategic industries. Key sectors were selected based on military importance and copied from Japan's earlier industrial strategy (Stern et al., 1995; B.-k. Kim, 2011). Just six years after its announcement, however, the big push died with its general: President Park's 1979 assassination signaled a *de facto* end to his cornerstone project.

The historic context of South Korea's big push allows me to avoid prominent

²I use the terms *sector* and *industry* interchangeably in this study.

sources of bias that plague studies of industrial policy. The political nature of industrial policy means interventions are often allocated based on elite patronage and special interest politics rather than economic rationality. For instance, subsidies and tariffs regularly go to declining, or “sunset,” sectors, and in the developing world, cronyism steers resources towards projects that defy latent comparative advantage (Harrison, 1994; Rodrik, 2005). Accordingly, empirical studies often reveal a negative relationship between industrial policies and industrial growth. By contrast, I argue that the big push was implemented under the duress of a security crisis that made rational implementation paramount. Also, I maintain HCI planning selected projects for which Korea possessed a latent comparative advantage.

Korea’s setting suggests an intuitive estimation strategy. I compare changes in industrial outcomes between targeted and non-targeted manufacturing industries for each year before and after the big push announcement. This flexible differences-in-differences strategy uncovers the effect of interventions aimed at promoting sectors in which it has latent comparative advantage. Pre-trends represent a counterfactual sectoral structure; absent HCI interventions, industries would have evolved according to their pre-1973 specialization, or static comparative advantage. The post-1973 differences reflect the efficacy of interventions—investment subsidies and trade policy—aimed at allocating resources toward sectors which South Korea had unrealized potential in, or latent comparative advantage.

My preferred estimates show the big push significantly shifted economic activity to capital-intensive industry, a shift which continued after the interventions were retrenched. During and after the HCI-period (1973–1979), targeted sectors grow significantly more than non-targeted sectors relative to pre-treatment levels. The results are robust to various measures of growth and indicators of industrial development. Importantly, I find evidence of significant improvements in productivity during and after the big push, as shown by measures of factor productivity, exports, and, importantly, output prices. Market entry and employment also increase.

A key argument for industrial policy, however, is that benefits accrue to industries *outside* of targeted sectors (Hirschman, 1958; Hirschman, 1968; Pack and Westphal, 1986; Grossman, 1990). To see whether this was the case, I estimate the network spillovers of policy by comparing the evolution of non-targeted industries with weak linkages and those with strong linkages to targeted sectors. I find HCI

policies positively impacted forward-linked (downstream) industry but negatively impacted backward-linked (upstream) industry. Results suggest industrial policy surprisingly lowered the prices for downstream buyers. On the other hand, HCI trade policies allowed targeted industries to import intermediates and subjected upstream suppliers to import competition. Thus, I provide new evidence that industrial policy generates pecuniary externalities, but in ways not fully anticipated by classic developmental theory.

My study speaks to an unresolved debate on the role of industrial policy in economic development. On one side of the debate, an influential descriptive literature has emphasized the role of state institutions and industrial interventions in postwar industrialization (including Johnson, 1982; Wade, 1990; Vogel, 1991; Amsden, 1992; Evans, 1995; Chibber, 2002; Kohli, 2004). This literature highlights the centrality of industrial policy in East Asia's transformation. Robert Wade (1990) and Alice Amsden (1992), in particular, emphasize that the big push interventions were essential to Korea's miracle.

Conversely, a large literature in economics criticizes the role industrial policy in economic development (Baldwin, 1969; Krueger and Tuncer, 1982; Lal, 1983; Noland and Pack, 2003). These criticisms are met with little empirical literature on the effect of industrial policy on structural change (Herrendorf et al., 2013).³ Accordingly, many doubt the role of these interventions in postwar East Asia (Weinstein, 1995; Beason and Weinstein, 1996; Lawrence and Weinstein, 1999). An influential critique of postwar policies is that NICs would have grown more in their absence (Krueger, 1995). Yoo (1990) argues this was the case for HCI in Korea, and Lee (1996) shows evidence that policies may have been detrimental to the industrial development of targeted sectors. (Noland, 2004) further contends that HCI failed to target "leading industries."

I provide one of the first econometric studies of East Asian industrial policy, adding econometric credence to the arguments made by Robert Wade (1990) and Alice Amsden (1992)—with important caveats for a small open economy. In doing so, I contribute to a nascent literature on industrial policy, including Nunn and Trefler (2010), Criscuolo et al. (2012), Aghion et al. (2015), as well as Juhász (2016) and Rotemberg (2015), who study the impact of industrial policy in a development

³"[T]he empirical evidence on the success of 'big-push' policies in particular, and industrial policies more generally, is mixed at best," Herrendorf et al. (2013).

context.

My study also contributes to the literature on network economics. It draws directly on original theories of industrialization and linkages emphasized by Scitovsky (1954), Rasmussen (1956), Myrdal (1957), Chenery and Watanabe (1958), and Hirschman (1958). Ciccone (2002), Jones (2008), and Jones (2013) formalize these theories, showing that key sectors can influence aggregate growth through input-output linkages. Similarly, (Long Jr and Plosser, 1983; Carvalho, 2010; Acemoglu et al., 2012; Atalay, 2015), explore the influence of sectoral shocks on the business cycle.⁴ My results on linkages also relate to a development literature on the intersectoral effects of FDI (Rodríguez-Clare, 1996; Markusen and Venables, 1999; Smarzynska Javorcik, 2004) and trade policy (Succar, 1987; Krugman, 1998; Puga and Venables, 1999; Forslid and Midelfart, 2005).

Finally, my study contributes to the literature on the role played by state capacity in economic development (Besley and Persson, 2010; Besley and Persson, 2011; Acemoglu et al., 2015) and the implementation of growth-enhancing policies (Dell et al., 2016).⁵ Industrial policy *is* state action, and thus intimately tied to the quality of government (Rodrik, 1997). Successful interventions require specific bureaucratic capabilities (Johnson, 1982; Evans, 1995; Fukuyama, 2014) and also require political incentive compatibility (Haggard, 1990; Chibber, 2002; Robinson, 2010; Vu, 2010). These conditions are rarely satisfied (Krueger, 1990). Nonetheless, Wade (1990) and Amsden (1992) suggest the strong institutions of South Korea, Taiwan, and Japan underpinned the successful deployment of HCI interventions. State capacity may be a necessary ingredient for executing proper industrial development strategies and thereby fostering economic development.

The remainder of the paper is organized as follows. Section 2 discusses the historical and institutional setting of the HCI big push. Section 3 outlines the effects of the policy using a multi-sector general equilibrium model. Section 4 describes my digitized manufacturing dataset for South Korea. Section 5 presents estimates of the direct effect of industrial policies on targeted industries. Section 6 reports estimates of how HCI spilled over onto non-targeted sectors through the input-output network. Finally, Section 7 summarizes the results of my study.

⁴Within this literature, Shea (2002), Conley and Dupor (2003), and Holly and Petrella (2012) highlight the importance played by intersectoral factor-demand linkages.

⁵My related work with Melissa Dell and Pablo Querubin (Dell et al., 2016) explores the historical effect of the Weberian state and its capacity to implement successful policy across Asia.

2 Institutional Context

2.1 Drivers of the Heavy Chemical and Industry Big Push

“The enemy will hesitate to invade only when they realize that we are equipped with strength and determined to fight to the end” – President Park Chung-hee⁶

“[Congress] may – as in the case of Vietnam – deny funds and use of U.S. forces needed to defend Korea and even force U.S. troop withdrawals ... Korea’s only alternative is to achieve a degree of self-reliance that will cushion possible loss of U.S. support before or during conflict” – U.S. Ambassador Sneider⁷

This paper focuses on a period of political emergency, during which President Park Chung-hee declared a lifelong dictatorship in late-1972 (the *Yushin Constitution*) and launched the Heavy Chemical and Industry Drive (HCI), 1973-1979.

A security crisis drove the South Korea’s heavy industrial big push (Haggard, 1990; Yoo, 1990; Stern et al., 1995; Horikane, 2005; Im, 2011; H.-A. Kim, 2011; Moon and Jun, 2011).⁸ Two parallel events were at the heart of this impasse (Kim, 1997; Kwak, 2003; Moon and Lee, 2009; Kim, 2004).⁹ First, a sudden change in U.S. foreign policy towards Asia. Second, the parallel militarization of North Korea.

In late 1969, facing domestic political pressure from the Vietnam War, President Nixon announced the end of U.S. military support for Asian allies, who would now be responsible for defense against Communist aggression [Nixon (1969); p.549]. This “Nixon Doctrine” effectively ended the Vietnam War and preceded normalized relations with China. South Korea, an anti-Communist stalwart that had sent 50,000 troops to South Vietnam for U.S. military commitments, was outraged (Kim, 1970; Kwak, 2003).

⁶Kim, 2004; p.166.

⁷Kim, 2011b; p.31.

⁸There is no ambiguity as to the security pretext for the HCI drive. Yoo (1990), in a Korean Development Institute report, “one of the main reasons why the government adopted the HCI policy was the security concern” [Yoo (1990); p.18]. “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]. For a summary of HCI in the context of building a domestic defense, see (H.-A. Kim, 2011)

⁹Historian, James Palais: “Park was so shocked by what he perceived as the American failure from the late 1960s to the mid-1970s to respond to North Korean provocations, to stay the course in Vietnam, and to maintain a solid commitment to the defense of South Korea, that he decided to institute a more determined policy to achieve the next phase of the industrial revolution by creating a heavy and chemical industrial sector” [Kim (2004); p.xiv].

Nixon's political shock introduced the risk of *full* U.S. troop withdrawal through the 1970s. The ROK believed that they could be left to defend against a DPRK *blitzkrieg* alone. A U.S. congressional subcommittee report summarized the causal implications: a "consequence of the [troop] withdrawal was the need for South Korea to improve its defense production capability" and needed to play "'catch-up ball' with the DPRK" [U.S. House. Committee on International Relations. Subcommittee on International Organizations. (1978); p.74].¹⁰ The ROK feared they would become the next South Vietnam, and the U.S. could normalize relations with the DPRK (Nam, 1986; Goh, 2004; Ostermann and Person, 2011).¹¹

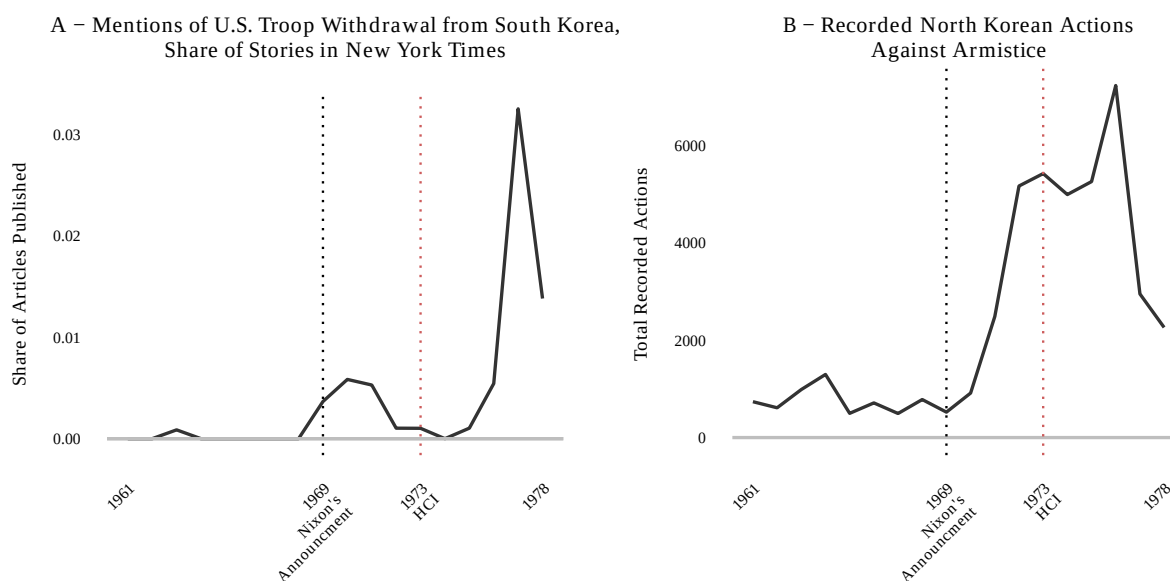


Figure 1: Political Events Behind the Heavy Chemical and Industry Drive

The U.S. troop withdrawal threat came in two waves. Figure 1, Panel A plots the occurrences of Korean troop withdrawal stories (share of stories) in the New York Times.¹² The first shock corresponds to the spike in stories between 1970–1972. Confirmation of the U.S.' commitment to the pull-out of ROK came in 1970 and "profoundly shocked" President Park, who expected exemptions from the Nixon Doctrine [Rogers (1970); Nixon (1970); Kwak (2003); p.34]. That summer,

¹⁰Janne E. Nolan (1986) makes the case that the Nixon doctrine promoted similar industrial reactions in both South Korea *as well as in* Taiwan, who were similarly threatened by U.S. *détente* with China.

¹¹Historian Nam Joo-Hong notes that normalized Sino-American relations were a "double loss" that strategically benefited North Korea [Nam (1986); p.126-128]. South Korean official, Kim Dasool: "when the U.S. entered into *détente* with China... then it was a definite possibility that the U.S. government could also enter into *détente* with North Korea and perhaps even normalize its relationship with North Korea" [Ostermann and Person (2011); p.15].

¹²Search term: *South Korea + Troop Withdrawal* .

U.S. Vice President Spiro Agnew unexpectedly announced the intention of a *full* troop withdrawal. Immediately after Agnew's announcement, Korean and U.S. press first reported that—unbeknownst to Korea—the U.S. had already scaled down their forces by 10,000 [U.S. House. Committee on International Relations. Subcommittee on International Organizations. (1978); p.34; Nam (1986); p.78; Kwak (2003); p.47]. The first wave of true withdrawals occurred in 1971, when the US pulled 24,000 ground troops and three air force battalions from the peninsula.

The threat of total U.S. withdrawal persisted through the 1970s, particularly during the 1976 U.S. presidential campaign.¹³ As explained by a contemporaneous Asian Survey report on South Korean relations: “The Jimmy Carter phenomenon became a veritable shock for the ROK government” [Oh (1977); p.71]. Total withdrawal and further reduction of military assistance became a campaign promise of the Democratic candidate, who denounced Park's human rights record and U.S. military support (Taylor et al., 1990).¹⁴

For South Korea, the U.S. withdrawal was ill-timed. Figure 1, Panel B plots the steady escalation of “actions against the amnesty treaty” (the post Korean War treaty) (Choi and Lee, 1989).¹⁵ Through the late-1960s, North Korean launched a steady wave of attacks on the South, inspired by Viet Cong tactics in Vietnam.¹⁶ As indicated by Panel B, through the 1970s the DPRK stepped up conventional antagonism against the ROK. In late-1971, South Korean CIA director stated, “[a]t this moment, our front-line is a half step before crisis. A North Korean attack may come anytime. They are deploying units and tanks much closer to the DMZ” [Kim (2001); p.55]. A few years later, the fall of Southern Vietnam roused South Korea's “the worst fears” [Oh (1976); p.78] and triggering a “near panic situation” in the Republic [Kim and Im (2001); p.64].

The connection between the military-industrial drives and North Korean action is illustrated by March 1974's “Yulgok Operation,” an emergency measure that followed DPRK attacks on Paeng'nyong Islands [Kim (2004); p.189]. The project,

¹³“The HCI drive was also largely motivated by national security concerns, *magnified by the Carter administration's plan to completely withdraw U.S.. [emphasis my own]*” [Kim et al. (1995); p.186].

¹⁴Immediately after taking office in 1977, Carter reiterated his commitment to withdraw the remaining U.S. troops [Han (1978); M. Y. Lee (2011); p.428]. However, the instability following Park's 1979 assassination meant the U.S. could not carry through with the campaign promise.

¹⁵Actions against the amnesty treaty include border crossings, military exercises, and other acts of antagonism.

¹⁶“Kim Il Sung understood the power of insurgency as a lesson learned from the Vietnam war” (Scobell and Sanford, 2007). Vietnamese-style tactics culminated in a 1968 surprise attack on the presidential residence (the Blue House). Another assassination attempt on Park in 1974 would kill the First Lady.

which sought to upgrade ROK's military hardware, coincided with the establishment of a National Defense Fund, followed by a new National Defense Tax.

North Korea was militarily and economically superior to South Korea through the 1970s (Eberstadt, 1999; Noland et al., 2000; Eberstadt, 2007).¹⁷ Through the 1970s, the DPRK continued a non-stop military-industrial course embarked on in 1962 [Hamm (1999); Michishita (2009); p.23]. By the early 1970s, the North had become "the most highly militarized society in the world today" (Scalapino and Lee, 1972). Taik-young Hamm argued that during the DPRK's crash military build-up campaign from 1967-1971, the ROK "did (or could) not follow suit" [Hamm (1999); p.79].

The U.S. withdrawal threat meant the South would have to militarize to reach military balance with the North. During the first U.S. withdrawal, the ROK had relied on dated M-1 rifles and WWII era artillery, and according to estimates, military stocks could last for three days in the event an invasion by the DPRK [Stern et al. (1995); p.21-22]. By the late-1970s, even after an unprecedented military modernization the South, the military advantage lay with North Korea – especially without U.S. troops (U.S. Senate. Committee on Foreign Relations, 1978; Cushman, 1979; Choi, 1985; Eberstadt, 1999).¹⁸

2.2 Heavy Chemical and Industry Drive Policy

Programme and Sectoral Choice The HCI drive was announced at a New Year's press event, January, 12 1973, and "rapidly turned into an all-out operation for South Korea's military modernization" [H.-A. Kim (2011); p.29].¹⁹ The official HCI Plan was the product of executive action and covertly drawn up by a team of technocrats (Haggard, 1990; p.131; Kim, 1997).²⁰ To further avoid upsetting domestic capitalist

¹⁷The exact growth rate of North Korea is mysterious. Prominent scholars of North Korea conclude that conservatively North Korean growth dominated the Republic's by the 1970s and, at most, even until the 1980s [Eberstadt (2007); p.xi]. Noland *et al.* state, "the conventional wisdom is that per capita income in North Korea exceeded that of South Korea well into the 1970s" [Noland et al. (2000); p.1769].

¹⁸A U.S. Senate report on U.S. military withdrawal summarizes the military balance on the peninsula in 1978: "[t]he principal advantages for the North today lie in ground weapons (tanks, artillery, mortars), quantity of fighter aircraft and quantity of naval combat vessels" [U.S. Senate. Committee on Foreign Relations (1978); p.2]. Lt. Gen. John Cushman concluded that the Second Infantry would be "essential" to stop North Korea's "superior forces in a surprise, Blitzkrieg-Style drive to capture or threaten Seoul" [Cushman (1979); p.361]. Nick Eberstadt echoes that by 1979 the DPRK "probably still enjoyed a military advantage over ROK [South Korea]" [Eberstadt (1999); p.34].

¹⁹The HCI Plan is was announced, June 1973. 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).

²⁰Alongside HCI, a secret defense program, project Yulgok, was carried out to upgrade military weaponry (Hamm, 1999; Kim, 2004; H.-A. Kim, 2011).

interests, as well as competing bureaucrats, administration fell to a superagency, the Heavy Chemical and Industry Promotion Committee (Lim, 1998; Haggard, 1990).²¹

Six broad “strategic” sectors were targeted by the policy: steel, non-ferrous metals, shipbuilding, machinery, electronics, and petrochemicals (Lee, 1991; Stern et al., 1995).²² Table 1 lists all 5-digit industries which fall into HCI policy.²³ Targeted industries were prioritized for ambitious investment and growth targets and, importantly, they were to achieve a 50 percent share of exports by the 1980s.²⁴

The choice of HCI sectors can be boiled down to two factors: strategic concerns and Japan’s historic experience.

First, HCI sectors were required for military-industrial modernization, as South Korea prepared for a future without U.S. assistance. It was clear to planners that heavy industry was necessary for future defense production. According to Yumi Horikane, earlier attempts at arms manufacturing failed due to lack of domestic input infrastructure: “the problem lay in the use of inadequate materials and the lack of precision production. Korean policy-makers realized the critical importance of creating a more advanced industrial base” [Horikane (2005); p.375].

Simply put, before HCI, the South lacked the capital and technology to develop a military-industrial base on par with the North, which received support from the USSR and China. The official big push documentation explicitly motivated the importance of cultivating key input sectors “with a view to enhancing self-sufficiency in industrial raw materials” [Kim and Leipziger (1993); p.18-19].

Steel, for example, exemplified a core input into defensive industry. Rhyu and Lew (2011) records that Park’s preference for steel “traced its origin to both real and perceived security threats” [Rhyu and Lew (2011); p.323].

Second, Japan’s industrial development influenced the choice of sectors (Kong,

²¹“The powerful role of the planning team minimized bureaucratic conflicts and increased effective implementation of the HCI Plan” [Lim (1998); p.81]. Planning in South Korea was routinely used to eliminate poor candidates for industrial projects Adelman (1969).

²²The term “HCI” is also used to define a specific set of sectors in Korea statistical publications. In this use of the term, HCI does not encompass the electronics industry. Hence, there is a distinction between HCI as it is used in statistical publications and its specific use in the 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].

²³The 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.

²⁴For HCI industries to be sustainable, it was necessary for them to export. Many of HCI industries required capacities larger than what could be sustained by the limited domestic market in Korea [Melo and Roland-Holst (1990); p.3-5].

2000; Stern et al., 1995). Lead HCI planner, Oh Won-chol, carefully studied the heavy industrial projects of other countries, in particular, Japan (Perkins, 2013). The New Long-Range Economic Plan of Japan (1958-68) was especially influential (Stern et al., 1995; Moon and Jun, 2011). Japan's plan presented a template of sectors—and their technologies—for which Korea may have a potential comparative advantage. A World Bank analysis of HCI tells that Korea used Japan to forecast their sectoral potential; 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].

While the World Bank questions Korea's proposal to enter into ship-building as quixotic, Meredith Jung-En Woo argues that Korea's belief in their latent comparative advantage lay in Japan: “Where did the Korean government get its confidence to push shipbuilding so massively? One of the answers was that Korea had found in Japan's shipbuilding industry a cynosure...observers noted that the Korean strategy to promote shipbuilding was very simply a carbon copy of Japan's” [Woo (1991); p.137]. Similarly, Atul Kohli credits the success of HCI's steel push with the availability of Japan's state-of-the-art expertise [Kohli (2004); p.112-113].²⁵ In other words, the proximity to Japan—institutionally and historically—meant the sectoral choices did not defy latent comparative advantage.

Unlike industrial policies elsewhere, copying (and partnering with) Japan indicated a concern that HCI sectors did not contradict potential comparative advantage. Technical requirements for erstwhile HCI projects would be acquired from Japan.²⁶ These technology transfers guaranteed reliable market for Japanese imports (Kong, 2000; p.53-55; Westphal et al., 1981).²⁷

Policy Levers The 1973 announcement was a distinct pivot in South Korea's development strategy: from industrial policies incentivizing general export activity to a big push policy aimed at driving resources, especially capital, toward strategic industry.

Before 1973, Park pursued total export-led industrialization. Industrial policies had no *de jure* sectoral bias, and scholars argued these policies were effectively

²⁵During HCI, Japanese lending was often contingent on purchasing Japanese inputs and technologies [Shim and Lee (2008); p.159].

²⁶See: *Korea's Economic Miracle: The Crucial Role of Japan*, Castley (1997)

²⁷Westphal et al. provide empirical evidence of many domestic Korean firms receiving foreign technological transfer vis-a-vis direct licensing and intermediate input suppliers [Westphal et al. (1981); p.40].

“liberal” (Krueger, 1979; Westphal and Kim, 1982; Westphal, 1990).²⁸ The World Bank’s Larry Westphal summarized pre-HCI policy as “a virtual free trade regime for export activity” where exporters enjoyed wide exemptions from import controls [Nam (1980); Westphal (1990); p.44].²⁹ In addition, ample subsidies bolstered exporters (Cho, 1989).³⁰

After 1973, industrial policy became surgical. HCI-era policies largely consisted of two levers: investment subsidies and trade policy.

Investment subsidies were the fundamental tool of HCI (Koo, 1984; Woo, 1991; Kim, 1997).³¹ The National Investment Fund (NIF) opened in 1974 and became the primary means of allocating capital to key sectors.³² Between 1975-1980, the NIF mobilized over 60 percent of financing for HCI industry equipment. In 1978 alone, at the crest of HCI policy, the NIF accounted for 67.2 percent of all HCI industry loans [Innovation and Development Network and Kim (2012); Vittas and Wang (1991); p.30].³³

The NIF provided discounted financing for equipment investment and factory construction, and loans were provided through commercial banks and, in particular, development banks (Koo, 1984).³⁴ Figure 2 plots the value of loans provided by the Korea Development Bank during the HCI period, the primary lender of NIF funds.³⁵ Grey lines correspond to non-targeted sectors and red lines indicate targeted sectors. Clearly, after 1973 there is a remarkable rise in credit lent by the principal NIF lender.

The tax code also shifted to subsidizing investments in HCI industries.³⁶ Major

²⁸A leading World Bank study on pre-HCI industrial policy notes, with rare exception, export incentives “were administered uniformly across all industries.” [Westphal and Kim (1982); p.217-218]. Nevertheless, these policies likely created distortions and had a *de facto* biased toward light, labor-intensive industries.

²⁹This idea is echoed by Korean Development Institute reports on 1960s industrial policy: “exemption of intermediate inputs and export sales from indirect taxes, and exemption from import duties on imported inputs allowed exporters to operate under a *virtual free trade regime* [my emphasis]” [Nam (1980); p.9]

³⁰Cho (1989) notes, until HCI in the early 1970, “the main thrust of directed credit programmes was to support export ‘activity’ rather than specific industries” [Cho (1989); p.93].

³¹“Allocation of loanable funds has been one of the most powerful tools to affect patterns of industrial development in Korea” (Koo, 1984). For overview of state financing of HCI, see *Race to the Swift: State and Finance in Korean Industrialization*, Woo (1991)

³²“Financial support for heavy and chemical industries may be said to have started with introduction of the National Investment Fund in 1974” [Kim (2005); p.18-19]. A 1984 Korean Development Institute study prepared for the U.S. Trade Commission notes the NIF was “the major source of long-term financing for so-called strategic industries” [Koo (1984); p.36].

³³NIF was funded primarily through bond sales to banks and to public non-banking institutions (e.g. pensions). Byung-kook Kim notes the “NIF was an outright forced savings program,” funded in part by requiring public non-banking institutions to purchase NIF bonds and then requiring 8 percent of wage income to be levied into pensions [B.-k. Kim (2011); p.226].

³⁴By the end of HCI, long-term NIF interest rates were about 5 percent lower than conventional commercial bank loans.

³⁵The Korea Development Bank lent 62 percent of all NIF funds through 1981 [OECD (2012); p.39].

³⁶The World Bank reported that “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 numbers of industries” [Trela and Whalley (1990); p.19]



Figure 2: Value of NIF Loans from Korean Development Bank, by 2-digit Manufacturing Industry

reforms after 1974 consolidated industry-specific laws under a new program aimed at incentivizing investment in key sectors (Kwack, 1984; Kim, 1990; Trela and Whalley, 1990; Stern et al., 1995). By 1975, the Korean corporate tax code included a menu of generous investment tax credits and depreciation allowances for HCI sectors.³⁷

Figure 3, Panel B plots estimates of the average effective tax rate (percentage) on the returns of capital, accounting for changes in industry-specific subsidies. Average rates were calculated for aggregate 2-digit manufacturing industries (thin lines). Thick lines show the average rates by treated and non-treated industries.³⁸ The figure presents the clear divergence in tax incentives for treated and non-treated sectors during HCI (in particular the 1975 reform).

³⁷In particular, these incentives were provided under the “Special Tax Treatment for Key Industries” heading of the Tax Exemption and Reduction Control Law (1975).

³⁸Rates were calculated by Kwack (1985) and reported by Stern et al. (1995). Estimated rates assume manufacturers fully avail of fiscal incentives.

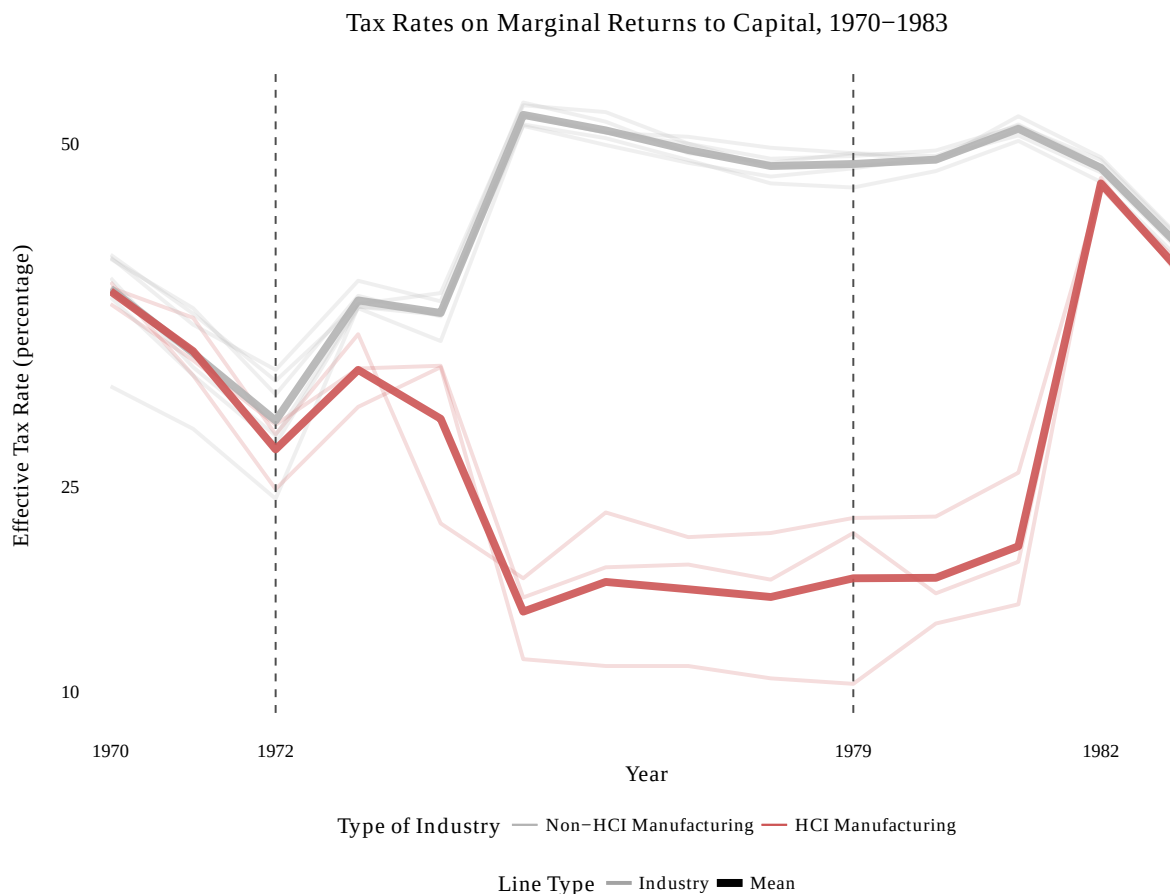


Figure 3: Tax Rates on Marginal Returns to Capital, 1970-1983, by 2-digit Manufacturing Industry

Post-1973 trade policy also shifted to targeting strategic sectors. Subsidies to exporters, such as wastage allowances, were eliminated in 1973 [Nam (1995); p.155].³⁹ The next year, exemptions on capital good imports were phased-out (Hong, 1992), followed by exemptions on raw material imports [General Agreement on Tariffs and Trade: Balance-of-Payments Committee (1978); p.6; Nam (1995); p.155].⁴⁰

Strategic industries, on the other hand, continued to enjoy import exemptions (Park, 1977; Woo, 1991; Cho and Kim, 1995; p.35; Smith, 2000).⁴¹ HCI exporters were able to purchase inputs from foreign investors and licensors, especially from Japanese

³⁹Wastage allowances permitted exporting firms import excess amounts of raw materials and resell them on the domestic market.

⁴⁰In 1974, an installment-based repayment system replaced the previous exemption system for capital good imports. In 1975, imported material exemptions were transformed into a so-called “drawback” system was reformed, whereby tariffs would be rebated only after finished goods were exported

⁴¹Until the 1980s, HCI industries could exempt up to 100 percent of duties and tariffs on imported inputs. A Korean study noted that “key industries,” on average, enjoyed 80 percent tariff exemptions across industries (with the exception of petrochemicals) [Park (1977); p.212].

partners (Castley, 1997).⁴² Hence, the “virtual free trade regime” that benefited exporting industries in the 1960s was reoriented to support heavy industrial sectors after 1973.

HCI industrial policies did not last. I use 1979 as the *de facto* end date for the big push; that year on October 26, President Park was assassinated by Korean Central Intelligence Agency director, Kim Jae-kyu.⁴³ The murder signaled a shocking close to the Park’s *Yushin* dictatorship and the garrison state’s core policy agenda (Cho and Kim, 1995; p.19; N.-y. Lee, 2011).⁴⁴

HCI was dismantled in the transition following the assassination.⁴⁵ In 1980, Oh Won-chol, the lead HCI planner, was arrested and banned from government work [Kim (2004); p.8-9]. Between 1981-1983, the commercial banking system was liberalized. The share of total government loans to manufacturing shrank, and interest rates between strategic and non-strategic sectors converged (Cho and Cole, 1986; Nam, 1992).⁴⁶ Between 1979-1980, the transitional government implemented multiple rounds of “investment adjustment” for targeted sectors [Kim (1994); p.349] as trade liberalization progressed in earnest (Kim, 1988; Kim and Leipziger, 1993). The import liberalization ratio, as calculated by the Ministry of Trade and Industry, climbed from 68.6 in 1979 to 76.6 by 1982.⁴⁷ Starting in 1982 and again in 1984, maximum import tariff exemptions for domestic industries were reduced.

3 Theoretical Framework

Section 2.2 described the details of South Korea’s industrial policy, which used capital subsidies and trade policy to shift economic activity toward targeted sectors.

⁴²While foreign direct investment was limited during the HCI period, foreign partnerships and other forms of investment were encouraged. Such partnerships were often based on foreign licensing agreements and thus necessitated imports of foreign inputs [Suh (2007); p.31-32]. These imports were a major source technology transfer during HCI.

⁴³For contemporaneous overview of the Park assassination and its political implications see *South Korea 1979: Confrontation, Assassination, and Transition* (Lee, 1980).

⁴⁴Earlier that year, 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.

⁴⁵“[W]ith the death of Park the state’s policy orientation changed fundamentally in the early 1980s, with the EPB-led proponents of economic stabilization and liberalization replacing the nationalistic mercantilist bureaucrats like O Won-chol in key decision-making positions” [N.-y. Lee (2011); p.318].

⁴⁶Similarly, in 1981 public finance reforms limited the “special tax treatment for key industries.” By 1982 the gap in effective corporate tax rates between strategic and non-strategic industries was closed [Kwack and Lee (1992); Nam (1992); p.7].

⁴⁷In general, though, average import liberalization ratios gradually climbed through the HCI period 1973-1979. KDI’s Young Soogil writes that import liberalization was only seriously discussed in 1978, but economic instability in 1979-1980 postponed until the post-Yushin era [Kim (1988); pg.1].

Below I use a multi-sector model by Long Jr and Plosser (1983), and revisited by (Jones, 2008, Acemoglu et al. (2012), and Acemoglu et al. (2016)), to illustrate the general equilibrium effects of the big push. The following section reviews key elements and predictions of this theoretical framework, emphasizing externalities generated by industrial policy to forward-linked (downstream) and backward-linked (upstream) sectors. This framework yields four simple predictions which I later use to motive my empirical findings.

I model Korea's industrial policy by considering two factor market distortions, or "wedges," which planners remove for key industries.⁴⁸ In the words of Alice Amsden (1992), planners "get prices wrong" so as to steer resources toward HCI sectors.⁴⁹ The first distortion, $(1 + \tau_i^M)$ resembles a tax on imported inputs; the second, $(1 + \tau_i^R)$, a tax on investment.⁵⁰ Removing $(1 + \tau_i^R)$ and $(1 + \tau_i^M)$ leads to growth in targeted sectors. This expansion of supply benefits forward-linked (downstream) sectors, but may be positive or negative for backward-linked suppliers, depending on whether targeted sectors import competing intermediate inputs.

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:

$$y_i = A_i k_i^{\alpha_i^k} l_i^{\alpha_i^l} \prod_{j=1}^N x_{j \rightarrow i}^{a_{j \rightarrow i}} \prod_{j=1}^N m_{j \rightarrow i}^{b_{j \rightarrow i}}. \quad (1)$$

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

In (1), production of good i requires products from other industries, j : $x_{j \rightarrow i}$. With Cobb-Douglas production and perfect competition, the coefficient $a_{j \rightarrow i}$ corre-

⁴⁸In a similar spirit, Cheremukhin et al. (2013) consider Stalin's structural change policies as the shifting of factor and product market wedges across different sectors. My discussion of wedges in a general equilibrium Long-Plosser model follows Leal (2016). Rotemberg (2015) frames Indian capital subsidies in terms of the removal of capital market distortions.

⁴⁹See: "Wrong" Prices, Right Direction? in Amsden (1992).

⁵⁰One could also imagine that industrial policy directly impacts the productivity of targeted industries. Recent work by Itskhoki and Moll (2016) conceptualizes industrial policy as interventions promoting the revenue productivity of industries with a latent comparative advantage.

sponds 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, $b_{j \rightarrow i}$ corresponds to entries in an input-output matrix for imported intermediates.⁵¹ 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, $x_{i \rightarrow j}$, and output consumed as final goods, c_i :

$$y_i = c_i + \sum_{j=1}^N x_{i \rightarrow j}, \forall i. \quad (2)$$

A representative household has Cobb-Douglas preferences $u(c_1, \dots, c_N) = \prod_{i=1}^N c_i^{\beta_i}$, where $\beta_i \in (0, 1)$ represents the weight of good i in the household's preferences, normalized such that $\sum_i \beta_i = 1$. The household finances consumption through capital and labor income, $C = \sum_i c_i p_i = rK + wL$. 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.

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

$$\max_{\{x_{j \rightarrow i}\}_{j=1}^n, \{m_{j \rightarrow i}\}_{j=1}^n, k_i, l_i} \left(p_i y_i - w l_i - (1 + \tau_i^R) r k_i - \sum_{j=1}^N p_j x_{j \rightarrow i} - \sum_{j=1}^N (1 + \tau_j^M) \bar{p}_j m_{j \rightarrow i} \right) \quad (3)$$

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 (3) 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

⁵¹Due 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.

curve with respect to changes in capital taxes $(1 + \tau_i^R)$ or intermediate input tariffs $(1 + \tau_j^M)$ yields,

$$\frac{\partial \ln y_i}{\partial(1 + \tau_j^M)} = -b_{j \rightarrow i} \quad (4)$$

$$\frac{\partial \ln y_i}{\partial(1 + \tau_i^R)} = -\alpha_i^k. \quad (5)$$

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,

$$p_i = \kappa_i \left[(1 + \tau_i^R) r \right]^{\alpha_i^k} w^{\alpha_i^l} \prod_{j=1}^N p_j^{a_{j \rightarrow i}} \prod_{j=1}^N \left[(1 + \tau_j^M) \bar{p}_j \right]^{b_{j \rightarrow i}} \quad (6)$$

where

$$\kappa_i = \left(\frac{1}{\alpha_i^l} \right)^{\alpha_i^l} \left(\frac{1}{\alpha_i^k} \right)^{\alpha_i^k} \prod_{j=1}^N \left(\frac{1}{a_{j \rightarrow i}} \right)^{a_{j \rightarrow i}} \prod_{j=1}^N \left(\frac{1}{b_{j \rightarrow i}} \right)^{b_{j \rightarrow i}}. \quad (7)$$

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 $\frac{\partial \ln p_i}{\partial(1 + \tau_j^M)} = b_{j \rightarrow i}$, 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 et al., 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 (1); plugging in the first order conditions from the firm's optimization problem, and total differentiating after log-linearization: $\ln y_i$ varies positively with $\sum_{j=1}^N a_{j \rightarrow i} \ln y_j$.

Moreover, as seen from industry i 's price index (6), a decline in the targeted sector's price, p_j , leads to a decline in the output price p_i .⁵² 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): 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 , $x_{i \rightarrow j}$. 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 (2) for a backward-linked industry i . Total differentiating (2), inserting the firm's first order conditions, and leveraging that consumption levels do not change, yields $\frac{d(y_i p_i)}{y_i p_i} = \sum_{j=1}^N a_{i \rightarrow j} \frac{d(y_j p_j)}{y_j p_j}$. With constant prices, this expression simplifies to $dy_i = \sum_{j=1}^N a_{i \rightarrow j} dy_j$. Output of the backward-linked industry, y_i , increases with the output of the targeted sector y_j .

⁵²Similar downstream effects of industrial policy (specifically, subsidies), are shown by Forslid and Midelfart (2005).

Realistically, however, targeted sectors use imported inputs that may compete with domestic industries, in which case industrial policy has negative effects through backward-linkages (Autor et al., 2013; Acemoglu et al., 2015). Let $m_{i \rightarrow j}$ be an intermediate import used by targeted sector j ; this good competes with a domestically supplied good $x_{i \rightarrow j}$. Since the policy lowers the price of intermediate imports for treated sectors, j imports more $m_{i \rightarrow j}$. 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 (2): $y_i = c_i + \sum_{j=1}^N x_{i \rightarrow j} - m_{i \rightarrow j}$.⁵³ Clearly, an increase the competing import $m_{i \rightarrow j}$ 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.

4 Data

Digitized Manufacturing Dataset Though South Korea's modernization was a relatively recent historical event, there are few sources of disaggregated, machine-readable data. For my study I created a new dataset on South Korean manufacturing industries that encompasses the period of rapid industrialization.⁵⁴ To create this dataset, I have digitized and combined materials from a number of archival sources.⁵⁵

The main source of industrial data were digitized from records published by the Economic Planning Board's (EPB) Mining and Manufacturing Surveys and Census (MMS), 1970-1986.⁵⁶ The industrial census records were published approximately every five years from 1970 onward, and intercensal statistics were published as individual survey volumes. Importantly, the unit of enumeration for each MMS is the establishment-level. With rare exception, variables are consistent across MMS publications, allowing me to construct a panel dataset from digitized materials.

⁵³Acemoglu et al. (2015) similarly examines the reduced form impact of intermediate imports on a competing domestic industry by using the market clearing condition.

⁵⁴In South Korea, this include the mining sector as well.

⁵⁵Unless specified, this study does encompass the non-table or agricultural sectors.

⁵⁶The Economic Planning Board is also the historic predecessor to Statistics Korea.

The digitized MMS dataset reports economic statistics at the lowest level of disaggregation, the 5-digit industry level.⁵⁷ To illustrate this level of aggregation consider two same sectors: 35291, *Manufactures of adhesives and gelatin products*, and 35292, *Manufactures of explosives and pyrotechnic products*. In other words, MMS industrial data is at a suitable level of variation.

A second source of MMS data come from tape data sold by the EPB in the 1980s and spans the years 1977-1986. The MMS mainframe data also reports annual industrial statistics at 5-digit level. However, this data spans a more limited set of variables relative to those published in the digitized MMS volumes. Variables includes (nominal) value of shipments, employment, wage bill, total fixed capital formation and total capital disposals. Data extracted from these tapes was cleaned using OpenRefine and converted to a contemporary data format.

The digitized MMS data was combined with the mainframe tape data to create a single harmonized panel. Table 2 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 essentially equivalent, log-normalized interpretations appear in the text and IHS estimates appear in tables.

Harmonization and Crosswalk Schemas My analysis requires industrial and product definitions that are consistent through time. For the MMS industrial publications, the EPB used codes based on the International Standard Industrial Classification (ISIC) system. Nonetheless, South Korean industrial codes were updated repeatedly (1970, 1975, and 1984), requiring 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

⁵⁷Firm-level data from the period is not available in published or machine readable format. To my knowledge, early firm- or establishment-level data is unavailable for most of the study period. However, product-level data and data by firm-size bin $\times$ industry data have also been digitized and compiled for my database.

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.⁵⁸ 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 dataset.

In addition to harmonizing digitized manufacturing data through *time*, manufacturing, price, trade, and input-output panels each use their own coding system.⁵⁹ Thus, further crosswalk schemas were used to harmonize datasets across coding schemes. Thus, over a dozen harmonization algorithms were required to create the main 5-digit industrial panel used below.

Input-Output Network Data Intersectoral linkage data comes from South Korea’s 1970 basic input-output (IO) tables, published by the Bank of Korea. The 1970 IO tables were translated from Korean into English and then digitized into a machine-readable format.⁶⁰ Machine readable input-output tables for later periods (1975, 1980, 1983, and 1985) were graciously provided by the Bank of Korea.⁶¹

⁵⁸Clearly, accounting for simple renaming of sector codes is a trivial problem.

⁵⁹Manufacturing data: Korean Standard Industrial Classification; prices: current (as of 2015) Bank of Korea industry classifications; trade: ISIC (Rev. 2); and input-output data: historic Bank of Korea sector codes.

⁶⁰The basic input-output tables for 1970, which encompass 320 sectors, was not available from the Bank of Korea in machine readable format. Unlike later years, the 1970 tables report *total* values of flows between industries and does not differentiate between domestic and imported values, as later publications do.

⁶¹Once again, all IO data was harmonized into consistent sectoral definitions using a crosswalk schema and concordance definitions digitized from IO table publications. Since IO tables use a separate industrial classification system from the

Trade Policy and Trade Data A panel of South Korean trade data has been constructed using the World Bank’s World Integrated Trade Solution (WITS) database, 1962-1987. Trade data analysis is conducted at the 4-digit ISIC (Revision 2) level.

Detailed measures of quantitative restrictions (QRs) and tariffs were digitized from Luedde-Neurath (1986) and are available at the product-level (Customs Commodity Code Number, or CCCN, product-level). Luedde-Neurath (1986)’s dataset is used because it is the most complete and disaggregated available.⁶²

The digitized trade policy data was then merged with the 1970-1986 MMS industry panel. Average tariffs (QRs) on output were calculated for each 5-digit KSIC industry. Input tariffs (QRs) are calculated as the weighted sum of average tariff (QR) exposure for each input into industry production using the 1970 input-output tables. Following Amiti and Konings (2007) and Amiti and Davis (2012), the input tariff (and QR) exposure is defined as $\text{input-tariff}_i = \sum_j \alpha_{j \rightarrow i} \times \text{output-tariff}_j$, where $\alpha_{j \rightarrow i}$ are estimated cost-shares for industry i from the input-output accounts.

5 Direct Effects of Industrial Policy

In this subsection I estimate the direct effect of the HCI big push on industrial development. Before turning to the core development estimates, I first discuss sources of endogeneity and motivate the estimation framework. Next, I show that measures associated with industrial policy change differentially for targeted and non-targeted sectors, as modeled by policy wedges in my theoretical framework (Section 3). Finally, I confirm *Prediction 1* and *Prediction 2* of my model and show that targeting was associated with the development of HCI industries.

5.1 Direct Effects: Empirical Framework

Identification I contend the Korean HCI context is a natural experiment in that (1) targeting was orthogonal to traditional sources of bias, and (2) industrial policy conformed to notions of latent or dynamic comparative advantage.

industrial census/surveys, a crosswalk schema is used to combine the datasets.

⁶²Westphal (1990) notes it is the most extensive source for. Alternative studies of South Korean tariff structure are often highly aggregated; make strong assumptions with the intention of measuring *effective* rates of protection; and focus mostly on period of 1960s export-oriented industrial policies.

Estimating the (direct) effect of industrial policy on industrial development is often problematic. Industrial policy is state action, and thus policies are allocated according to politics (Grossman and Helpman, 1994; Goldberg and Maggi, 1999; Baldwin and Robert-Nicoud, 2007). Such political-economy factors can be both unobserved and negatively correlated with industry fundamentals. Unsurprisingly, many empirical studies report a negative relationship between the effect of protection on growth or productivity (Harrison, 1994; Harrison and Rodriguez-Clare, 2009; Rodriguez and Rodrik, 2001). Moreover, unlike many economic policies, research designs based on the random allocation of policies may be uninformative (Rodrik, 2004). Industrial policy are systematic interventions to promote industries with a latent comparative advantage (Noland and Pack, 2003; Lin and Chang, 2009).

Two sources of political bias translate into a negative relationship between industrial development and interventions.

First, policies often benefit declining, or “sunset,” sectors.⁶³ For example, Japan’s Ministry of International Trade and Industry (MITI) notably intervened in troubled manufacturing sectors and similar policies have been widely documented around the developing world.⁶⁴

Second, around the world cronyism shapes the allocation of interventions, which frequently defy notions of comparative advantage (Rodrik, 2005; Lin and Chang, 2009; Lin, 2012). For example, Tommy Suharto, son of Indonesia’s General Suharto, received gracious subsidies to develop a national automobile industry—without any prior experience or skill in automobile manufacturing (Eklof, 2002; Fisman and Miguel, 2010). Ferdinand Marcos, Park Chung-hee’s contemporary in the Philippines, used ambitious, capital-intensive industrial projects as a vehicle for pure clientalism rather than industrial development (Boyce, 1993; Kang, 2002; White, 2009).⁶⁵

In South Korea, targeted industries were not chosen because of unobserved and/or anticipated declines in economic conditions, nor were they chosen due to political criteria that defied latent comparative advantage. Why did HCI cut across

⁶³A theoretical literature has long discussed optimal policies to declining industries (Gray, 1973; Hillman, 1982; Flam et al., 1983).

⁶⁴For example the U.K.’s National Enterprise Board, buffered a failing automotive industry in the 1970s (Hindley and Richardson, 1983; Sawyer, 1992). U.S. presidential candidate Richard Nixon wooed southern constituents with protection for textile sectors facing declining comparative advantage (Cox and Skidmore-Hess, 1999). Supports for declining industry defined U.S. industrial policy debates in the Reagan-era (Congressional Budget Office, 1983).

⁶⁵For 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).

critical sources of unobserved endogeneity?

To begin with, many industries targeted by South Korea, such as shipbuilding, simply did not exist in that country, and so could certainly not have been sunset industries. To argue that unobserved negative trends guided policy — negative or otherwise — is moot. The chemical industry was similarly minuscule and had to be built from scratch (Woo, 1991).⁶⁶

Institutionally, the political environment of South Korea meant that policy was guided by strategic criteria rather than the cronyism. A binding security crisis provoked a shift in national industrial strategy with little political interference. Park's sudden consolidation of power allowed for the creation of a technocratic Heavy Chemical and Industry Planning Board that superseded competing political actors. Planning conformed to what Peter Evans called "*embedded autonomy*:" a bureaucracy insulated from special interest politics and administered by specialists with knowledge of environment they are operating in (Evans, 1995).⁶⁷

A core criterion for successful industrial policy is that targeted industries possess dynamic, or latent, comparative advantage. Though Korea did not have static comparative advantage in HCI industries, targeted sectors did not grossly defy latent comparative advantage as with industrial policy of other countries. In section 2.2, I explain that Japan's earlier heavy industrial targeting reflected the potential comparative advantage of Korean industries. Moreover, professional bureaucratic guidance minimized the potential of choosing sectors that contradicted notions of comparative advantage.⁶⁸

The dynamic differences-in-differences framework I introduce below maps naturally into a notion of latent, or dynamic, comparative advantage. The thrust of industrial policy is that the state is selectively intervening in sectors to produce industrial development that would have not occurred had the economy expanded according to static comparative advantage [Noland and Pack (2003); p.10]. This dovetails with assumption of differences-in-differences estimation: without policy interventions, the economy would have evolved according to the pretrends — that

⁶⁶Woo-Cummings notes 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].

⁶⁷The South Korean developmental bureaucracy, specifically, is a representative of Evan's embedded autonomy concept.

⁶⁸Stern et al. (1995) notes the use of technical and scale feasibility studies used by HCI planners to constrain the choice of industries [Stern et al. (1995); p.23-25]. For instance the construction of jet engines was seen as beyond the technical capability of South Korea.

is, according to static comparative advantage.

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:

$$Y_{it} = \sum_{j=1970}^{1986} \beta_j \cdot (\text{Targeted}_i \times \text{Year}_t^j) + \sum_{i=n} \alpha_n \cdot I_i^n + \sum_{j=1970}^{1986} \lambda_j \cdot \text{Year}_t^j + \sum_{j=1970}^{1986} X_i' \text{Year}_t^j \Omega_j + \epsilon_{it} \quad (8)$$

where Y is an industrial development or policy-related outcome, i indexes 5-digit industries, and t indexes the years 1970–1986. The variable *Targeted* is an indicator equal to one if a sector is targeted by the Heavy Chemical and Industry committee, zero otherwise; *Year* are time period indicators. Specification 8 contains industry-level fixed effects $\sum_n I_n$ and time period effects $\sum_j \text{Year}_j$.

Preferred specifications include a rich set of pre-treatment variables—and their trends—to control for unobserved productivity. Controls include average establishment size, average wages, raw material costs, employment, fixed capital investment, and labor productivity. Each baseline control (trend) is interacted with time period indicators: $\sum_{j=1970}^{1986} X_i' \text{Year}_t^j \Omega_j$.

The coefficient of interest in equation 8, β_j , gives the estimated difference between targeted and untargeted sectors in year j relative to 1972, the year preceding the big push announcement. The set of estimated coefficients give a sense of 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, $\hat{\beta}_{1974} \leq \hat{\beta}_{1975} \leq \dots \leq \hat{\beta}_{1979}$, 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:

$$\hat{\beta}_{1979} \geq \hat{\beta}_{1980} \geq \hat{\beta}_{1981} \dots \geq \hat{\beta}_{1986}.^{69}$$

While estimates from the flexible specification in 8 convey the pattern of the policy roll-out, it is useful to get a sense of the total average impact of industrial targeting before and after 1972. Here the conventional differences-in-differences is useful. I ascertain the average effect of targeting on industrial development by interacting the *Targeted* sector indicator with a post-announcement indicator:

$$Y_{it} = \beta \cdot (\text{Targeted}_i \times \text{Post}_t) + \sum_{i=n} \alpha_n \cdot I_i^n + \sum_{j=1970}^{1986} \lambda_j \cdot \text{Year}_t^j + \sum_{j=1970}^{1986} X_i' \text{Year}_t^j \Omega_j + \epsilon_{it} \quad (9)$$

Substantively, the estimated coefficient of interest, β , captures the average growth in treated industries before-after the policy announcement. The $\text{Targeted}_i \times \text{Post}_t$ interaction is the only difference between the difference-in-differences equation (9) and the flexible regression in equation (8).

5.2 Results: Targeting & Policy Mixtures

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 change 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 et al. (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

⁶⁹For a similar discussion, see: Nunn and Qian (2011).

imported inputs and protective measures (purportedly) sheltered domestic industry from international competition. Thus, in addition to subsidy variables, I analyze changes of trade policies over the planning period.

Responses to Targeted Subsidies Figure 4 conveys the relative changes in (gross) fixed investment measures and materials investment for the periods 1970-1986, relative to a 1972 baseline. Panels A and B plot the flexible coefficient estimates of equation (8) for each year. Figure 4 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 2.2), emphasized the financing of equipment purchases and factory expansions for HCI firms. All specifications include both 5-digit industry fixed effects, period fixed effects, and include baseline covariates and pre-trends, both interacted with period fixed effects. Data for disaggregated capital acquisitions is only available until 1982 and does not include acquisitions for the census year 1973. The light gray bands represent standard errors for each coefficient, clustered at the 5-digit industry-level.

Figure 4 illuminates four points. First, a robust pattern confirms that, conditional on controls, targeted and non-targeted sector outcomes are not significantly different before the policy announcement. There is no sign of significant anticipatory investment activity. 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. For all outcomes, estimated differences decline relative to their 1979 peak, corresponding to the liberalization of state lending in the early 1980s.⁷⁰ Finally, 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).⁷¹

While Figure 4 presents the pattern of estimates for (8), it is also informative to estimate the average effect over the same period.

⁷⁰The 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.

⁷¹The pattern also indicates the source of worries of growing excess capacity prior in the early 1980s (Kim, 1994).

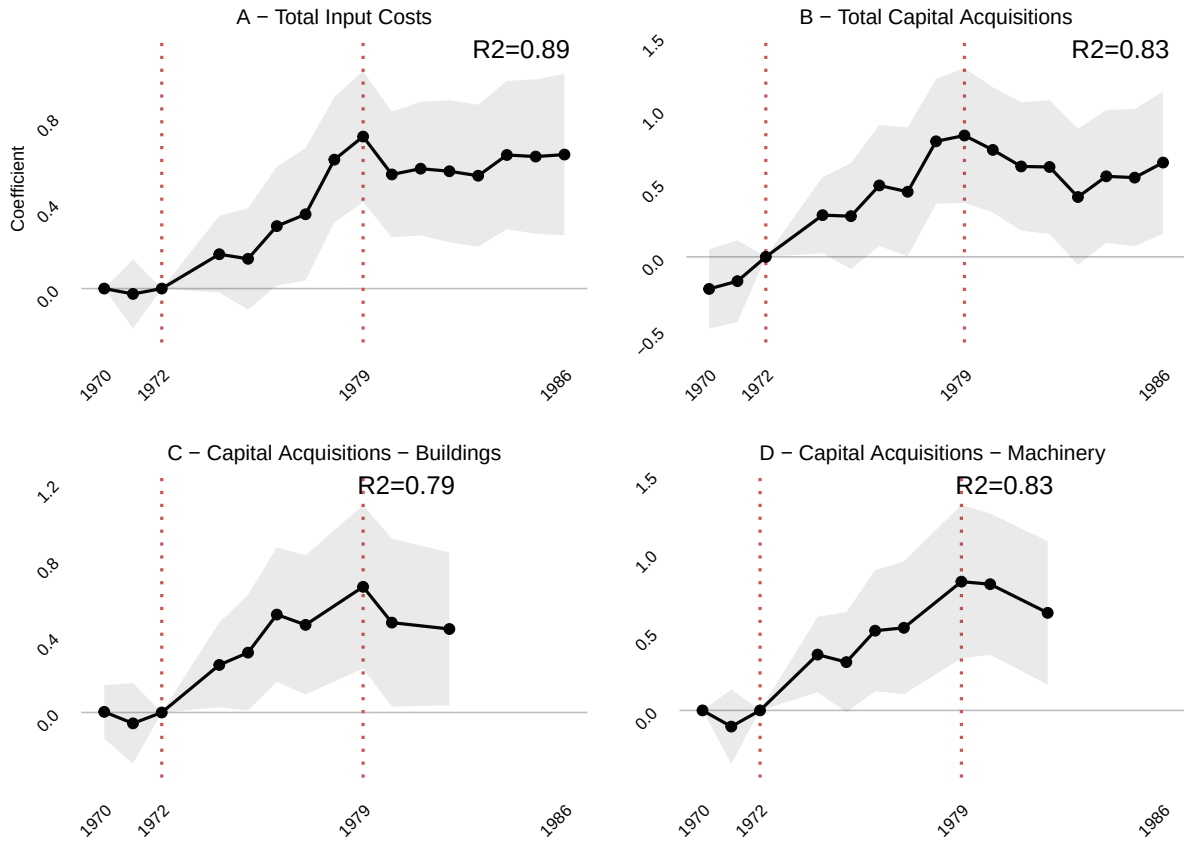


Figure 4: Industry Responses to Targeted Subsidies, Estimated Differences in Total Costs, Total Gross Capital Formation, and Capital Formation Across Asset Classes, 1970-1986, Relative to 1972

Table 3 shows average estimates of HCI targeting on total value of (real) gross capital formation and total (real) value of intermediate input purchases. 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 controls. Columns (2) and (5) include baseline controls. In addition, columns (3) and (6) include linear pre-trends in baseline control variables, each interacted with a period effects.

Preferred estimates of total capital investment in (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 costs (.479 at a 5 percent level of significance).

Table 4 presents the average estimates for different capital assets. Column (1) shows estimates for (real) value of building and structure acquisitions. Column (2) shows machinery; column (3), land; and column (4), transportation equipment. Estimates for machinery acquisitions are the strongest, indicating an 85 percent growth (1 percent level of significance) in machinery acquisitions after the announcement over non-targeted sectors. Building and land acquisitions are the next largest, corresponding to 61 (5 percent) and 49 (1 percent) percent differences, respectively. Transportation equipment investment show 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 5 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 the South Korea was actively liberalizing its trade policy since the late 1960s. From 1970-1980, import controls dropped. Though 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 5, 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 5 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),

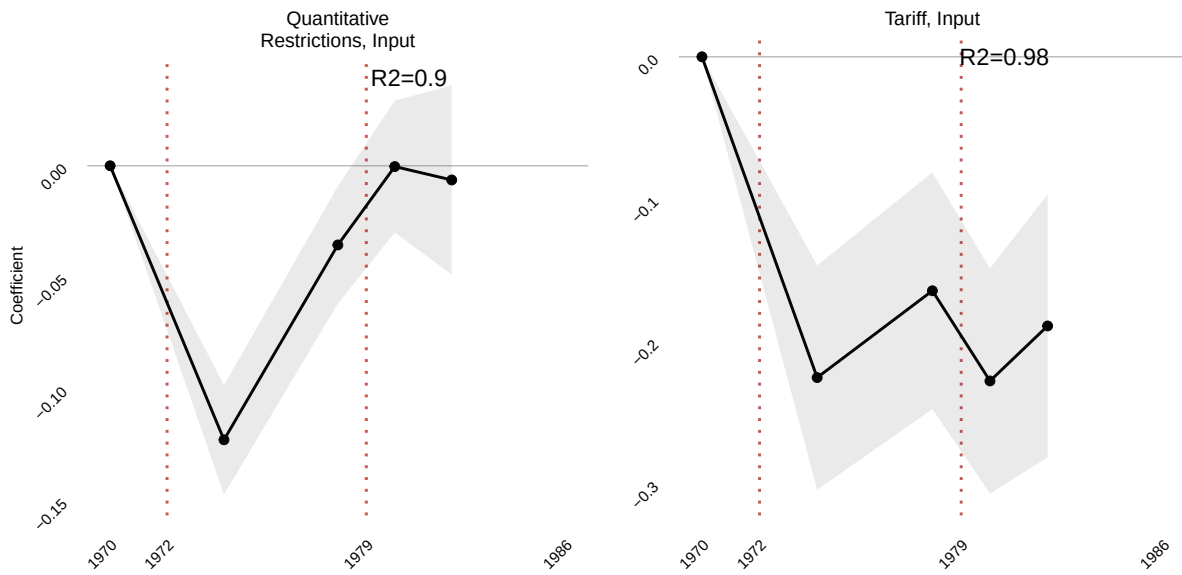


Figure 5: Estimated Differences in Input Protection, Targeted Versus Non-Targeted, Relative to 1972, 1970-1982

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 pretrend controls. Importantly, differences in average output protection for targeted industry is insignificant and the estimates straddle zero.

Input protection measures, however, declines 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.

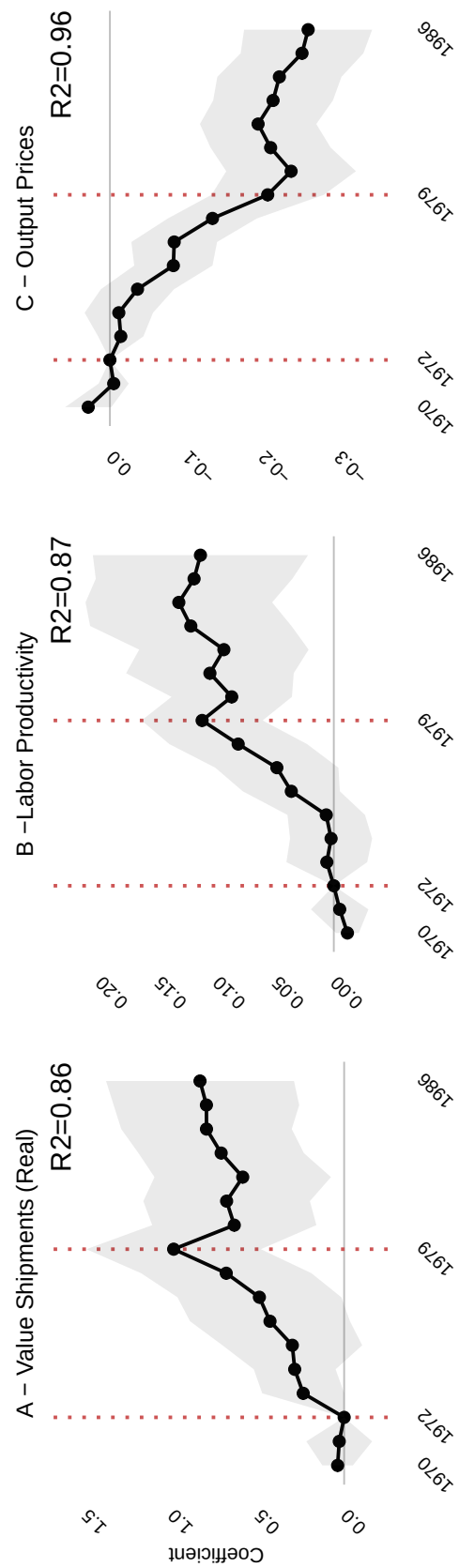


Figure 6: Estimated Differences in Value of Output, Labor Productivity, and Output Prices, Relative to 1972 Baseline, 1970-1986

5.3 Results: Manufacturing Growth and Industrialization.

Having confirmed that industrial policies, especially responses to directed credit, vary as expected over the big push period, I turn to industrial growth and industrial development outcomes.

Growth (Prediction 1) Figure 6, Panel A plots estimates from equation (8) for industrial output (real value shipped). Estimated coefficients include time and year fixed effects, as well as time-varying baseline controls and associated pretrends. The estimates illustrate a distinct 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 6, Panel A convey three key insights. First, conditional on controls, the plots show no pre-pretreatment 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 declines a bit but nonetheless remain significantly higher than their 1972 level relative to non-targeted sectors.

For completeness, Table 6 column (3) shows the estimates associated with Figure 6 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 6, Panel A are robust across various measures of output and controls.

Table 7 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 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 a, respective, 81 percent (5 percent significance) and 77 percent (1 percent significance) difference in growth between the targeted and non-targeted sectors for the same period.

Factor Productivity and Prices (Prediction 2) Figure 6, Panel B visualizes the pattern of coefficient estimates for labor productivity, measured as (real) gross output per worker. The pattern for labor productivity reveal the same pattern for the levels of output in Panel A.

Table 8 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) 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 6, 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 9, 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.

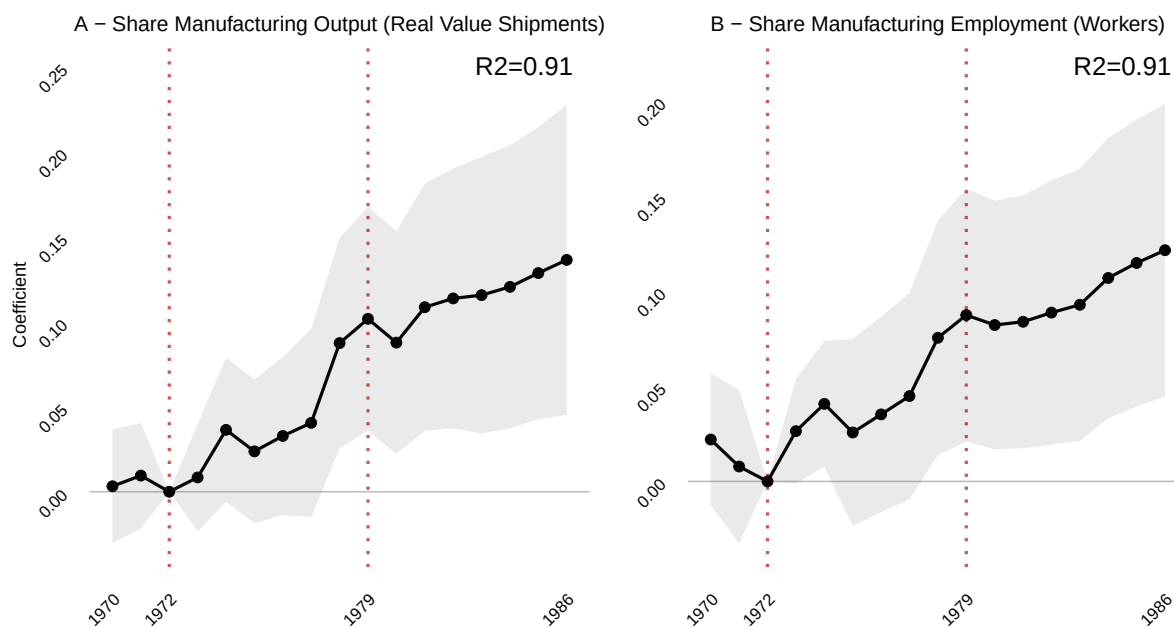


Figure 7: Estimated Reallocation of Industrial Activity, Relative to 1972 Baseline, 1970-1986

Structural Change, Entry, and Labor The big push aimed to reallocate manu-

facturing activity from low value added, light industries to HCI sectors. Figure 7 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. More so, 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 7 makes the case that HCI policy induced structural change towards strategic industry. Table 9 reports the average relative rise 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 8 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).⁷²

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 10 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 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

⁷²Itskhoki and Moll (2016) suggests wage suppression was an implicit industrial policy used by NICs.



Figure 8: Estimated Differences in Industrial Development, Relative to 1972 Baseline, 1970-1986

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 post-war 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. Broadly, the relationship between trade policies and growth are often negative [Rodriguez and Rodrik (2001); Harrison and Rodriguez-Clare (2009); p.4092].

Surprisingly, it appears that South Korean heavy industrial policy successfully

decreased the price of domestically produced capital goods and intermediate materials. 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).

6 Network Externalities

The case for industrial policy has typically 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). South Korea’s Heavy Chemical and Industry drive exemplified a big push policy targeting key intermediate goods sectors. 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.

Accordingly, I use the traditional language of development economics (“*linkages*”) to discuss the network externalities. Effects of HCI interventions propagates through *backward linkages*—to downstream firms selling goods to targeted sectors, or through *forward linkages*—to upstream firms purchasing goods from targeted sectors.

The network graphs shown in Figures 9 and 10 illustrate the (pre-treatment) variation in linkages for the South Korean economy. Both plots visualize input-output accounts (aggregated 153×153 sector) for 1970, including both tradable and non-tradable sectors.⁷³ Red nodes correspond to targeted (HCI) industries; gray nodes, non-targeted. The relative size of each node is weighted by its number of raw connections (“degrees”, in the language of network theory).⁷⁴

Figure 9 gives a sense of the distribution of forward links (“out degrees”) from IO sectors, and figure 10 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

⁷³While the study uses 320×320 sectors, I use the “medium” 153×153 input-output accounts for visual clarity. Summary “sectors,” such as employee remuneration, and scrap sectors are excluded.

⁷⁴Note: The number of “treated” HCI nodes in the graph differs from number used in the industrial census dataset, since input-output data is presented at a different level of aggregation.

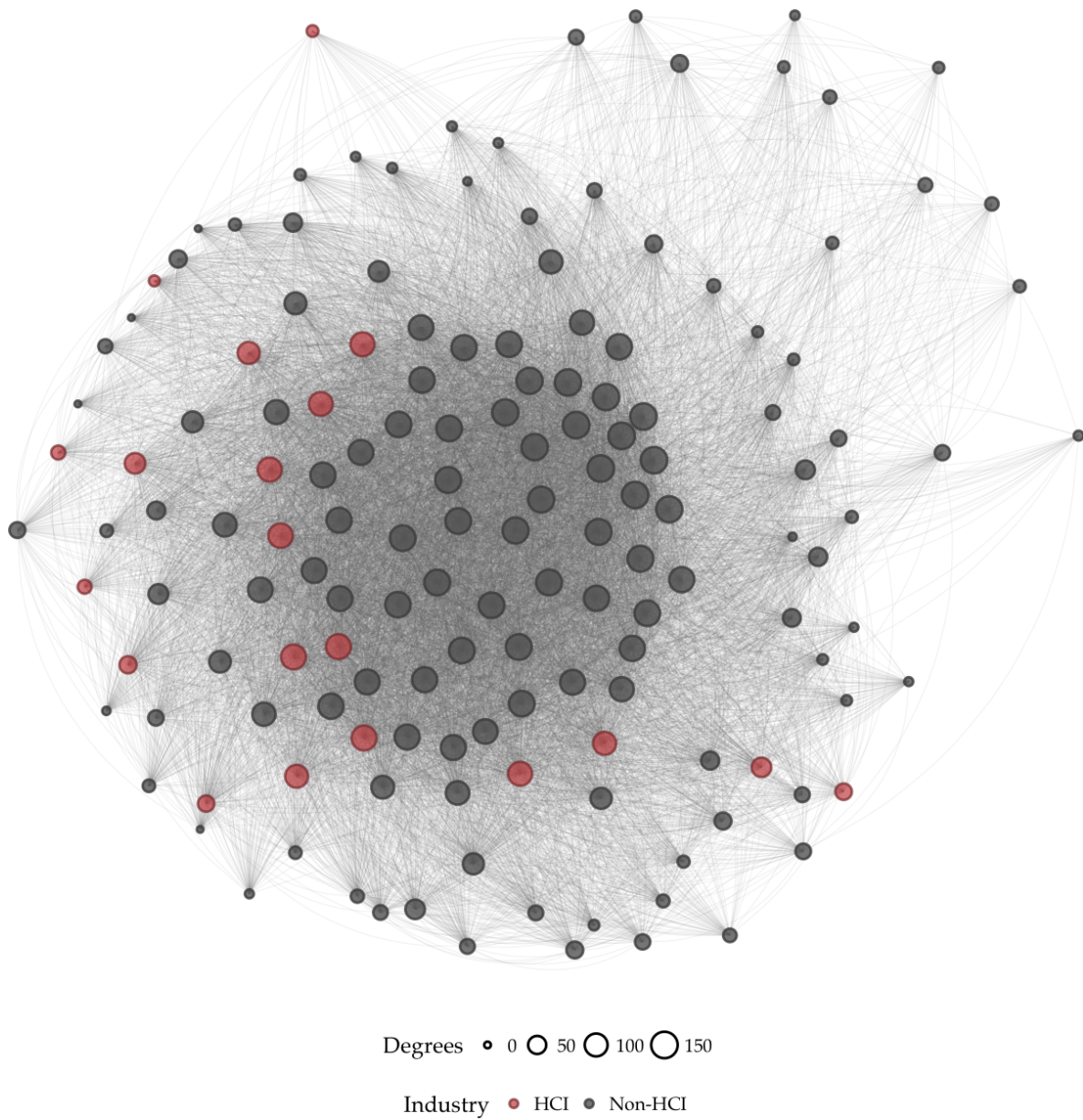


Figure 9: Targeted Sectors in the Korean Industrial Network, 1970 - Weighted by Number of Forward Links (Out Degrees)

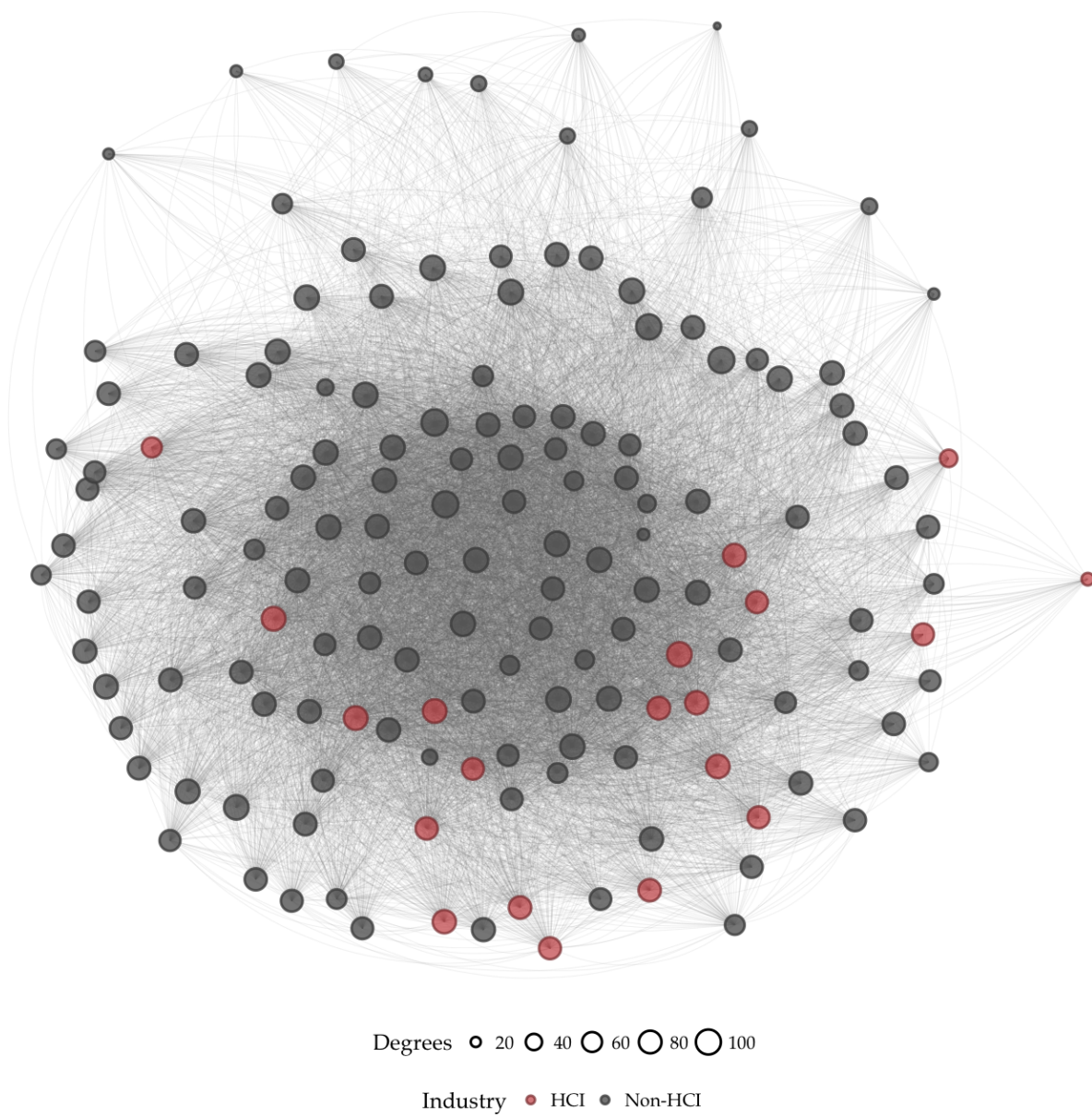


Figure 10: Targeted Sectors in the Korean Industrial Network, 1970 - Weighted by Number of Backward Links (In Degrees)

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 two 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 effects that propagate through backward linkages. Let i be non-targeted industry.⁷⁵ 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 $i \rightarrow j$.

The backward linkage measure is defined as the weighted sum of all links between industry i and their buyers:

$$\text{Backward Linkage}_i = \sum_j \alpha_{i \rightarrow j} \quad (10)$$

where the linkage weight $\alpha_{i \rightarrow j}$ is defined as

$$\alpha_{i \rightarrow j} = \frac{\text{Sales}_{i \rightarrow j}}{\sum_{j'} \text{Sales}_{i \rightarrow j'}} \quad (11)$$

⁷⁵The description of the first-degree connections and their calculation follow the language of Acemoglu et al. (2015) and Acemoglu et al. (2016).

The linkage weight (11) is the value of i 's sales to j , divided by the total sales of i to all purchasing industries j' .⁷⁶ Following traditional input-output analysis, the denominator of equation 11 is equivalent to summing over industry i 's total sales across all industries—tradable and non-tradable alike—including i 's output sold as final products.⁷⁷ Notice that weight $\alpha_{i \rightarrow j}$ is the very weight used in j 's Cobb-Douglass production functions (Section 3, Equation 1).

We are interested in how industry i may be exposed to HCI policy vis-a-vis their total collection of backward (forward) linkages to (from) *targeted industries only*. Equation 12 captures the policy exposure by summing the share of sales ($\alpha_{i \rightarrow j}$) only to targeted industries:

$$\text{Backward HCI Linkages}_i = \sum_{j \in \text{HCI}} \alpha_{i \rightarrow j} \quad (12)$$

In other words, (12) measures only linkages between i and targeted sectors ($j \in \text{HCI}$, where HCI is the set of all targeted industries).

The preceding calculations were shown for backward linkages. The forward linkage versions of equation 12 are calculated in a similar manner: measure Forward Linkages $_i$ is equal to $\sum_j \alpha_{j \rightarrow i}$ and Forward HCI Linkages $_i$ is equal to $\sum_{j \in \text{HCI}} \alpha_{j \rightarrow i}$. Similarly, a Forward non-HCI Linkages $_i$ captures these forward linkages to non-HCI manufacturing sectors. Thus, the forward linkage measure reflects the extent to which industry i 's intermediate inputs are purchased from targeted industries j .

Total Linkages The measures calculated in equation 12 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 (forward) linkages.

Define the technical coefficient matrix A as a matrix of the weights defined in equation 10. An entry of A , $a_{i \rightarrow j}$, captures the share of sales from industry i sold to industry j .

⁷⁶Note, I do not count i 's sales to itself; this amounts to excluding "diagonals" in the input-output table, i.e. $\alpha_{i \rightarrow i} = 0$. In the parlance of network/graph theory, I do not count "loops."

⁷⁷See: Acemoglu et al. (2016)'s calculations.

$$A \equiv \begin{bmatrix} a_{1 \rightarrow 1} & a_{1 \rightarrow 2} & \dots & a_{1 \rightarrow j} \\ a_{2 \rightarrow 1} & a_{2 \rightarrow 2} & \dots & a_{2 \rightarrow j} \\ \vdots & \vdots & \ddots & \vdots \\ a_{j \rightarrow 1} & a_{j \rightarrow 2} & \dots & a_{j \rightarrow j} \end{bmatrix} \quad (13)$$

The Leontief inverse is calculated by taking the inverse of the technical coefficient matrix A , $L \equiv (I - A)^{-1}$:

$$L \equiv \begin{bmatrix} \ell_{1 \rightarrow 1} & \ell_{1 \rightarrow 2} & \dots & \ell_{1 \rightarrow j} \\ \ell_{2 \rightarrow 1} & \ell_{2 \rightarrow 2} & \dots & \ell_{2 \rightarrow j} \\ \vdots & \vdots & \ddots & \vdots \\ \ell_{j \rightarrow 1} & \ell_{j \rightarrow 2} & \dots & \ell_{j \rightarrow j} \end{bmatrix} \quad (14)$$

Consider a single entry, $\ell_{i \rightarrow j}$, from the Leontief matrix L in 14. These Leontief coefficients represent how much a 1 percent increase in sector j 's output raises sector i 's output.⁷⁸ If $\ell_{i \rightarrow j} = 1.2$, a 1 percent rise in industry k leads to a 1.2 percent rise in i , accounting for *all* of j 's first, second, third, etc., degree effects on i 's output.

I calculate the total backward linkage effects of industrial policy using the following measure:

$$\text{Total Backward HCI Linkage}_i = \sum_{j \in \text{HCI}} \ell_{i \rightarrow j} \quad (15)$$

The measure in equation 15 adds industry i 's Leontief coefficients for purchasing sectors, j , but only for j 's targeted by the HCI big push.⁷⁹ 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 12). Substantively,

⁷⁸In this method of input-output economics, more precisely, the entry refers to a rise in i 's final demand.

⁷⁹As with the direct linkage calculations, I do not count on-diagonal Leontief coefficients. E.g.: $\ell_{i \rightarrow i}$.

Total Backward HCI Linkage_{*i*} captures the total exposure of industry *i* vis-a-vis targeted industries purchasing *i*'s output.

The preceding calculations were shown for total backward linkage effects of industrial policy. The Total Forward HCI Linkage_{*i*} measure is calculated in a similar way. However, instead of summing across columns for row *i*, I sum across rows, indexed by *j*, for column *i*. These row-wise sums are restricted to suppliers *k* 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 11 lists non-targeted sectors with the highest *direct connections* to targeted sectors—measured by Backward HCI Linkages_{*i*} and Forward HCI Linkages_{*i*}, Equation (12).⁸⁰ The left-hand side shows the top-20, 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 more downstream industries.

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 the spillover effects from targeted industries to external industries. Figure 12 shows a simple bivariate relationship between log growth (1972-1982) and the strength of (first-degree) 1970 linkages (Equation 12) 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.

⁸⁰Names 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.

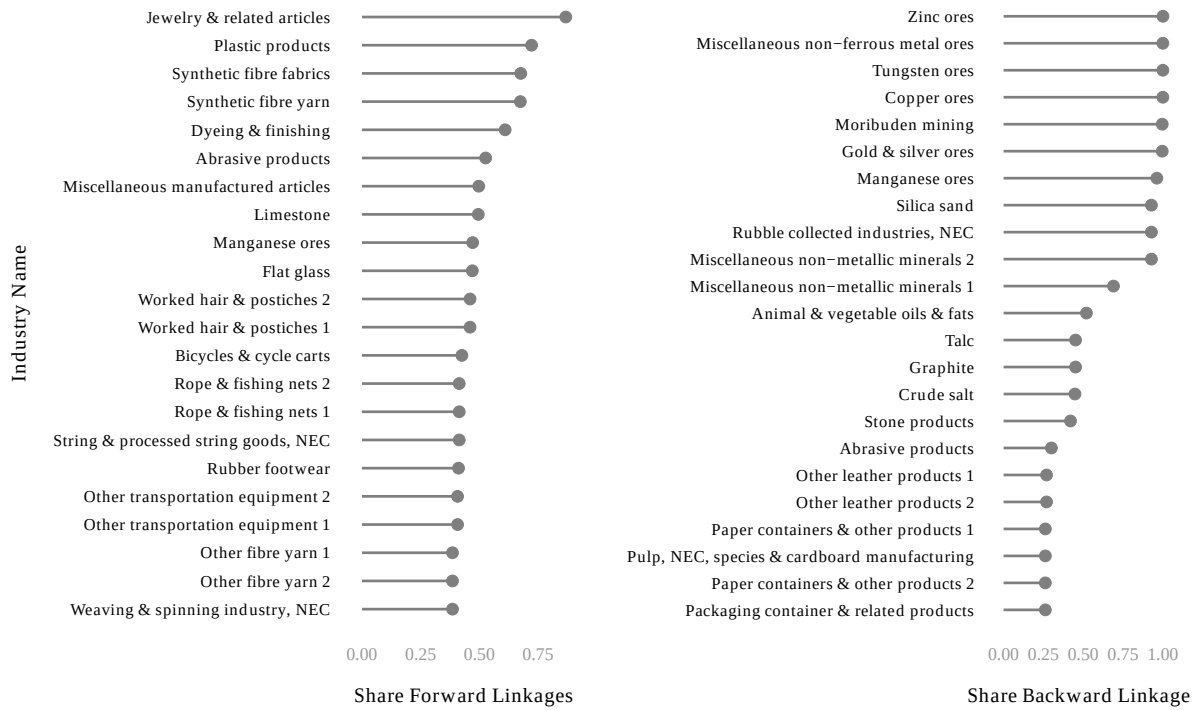


Figure 11: Top 20 Non-HCI Sectors with Highest Forward and Backward (Direct) Linkages to Targeted Industry, 1970.

The empirical pattern displayed in Figure 12 encapsulate the patterns I will explore in depth below. The left-hand panel shows a positive relationship between forward linkages from targeted sectors and (real) growth in 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 output growth and the strength of forward connections from targeted sectors. On the other hand, the right-hand panel of Figure 12 shows a negative, weak relationship between backward linkages and industrial growth over the same period: $\hat{\beta} = -0.9871$ ($t = -1.63$).

I estimate the effect of the HCI big push on backward (forward) linked industries, regressing industrial development outcomes on my first-degree (and also total) linkages measures defined above. These continuous measures are interacted with time period indicators to convey the dynamic pattern of changes for backward (forward) linked industries.

Specifically, I estimate the following flexible specification:

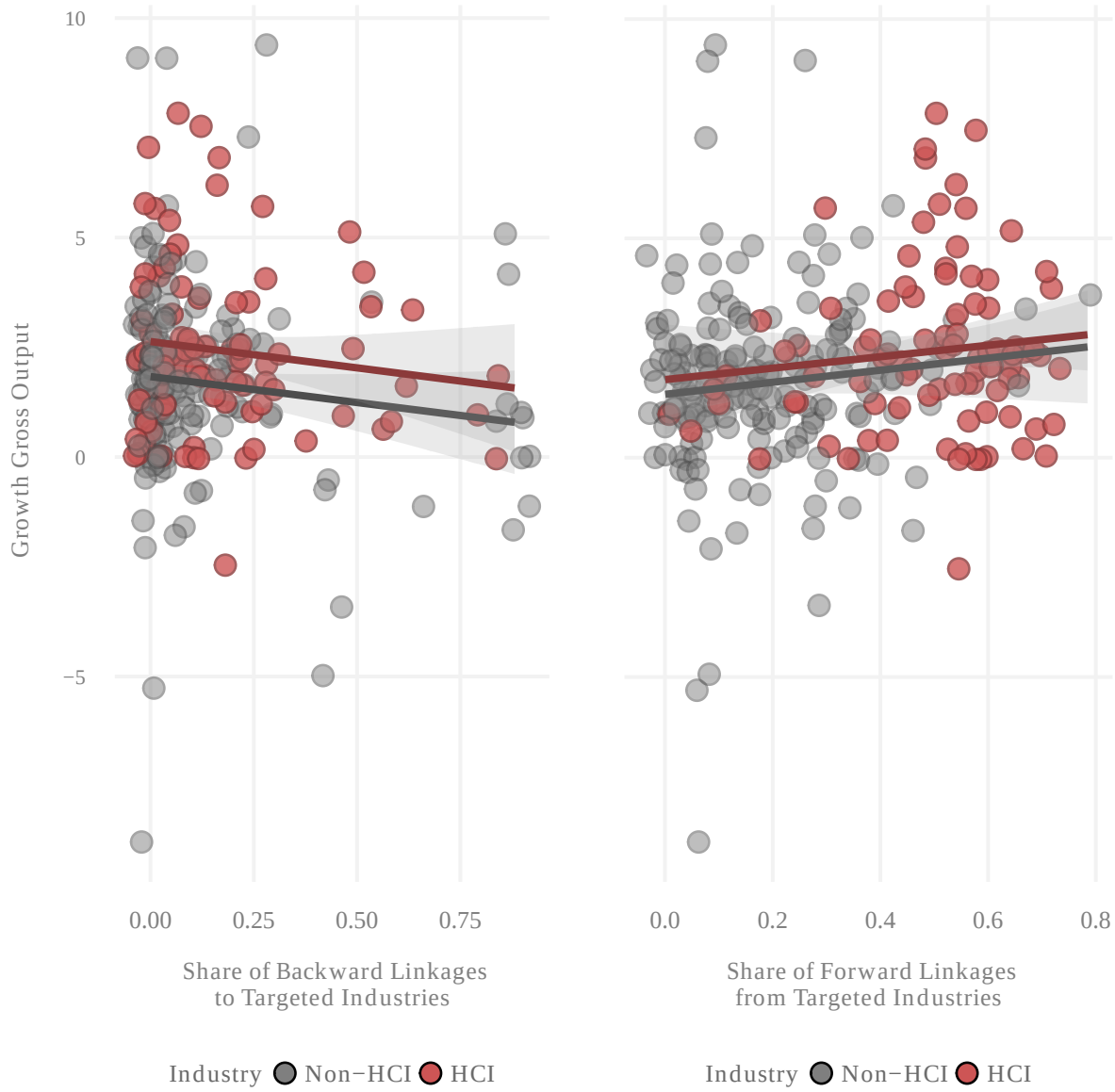


Figure 12: The Relationship Between Linkages from Targeted Sectors and Growth, 1972-1982.

Notes: Red dots (line) correspond to *targeted* industries; gray, *non-targeted*. The y-axis corresponds to $\Delta \text{Value Shipments}$ 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, $\Delta \text{Value Shipments}_{i1970-1982} = \alpha + \beta \times (\text{Forward (Backward) Linkages HCI}_{i1970}) + \epsilon_i$. 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.

$$\begin{aligned}
Y_{it} = & \sum_{j=1970}^{1986} \gamma_j \cdot (\text{Backward HCI Linkages}_i \times \text{Year}_t^j) + \\
& \sum_{j=1970}^{1986} \beta_j \cdot (\text{Targeted}_i \times \text{Year}_t^j) + \\
& \sum_{i=n} \alpha_n \cdot I_i^n + \sum_{j=1970}^{1986} \lambda_j \cdot \text{Year}_t^j + \epsilon_{it}
\end{aligned} \tag{16}$$

The parameters of interest are the estimated γ_j s, which show the growth of linked sectors versus unlinked sectors, relative to the pre-treatment levels. Substantively, these coefficients represent the estimated changes in linked, relative to changes in less-linked sectors. 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 gradually, until at least the 1979-1982 period, when the policies were taken away. Estimates for the post-liberalization period indicator 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: $\text{Targeted} \times \text{Year}$. As in the direct effect analysis, I include industry controls $\sum_n I^n$ 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 industry and year fixed effects, the difference in industrial growth between backward (forward) linked and non-linked industry 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 rapid growth 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 13 presents flexible estimates of the coefficient of interest from equation 6.3. In the following results, growth is measured by the (real) value of output shipped.⁸¹ Panel A shows results using the direct measure of forward linkages. Similarly, Figure 13, 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 control flexibly for targeted and non-targeted sectors.

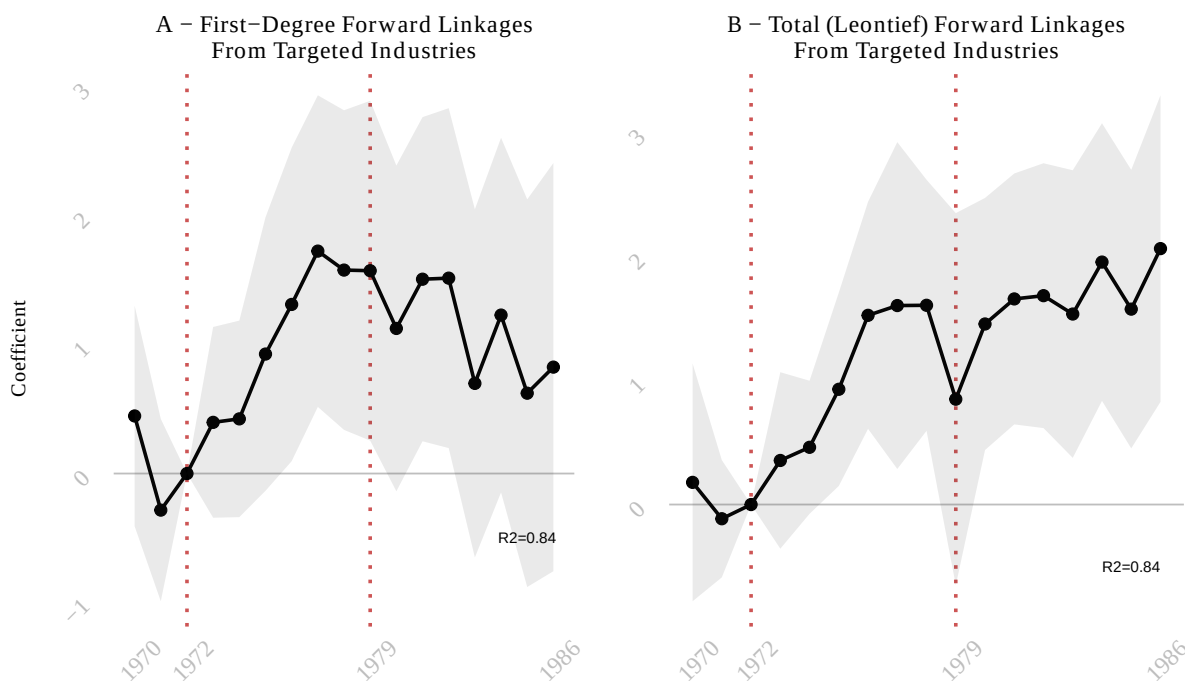


Figure 13: The Effect of First-Degree and Total Forward Linkages on Output, Relative to 1972 Baseline, 1970-1986.

Figure 13 illustrates the estimated correlation between industrial growth and

⁸¹ As before, results are robust to using measures of gross output and value added. In fact, results are usually strongest for value added measures.

the strength of (pre-treatment) forward linkages from targeted sectors. Panels A (direct forward linkage effects) and Panel 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 dissipate.⁸² These findings are consistent with *Prediction 3* of the multi-sectoral model.

Table 11 reports the average effect 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 . Columns (1), shows estimated spillover effects using the entire sample of industries. The estimates are substantial and significant, 1.15 (10 percent). Columns (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 similar in positive and similar in magnitude, though only significant for the model restricted to targeted sectors.

Table 12 presents estimates from a similar differences-in-differences specification to Table 11 but using a total (Leontief) forward linkage measure. Forward linkage effects (columns 1-3) are much stronger than the direct effects of Table 11. 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 13 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 1 percent level of significance. Column (3) shows a corresponding 1.694 estimate (1 percent significance) for employment.

⁸²For example, estimates for second-degree effects (not shown) are about half the size of direct effects and insignificant.

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 14 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 14, 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 et al. (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; Hsieh, 2001). Specifically, DeLong and Summers (1991), DeLong and Summers (1993), and Bond et al. (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.

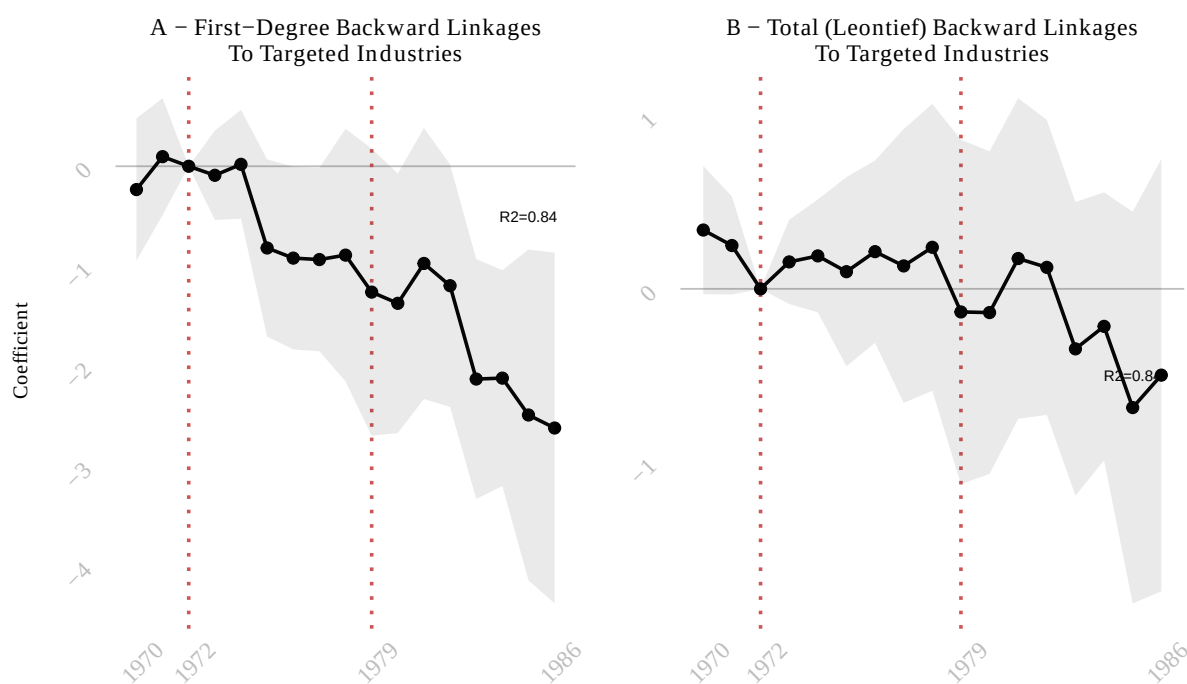


Figure 14: The Effect of First-Degree and Total Backward Linkages on Output, Relative to 1972 Baseline, 1970-1986

Figure 14 illustrates the negative to mixed results 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 out 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 Park.

Table 11 columns (4-6) illustrate 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 (6.3). 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 (column 8), the spillover effect is positive and insignificant for targeted industries (column 9).

Accounting for total backward linkages, Table 12 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 13 column (2) shows a large relative decline in employment, -0.975, though the effect is insignificant.

Backward-Linkages and Import Competition The preceding results show 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 15 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 and significant relationship between industries with connections to targeted industries and the value of imports: $\hat{\beta} = 4.828$ ($t = 4.118$). The pattern is consistent with a story that targeted industries increased imported intermediate inputs after 1973.

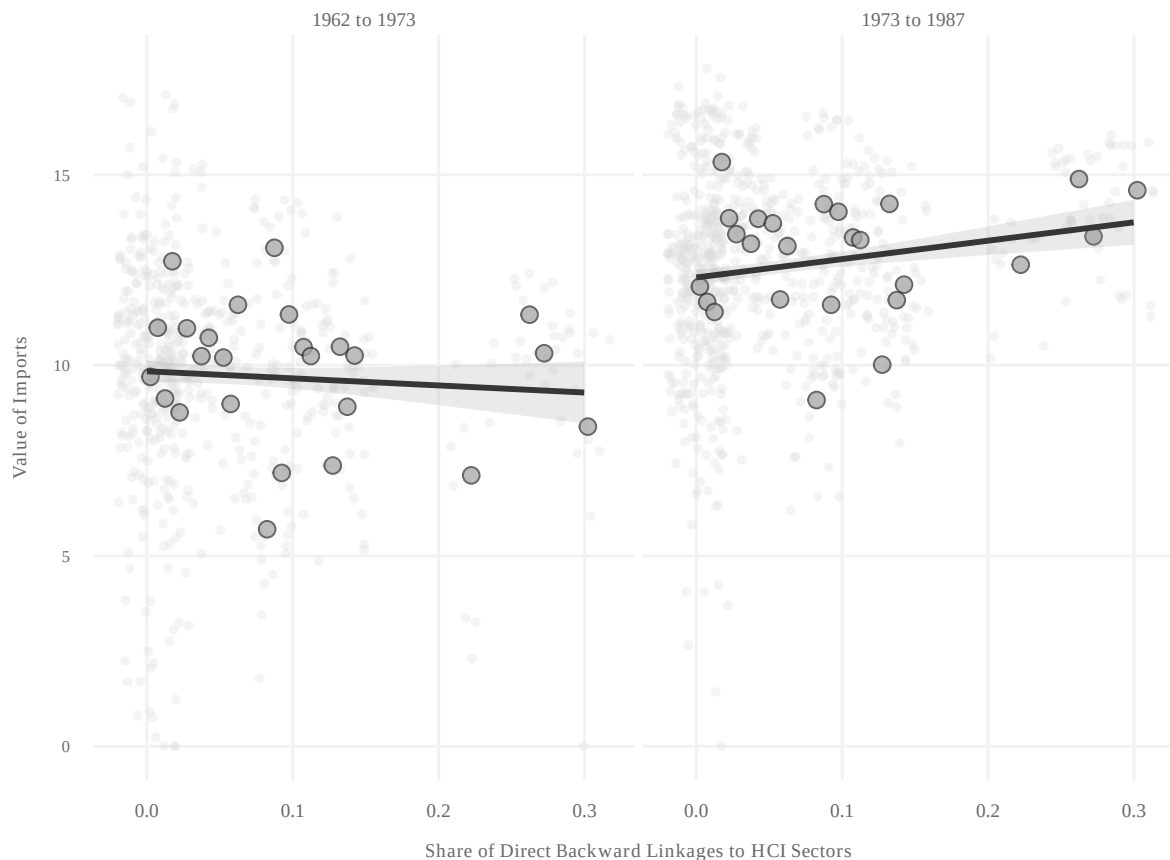


Figure 15: Relationship Between Import Competition and Backward Linkages, Pre- and Post-1973

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.

I next consider the relationship between backward-links and import competition more formally. Table 15 presents the differences-in-differences estimates of this relationship. Columns (1)-(2) shows the effects of direct backward linkages on the value of exports; Columns (3)-(4) show the value of imports. Column (4) confirms the there is a significant rise in the relative value of imported inputs used by HCI industries: 2.46 at 1 percent level of significance.

The relative growth in the value of imports used by HCI sectors coincides with a commensurate decline in exports from upstream Korean industry. The estimated effect of backward linkages on the value of exports (column 2) is -2.91 (1 percent significance). The drop in Korean exports after 1973 further indicate the decline of upstream industries.

Together, these findings are consistent with a story that domestic suppliers were negatively impacted by import competition. Interestingly, Table 15, column (1) also shows that sectors with strong forward linkages increased exports, relative to unconnected industries. This evidence contrasts with the general findings of Blonigen (2016), who shows cross-country evidence that industrial policy, specifically interventions targeting steel, hurt the export performance of downstream (forward-linked) industry.

In summary, it is far from conclusive that industrial policies like HCI, which require the importation of foreign inputs, (relatively) benefited upstream suppliers. There is evidence that HCI may have sacrificed upstream sectors to the benefit of downstream producers, by virtue of enabling key sectors to liberally import key inputs from abroad.

At face value, negative results for backward-linked industry seems counter-intuitive. Scholars like Albert Hirschman, stressed the importance of backward linkages in industrial development.⁸³ In the HCI context, however, targeted firms were allowed to freely import many raw materials and intermediate goods. In a small (relatively) open economy setting like South Korean setting, instead of receiving a positive demand shock from targeted industries, upstream sectors were subjected to increased competition as targeted sectors expanded and increased their use of imported intermediates.

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 12?⁸⁴

The grey points (grey confidence bands) in Figure 16 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 12.

Side-by-side, Figure 16 shows estimates from the two models are strikingly

⁸³See *Backward Linkages at Work* [Hirschman (1958); p.109-113].

⁸⁴The 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.

similar. The implication: accounting for first-order linkage effects does not significantly change the pattern 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 estimates is not polluted by spillovers from the treated sector.

7 Conclusion

In this paper, I study a seminal event in post-war 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 widescale 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 of the impact of infant industry policy on industrial development.⁸⁵ For example, real output of industries targeted by the HCI big push grew 80 percent more relative to non-targeted manufacturing industries during the policy period. Not only did Korea's interventions promote growth in real output, but also a permanent reallocation of economic activity from light to heavy industrial sectors. This transformation of the Korean economy delivered a nearly 11 percent decline in the relative price of output in treated sectors. I document that, contrary to popular wisdom, Korea relied on capital subsidies and subsidies to imported intermediate inputs, rather than the differential protection of treated industries.

⁸⁵Recent work by Juhász (2016) provides some of the first causal estimates of industrial policy using historic French data.

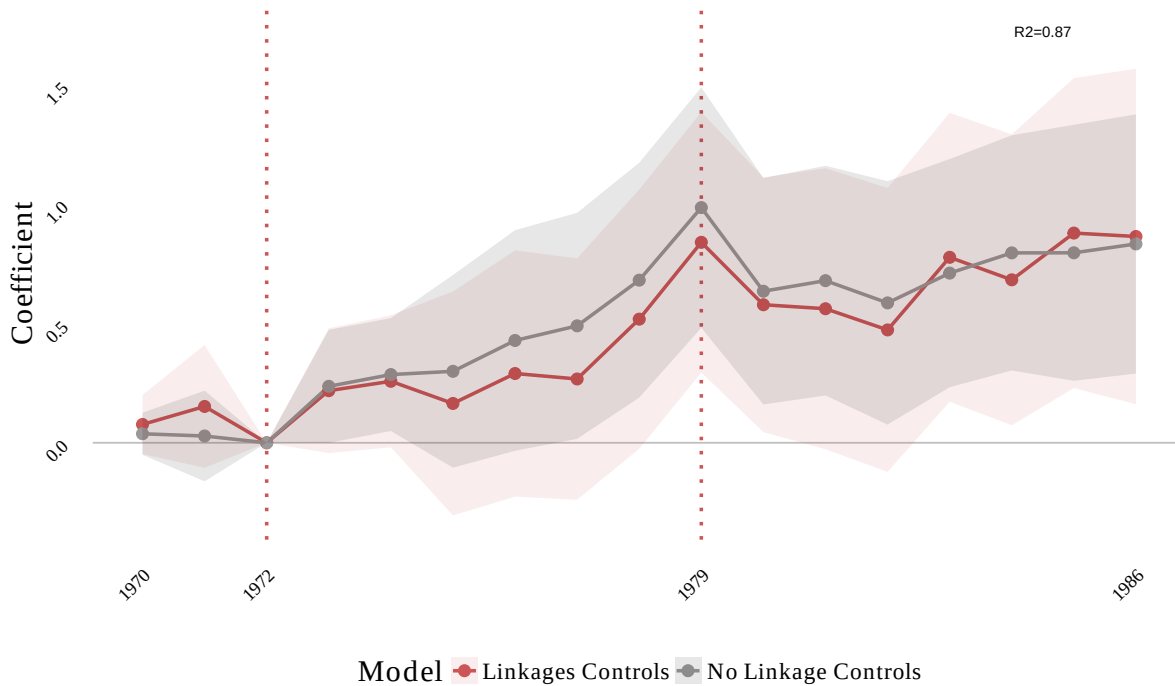


Figure 16: Revisiting the Effect of HCI on (Real) Value Shipped, 1970-1986, Relative to 1972 Baseline. Including versus Not-including First-Order Linkage Effects.

Notes: Each point corresponds to the coefficient $\text{Targeted} \times \text{Year}$, 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.

Finally, I show most of the direct effects of industrial policy persist long after the *de facto* end date of the policy, when South Korea began the process of liberalization.

Targeted industries impacted external industries through the input-output network. Guided by the predictions of a multi-sectoral general equilibrium model (Long Jr and Plosser, 1983; Acemoglu et al., 2016), 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 un-linked sectors. Accordingly, I also provide evidence that these forward-linked sectors invested more in capital and increased their purchases of intermediate goods. The combined results indicate that HCI industrial policy generate positive pecuniary externalities to forward-linked sectors. These conclusions agree with earlier theoretical studies of big push development policy (Murphy et al., 1989) and research highlighting the potential spillovers from equipment investment (DeLong and Summers, 1991).

Development scholars, such as Albert Hirschman, have long highlighted the role of linkages in promoting industrialization, emphasizing the role of backward linkages in producing demand for upstream producers. I find, however, that HCI industrial policies had mixed effects on backward linked sectors. In particular, upstream suppliers with strong links to targeted industry – *e.g.* raw material producers – decline relative to those with weak links. I show the decline of upstream industry arose from industrial policies that benefited targeted industries, such intermediate import subsidies. 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 industrial policy sacrificed more upstream sectors for the benefit of downstream sectors.

Together, this study unpacks the effects of South Korea's influential heavy industrial big push. My study's findings correspond to rich qualitative arguments posed by Wade (1990) and Amsden (1992), who argued that industrial policies promoted post-war industrialization. Moreover, I also show that industrial policies may have heterogeneous impacts on other industries through the input-output network. These

results update earlier work by Hirschman (1958) and others, indicating that the effects of traditional policy prescriptions may be more complex in a highly globalized economy. Nonetheless, the results of my study should be interpreted with caution. While my study highlights the effects of industrial policy on a multitude of industrial development outcomes — such as output prices, output growth, and the reallocation of manufacturing activity — I have not delved into issues of total factor productivity, which I investigate deeper in an upcoming analysis. Similarly, a next step for future research would be to fully account for the effects of industrial policy on aggregate welfare and factor misallocation.

Table 1: Treated Disaggregated 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 distilled 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 equipment	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		

Table 2: Pre-1973 Industry Statistics, Non-HCI v. HCI

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

Table 3: Differences in Total Gross Capital Investment & Costs, Before-After 1973, 1970-1986

	Dependent Variable (IHS) :					
	Total Capital Formation (1)	Total Capital Formation (2)	Total Capital Formation (3)	Total Input Costs (4)	Total Input Costs (5)	Total Input Costs (6)
Targeted X Post	0.594*** (0.164)	0.667*** (0.162)	0.683*** (0.164)	0.568*** (0.141)	0.496*** (0.137)	0.493*** (0.136)
Constant	1.741 (0.071)	2.154 (0.338)	2.119 (0.351)	2.646 (0.058)	2.008 (0.261)	2.004 (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 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 4: Differences in Gross Capital Investment Across Asset Classes, Before and After 1973, 1970-1986

	Dependent Variable (IHS) :			
	Acquisitions Building (1)	Acquisitions Machinery (2)	Acquisitions Land (3)	Acquisitions Vehicle (4)
Targeted X Post	0.485*** (0.141)	0.631*** (0.152)	0.335** (0.116)	0.244* (0.106)
Constant	1.855 (0.210)	2.274 (0.275)	1.326 (0.147)	1.283 (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 effect 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 5: Differences in Protection Policy, Before-After 1973, 1970-1982

	Dependent Variable (IHS) :											
	QR Output (1)	QR Output (2)	QR Output (3)	Tariff Output (4)	Tariff Output (5)	Tariff Output (6)	QR Input (7)	QR Input (8)	QR Input (9)	Tariff Input (10)	Tariff Input (11)	Tariff Input (12)
Targeted X Post	0.039 (0.047)	0.029 (0.047)	0.034 (0.048)	0.028 (0.028)	0.017 (0.027)	0.010 (0.027)	-0.045** (0.014)	-0.044** (0.014)	-0.041** (0.014)	-0.216*** (0.043)	-0.203*** (0.041)	-0.201*** (0.040)
Constant	0.701 (0.019)	0.650 (0.083)	0.660 (0.085)	4.536 (0.010)	4.520 (0.037)	4.548 (0.036)	0.391 (0.006)	0.360 (0.024)	0.362 (0.024)	3.719 (0.012)	3.659 (0.024)	3.660 (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 effect 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 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 6: Differences in Industrial Growth Relative to 1972, 1970-1986

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

	Dependent Variable (IHS) :								
	Value Shipments (1)	Value Shipments (2)	Value Shipments (3)	Gross Output (4)	Gross Output (5)	Gross Output (6)	Value Added (7)	Value Added (8)	Value Added (9)
Targeted X Post	0.710*** (0.191)	0.603*** (0.180)	0.596** (0.183)	0.673*** (0.197)	0.562** (0.185)	0.551** (0.187)	0.593** (0.179)	0.530** (0.173)	0.504** (0.173)
Constant	4.680 (0.086)	3.068 (0.446)	2.966 (0.456)	4.662 (0.093)	3.040 (0.472)	2.984 (0.485)	3.949 (0.085)	2.760 (0.419)	2.721 (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 effect 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 8: Differences in Labor Productivity, Before-After 1973, 1970-1986

	Dependent Variable (IHS) :					
	Labor Prod. (Value Added) (1)	Labor Prod. (Value Added) (2)	Labor Prod. (Value Added) (3)	Labor Prod. (Gross) (4)	Labor Prod. (Gross) (5)	Labor Prod. (Gross) (6)
Targeted X Post	0.025 (0.015)	0.029* (0.014)	0.028* (0.012)	0.092** (0.031)	0.084** (0.028)	0.084*** (0.025)
Constant	0.081 (0.007)	0.080 (0.022)	0.095 (0.020)	0.170 (0.012)	0.177 (0.053)	0.207 (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 effect of Heavy Chemical and Industry industrial targeting on industrial labor productivity. All outcomes are deflated 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: Differences in Industrial Outcomes, Before-After 1973, 1970-1986

	Dependent Variable (HS) :																	
	Prices (1)	Prices (2)	Prices (3)	Avg. Wages (4)	Avg. Wages (5)	Avg. Wages (6)	Entry (7)	Entry (8)	Entry (9)	Employment (10)	Employment (11)	Employment (12)	Labor Share (13)	Labor Share (14)	Labor Share (15)	Share of Output (16)	Share of Output (17)	Share of Output (18)
Targeted X Post	-0.1726*** (0.0389)	-0.1681*** (0.0335)	-0.1667*** (0.0329)	0.0008 (0.0024)	0.0001 (0.0002)	0.0002 (0.0002)	0.3241* (0.1502)	0.1861 (0.1306)	0.1897 (0.1316)	0.5800* (0.2530)	0.3783 (0.2151)	0.3786 (0.2201)	0.0758* (0.0301)	0.0675* (0.0293)	0.0632* (0.0297)	0.0916** (0.0316)	0.0839** (0.0318)	0.0803* (0.0312)
Constant	3.3223 (0.0153)	3.4422 (0.0447)	3.4315 (0.0443)	0.0057 (0.0016)	0.0004 (0.0006)	0.0007 (0.0002)	3.6454 (0.0586)	2.2696 (0.1966)	2.2978 (0.1982)	6.7478 (0.1020)	4.4773 (0.3718)	4.4653 (0.3747)	0.2929 (0.0122)	0.1650 (0.0282)	0.1653 (0.0286)	0.2145 (0.0121)	0.1274 (0.0402)	0.1314 (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	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 effect of Heavy Chemical and Industry industrial targeting on industrial labor productivity. All outcomes are deflated by industry-level price indexes 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 10: Differences in Exports and Imports, Before-After 1973, 1970-1986

	Dependent Variable (IHS) :					
	Import Value (1)	Import Value (2)	Import Value (3)	Export Value (4)	Export Value (5)	Export Value (6)
Targeted X Broadpost	-0.4832 (0.2706)	-0.2089 (0.3350)	-0.2284 (0.3327)	0.8070 (0.4420)	1.0416* (0.4954)	1.0604* (0.5017)
Constant	11.8400 (0.0859)	8.9995 (0.6243)	9.3343 (0.7368)	11.3009 (0.1291)	7.0224 (1.2135)	6.6820 (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 effect of Heavy Chemical and Industry industrial targeting on industrial labor productivity. All outcomes are deflated 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 11: 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* (0.507)	0.895 (0.736)	1.315* (0.582)			
Post X Backward HCI Linkage				-1.224* (0.479)	-1.553* (0.611)	-0.492 (0.648)
Constant	4.989 (0.081)	4.833 (0.111)	4.381 (0.135)	4.989 (0.080)	4.833 (0.109)	4.381 (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 12: 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** (0.417)	3.742*** (0.930)	0.410 (0.389)			
Post X Leontief HCI Backward Linkage				-0.245 (0.365)	-0.486 (0.504)	0.302 (0.383)
Constant	4.989 (0.080)	4.833 (0.107)	4.381 (0.135)	4.989 (0.081)	4.833 (0.110)	4.381 (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 13: 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*** (0.363)		1.514* (0.592)		0.015 (0.011)		0.005 (0.008)	
Post X Backward HCI Linkage		-0.382 (0.305)		-1.184* (0.594)		-0.006 (0.004)		0.013* (0.006)
Constant	3.619 (0.062)	3.619 (0.062)	6.807 (0.102)	6.807 (0.101)	0.004 (0.001)	0.004 (0.001)	0.031 (0.001)	0.031 (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 14: 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 15: 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 (1.095)		0.257 (0.715)	
Post X Backward HCI Linkage		-2.911*** (0.592)		2.475*** (0.689)
Constant	2.313 (1.111)	2.368 (1.025)	8.394 (1.094)	8.373 (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.

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