Trade, Firms, and Economic Development[*†]

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Abstract

International trade and openness can foster technological enhancement and economic growth as countries advance to higher levels of economic development, helping them avoid potential middle-income traps. This note summarizes various channels through which this relationship can operate, highlighting the importance of foreign competition and international technology spillovers. It also provides an in-depth look at the experience of the South Korean economy in the second half of the 20th century focusing on the development of its competitive industries and firms.

Keywords: Foreign competition, international knowledge flows, innovation, imitation, firm dynamics in South Korea

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1 Introduction

South Korea is often cited as the poster child of the Asian growth miracle. It has managed to follow a sustained path of economic development for about four decades, fending off any middle-income trap and reaching high-income country status by the mid-2000s. During this process, it has become increasingly integrated to the global markets, with its trade volume climbing to roughly the size of its GDP and the volume of its goods exports accounting for about half of it. In a more recent example of sustained economic growth and development, China has exhibited a remarkable rate of growth, which picked up in the early 2000s when China became a member of the World Trade Organization, marking the start of a period of quick integration to the global markets and value chains. These cases are suggestive of a positive contribution of international trade and openness to economic growth and development.

In this note, we focus on the linkages between international trade and openness and firm dynamics. We first review the literature, highlighting the evidence on various channels through which international linkages can foster technological upgrading and firm growth, with a particular focus on developing economies. We then provide an in-depth look into firm dynamics in South Korea over the course of its economic development process.

An extensive literature has explored the effects of trade liberalization on firm performance.[1] Several important empirical contributions highlight the pressure exerted by foreign competitors as a factor that forces domestic firms to improve their products or production processes. This competitive pressure induces firms to invest in technology upgrading as they vie for market shares in the presence of foreign rivals, constituting a key source of productivity growth.[2] Yet these effects are heterogeneous; firms that are too technologically laggard to begin with do not respond positively. In line with the theoretical predictions of Schumpeterian step-by-step models, the positive effects benefit firms that are technologically close to the rivals.

These empirical findings as well as theoretical investigations suggest that benefits from foreign competition driving firm-level innovation and productivity growth materialize after a certain level of development. As such, openness to trade can potentially act as a propeller of growth helping

[1] Here, we provide a brief summary of the evidence and therefore avoid references to specific academic studies. A thorough discussion follows in Section 2.

[2] The evidence points also to a selection effect—elimination of incompetent firms—though these appear to materialize over longer term.

countries avoid middle-income traps as they inch closer to frontier economies. For instance, the data show that South Korea has steadily reduced tariffs on imported goods as it continued to develop its industry, exposing it to foreign competition. This example contrasts with those of many Latin American countries, in which industrialization policies based on import substitution created vast inefficiencies that were noticed even by leading proponents of these policies in the early days of their adoption (Irwin, 2020).

Another major source of technology improvement highlighted by the literature emerges from international knowledge diffusion. A recent anecdote is China's increased dominance in the electric vehicle sector. The auto maker BYD, which surpassed Tesla as the leading global producer last year, entered the business in 2003 and has since benefited greatly from observing foreign manufacturers in China.[3] Chinese manufacturers are now able to provide Tesla with electric motors. Reflecting on such spillovers, the literature finds notable productivity gains created by technology diffusion from the frontier countries to laggard ones. Using micro-level data, recent studies document direct firm-level evidence on the existence of knowledge transfers.

The second part of this note concerns the economic progress of South Korea, presenting new evidence on Korean firms. Korea's sustained journey of convergence to the frontier without major protracted downturns makes it worthwhile for exploring the dynamics that contributed to its success. To start, it developed substantial capacity of manufacturing and heavy industry during the 1970s. These firms invested a great deal in technology adoption early on. In the 1980s, they started to expand their global market shares while shifting their investments from imitation and adoption to innovation. These slow-moving changes were influenced by deliberate policy actions. The Korean governments initially subsidized technology adoption from frontier countries, whereas later on, they provided substantial support for innovation investments after Korean firms have developed enough capacity to create and compete with their own technologies. Successive governments also reduced import tariffs steadily, pushing domestic firms to face foreign competitors. While this industry and export-led growth process caused market concentration to increase markedly, overall, the emergence of large firms has boosted productivity growth.

Section 2 reviews the literature. Section 3 describes the data sources used in the analysis of

[3]Source: https://asia.nikkei.com/Spotlight/Electric-cars-in-China/BYD-eyes-overtaking-Tesla-this-year-as-world-s-top-EV-maker, *accessed on July 23, 2023.* BYD has also attracted the former Audi designer.

Korean firms. Section 4 presents new firm-level evidence along Korea's progress in economic development. Section 5 concludes.

2 International Aspects of Economic Growth at the Firm Level

Numerous studies explore the impact of trade openness on firm productivity, highlighting the forces generated by the escalating competition with foreign enterprises.[4] As far as developing economies are concerned, Pavcnik (2002) investigates the effects of trade liberalization on plant productivity in Chile. Between 1974 and 1979, the Chilean government abolished most non-tariff barriers and reduced tariff rates substantially. The paper documents that within-plant productivity in the import-competing sectors rose following trade liberalization during the late 1970s and early 1980s. Foreign competition forced plants in previously protected sectors to trim their fat, enabling their productivity to grow three to ten percent faster than in plants in the nontraded-goods sectors. This boost to productivity has been supported by the relocation of resources from lower productivity firms to those with better prospects as the former were forced out of business.

On a similar note, Muendler (2004) explores the role of trade liberalization on firm-level productivity in Brazil. Mimicking Chile's strategy, the Brazilian government slashed non-tariff barriers and reduced tariffs between 1990 and 1993. The paper discovers a marked rise in firm-level productivity following the trade liberalization. Moreover, the short-run effects do not stem from access to better foreign inputs, suggesting that other factors such as a "competitive push"—competitive pressure forcing firms to enhance their products and processes—have been at play, reminiscent of the escape-competition effect in Schumepterian creative destruction models (Akcigit et al., 2021). Over the longer horizons, trade reform also drives inefficient firms to exit the business, thereby boosting aggregate productivity.

Bustos (2011) examines Argentine firms' decisions to upgrade their technology following the establishment of MERCOSUR. As part of the this trade agreement, Brazil's tariff on Argentine goods declined from 29 percent in 1991 to zero by 1995, leading to a significant decrease in the export costs for Argentinian firms. Bustos (2011) finds that sectors experiencing higher reductions in tariffs saw a greater increase in investments in advanced technology, which includes expen-

[4] Burstein and Melitz (2013) and Shu and Steinwender (2019) provide through accounts of the literature on trade liberalization and firm dynamics.

ditures on computers, software, and payments for technology transfers and patents. Reflecting substantial heterogeneity across firm responses, the effects were more pronounced for firms in the third quartile. This observation aligns with recent theoretical investigations (Aghion et al., 2022), given that top quartile firms were already adopting technology and engaging in export activities. Conversely, the bottom quartile firms were unlikely to adopt and export even in the wake of liberalization.

Several other studies utilize China's accession to the World Trade Organization (WTO) as an impetus for increased import competition and investigate the relationship between trade openness, foreign competition and innovation and productivity at the firm level. Iacovone et al. (2011) examine the innovation activities of Mexican firms, where innovation is quantified by survey data capturing the adoption of new production techniques. They detect little change in aggregate innovation. However, they note considerable heterogeneity and a divergence between firms: more productive firms tend to innovate more, while less productive ones do otherwise. Utilizing patent data, Bloom et al. (2016) find a positive influence of import competition from China on the innovation of firms in 12 European countries. In contrast, Autor et al. (2020) document a negative impact on firms' innovation, particularly for less profitable firms. Providing a conciliatory note between these contradicting findings, Akcigit et al. (2021) argue that the positions of domestic firms relative to foreign rivals in the technology space matter for their response, and as a result, the aggregate changes can go either way depending on the distribution of firms across technology distance from the rivals. With a similar emphasis on firm heterogeneity in the technology space, Aghion et al. (2022) investigate the effects of export demand shocks on French firms' innovation. They report a positive influence on patenting, with larger effects observed for firms that were more productive initially.

In recent work, Akcigit et al. (2021) provides a theoretical framework that lays bare the linkages between foreign competition, firms' innovation incentives, and economic growth. In this two-country dynamic general equilibrium setting based on Schumpeterian step-by-step innovation models (Aghion et al., 2001, 2005), the authors analyze industrial and trade policy and their implications for growth and welfare in the face of international technological competition. In the heart of step-by-step innovation models lies an escape-competition effect: more intense competition between firms with similar technologies (smaller technology gap) induces firms to enhance

their products and processes to overcome their rivals. Firms that fall far behind their competitors (facing large technology gaps) are discouraged from doing so.[5] In the open-economy version built by Akcigit et al. (2021), market competition gains an international aspect, and firms' innovation incentives peak when faced with foreign competitors having similar technological capacities; i.e., when technology gaps close and foreign competition stiffens. As such, the growth and welfare effects of industrial or trade policies crucially depend on technology gaps and how policies affect those gaps.[6] In other words, the key metric is how different policies alter the strength of foreign competition that domestic firms face, and, consequently, the dynamic gains from trade they create.

Using the heightened foreign competition that U.S. firms faced during the 1980s and the policy responses at the time as a laboratory, Akcigit et al. (2021) demonstrate that protectionist measures generate large dynamic losses by distorting the firms' innovation incentives. Indeed, they find that the optimal unilateral import tariff is zero for all policy horizons. Moreover, the optimal level of R&D subsidy decreases in trade openness, highlighting the key role of foreign competition in incentivizing firms to enhance their technologies and thereby reducing the need for policy intervention. This boosting effect of foreign competition on firm dynamism is corroborated by the empirical findings of Akcigit et al. (2023b). Utilizing a cross-country firm-level panel data, they document that in more concentrated sectors of the economy, a larger presence of firms with foreign owners alleviates the negative effects of market concentration on firm growth considerably, giving a lift to domestic business dynamism.[7]

Another strand of research examines the role of international knowledge diffusion in economic growth.[8] Seminal contributions by Coe and Helpman (1995), Coe et al. (1997), and Eaton and Kortum (2001) posit that knowledge is embedded within goods and can be disseminated through international trade. Similarly, Grossman and Helpman (1991), Alvarez et al. (2017), Buera and Oberfield (2020), Hsieh et al. (2023), and Rachapalli (2021) model knowledge diffusion as a byproduct

[5] They may benefit from the advantage of backwardness (Gerschenkron, 1962).

[6] A significant body of empirical work examine the effect of foreign competition on domestic firms (Pavcnik, 2002; Muendler, 2004; Aghion et al., 2005; Gorodnichenko et al., 2010; Bustos, 2011; Iacovone et al., 2011; Amiti and Khandelwal, 2013; Bloom et al., 2016; Hombert and Matray, 2018; Autor et al., 2020 among others). Many of these studies also highlight heterogeneous responses of firms to foreign competition based on their initial conditions. Firms that are better in technology or more productive happen to respond positively to competitive pressures.

[7] Akcigit et al. (2021) emphasize the role of R&D subsidies in managing pressures from foreign competition. On a related note, Zilibotti (2017) documents that developing economies that are more R&D-intensive are more likely to avoid growth slowdowns as they become middle-income countries. That said, the allocation of resources for R&D to productive firms proves key for R&D-based policies to be effective in promoting growth (König et al., 2022).

[8] Keller (2004) provides a through review of international technology diffusion.

of goods trade. Meanwhile, Eaton and Kortum (1999), Santacreu (2015), and Lind and Ramondo (2022) focus on technology adoption, treating it as a deliberate decision by firms. Perla et al. (2021), Sampson (2023), and Hsieh et al. (2023) provide recent examples of endogenous growth models that embed international knowledge diffusion as a driver of economic growth. Following that tradition, Cai et al. (2022) reckon substantial contributions by foreign R&D and knowledge spillovers to domestic productivity growth across a large number of countries, echoing earlier findings by Coe and Helpman (1995). Santacreu (2022) analyzes dynamic gains from deep trade agreements—trade agreements that combine provisions on tariffs and intellectual property protection—and their effect on knowledge spillovers and technology adoption.

A few papers study technology adoption and innovation with direct empirical measures. De Souza (2021) studies the effect of technology substitution policy on labor market, where the Brazilian government reduced adoption subsidy while increase innovation subsidy. He finds that while the policy increased innovation measured by patents, it decreased skill premium and the aggregate production. Choi and Shim (2022a) study the role of adoption and innovation on economic growth over different stages of development in South Korea. Digitizing data on licensing agreements between South Korea and Japan, they find that when the technology gap with foreign firms is larger, i) firms are more likely to invest in adoption than innovation, ii) productivity growth after adoption is larger, and iii) price of technology transfer is less expensive. Of note, the result that technology adoption boosts firm growth more than innovation when the distance to frontier is larger echoes the notable contribution of Acemoglu et al. (2006).

On a similar note, Akcigit et al. (2023a) provide a detailed account of technology transfers. The paper uses a novel cross-country data on cross-border venture capital investments by foreign corporations into U.S. startups. Analyzing investments from a multitude of countries including both developing and developed ones (including investments by Chinese firms), the paper applies event study and difference-in-difference regression techniques to document the increased flow of technological knowledge measured by patent citations from the invested US startups at the technology frontier to the investing firms. At the technology class level, patenting by firms of the investing country in the invested class grows disproportionately more along with increased number of citations to the US firms in the same class with the funded startup. Moreover, this increased innovative activity depends on the technology gap: spillovers from the frontier are larger when

the sector-level technology gap between the country of the investing firm and the United States is larger. The effects are also stronger in technology classes that concern more basic knowledge and research, which are harder to replicate. These results are akin to Keller and Yeaple (2009), who show that spillovers are stronger in high-tech sectors.

In recent work, Fons-Rosen et al. (2020) and Fons-Rosen et al. (2021) identify substantial spillovers and productivity gains associated with foreign investment, making a decisive contribution to the extensive literature on FDI and economic performance in the host country.[9] In Fons-Rosen et al. (2021), the authors find that firms benefit from receiving FDI with a notable boost to their productivity, though only when the foreign investor receives the majority stake at the company. Going beyond this direct effect, Fons-Rosen et al. (2020) document substantial knowledge spillovers facilitated by foreign investments and occurring in multiple layers. The authors observe that spillovers from FDI does not only benefit the firms that receive the investment: firms in the same sector with an FDI-receiving firm as well as firms in vertically connected sectors also enjoy technology spillovers and a boost to their productivity growth.[10] At the firm level, the positive effect of FDI on productivity growth via knowledge spillovers within the same sector and from technologically close sectors dominate the negative effects stemming from market losses to the foreign-owned firms. While the evidence in these studies is based mostly on advanced countries, it is indicative of considerable potential for productivity growth via international knowledge flows as a country climbs up the ranks of economic development and gets closer to the technology frontier.[11]

Since the analysis of South Korea's success in sustained rise in the development ladder has a particular weight in this piece, it is worthwhile to review some recent work that studies different episodes of South Korean economy. Several recent papers explore the influence of governmental policies on Korea's miraculous economic growth, leveraging micro-level data. Choi and Levchenko (2021) study the effect of allocating foreign credit to individual firms, which was one of the main industrial policies in South Korea in the 1970s. Exploiting the fact that policy was

[9] See Keller (2010) for a thorough discussion on trade, FDI flows, and technology spillovers.

[10] This effect is predicated on technological closeness between the foreign investor and the firm in question, which the paper measures based on the proximity between technology classes firms' prior patenting activity occurs.

[11] The evidence paints a consistent picture with the theoretical investigation of Howitt (2000), who posits that after a certain level of development countries are able to benefit from frontier technology growth, which leads to the emergence of convergence clubs.

centered around specific regions, the authors causally estimate the long-term effect of the policy on firm-level sales and productivity. They find that doubling of credit led to 12 percentage points higher sales growth and 4 percentage points higher TFP growth between 1982 and 2009.[12]

Connolly and Yi (2015) study the role of trade policy in South Korea's growth. During the 1960s the Korean government granted exemptions on imported inputs and capital goods if they are used to make export goods. Also, in 1970s and 1980s, Korea engaged in a broader tariff reductions including GATT rounds. They demonstrate that these tariff reductions can account for 17 percent of South Korea's catch-up, which is measured by the ratio of GDP per capita of G7 countries and South Korea. They show that the effect is mainly driven by multistage production and imported investment goods.

Lastly, Choi and Shim (2022a) explore the role of innovation and adoption policies over different stages of development in South Korea. They indicate that a state-dependent policy, commencing with an adoption subsidy before transitioning to an innovation subsidy, played a pivotal role in transforming South Korea from a low-income to a high-income nation. Specifically, they show that the productivity gain and knowledge spillover from adoption is larger than those from innovation when the technology gap is larger. This makes adoption subsidy more effective than innovation subsidy at the early stages of development. As the domestic firms catch up with foreign firms, productivity gap diminishes and the productivity gain and its spillover from adoption become less pronounced, making innovation subsidy more effective than the adoption subsidy. As a result, they find that the state-dependent policy in South Korea increased welfare by 5%, which exceeds the impact of other time-invariant policies. Also, they find that the optimal subsidy would have switched from an adoption to innovation subsidy when GDP per capita of Korea becomes roughly half the Japan's. These findings echo the seminal work by Acemoglu et al. (2006), who show that policies skewed heavily to investment and use of adopted technologies may leave developing economies in a trap impeding the buildup of innovative capacity and convergence to the frontier and need to be replaced by policies supporting innovation.

[12] Lane (2022) find that the sector-specific subsidies increased output and productivity of the heavy manufacturing sector persistently using sector-level data. Likewise, Kim et al. (2021) uncover a positive influence of subsidies; however, they note that such policies concurrently heightened misallocation across firms. Choi et al. (2023) document a notable rise in sale and labor concentration among manufacturing firms and in the dominance of large firms during similar periods. Yet, the authors find a positive contribution of large firms to aggregate productivity growth on net.

3 Data

For firm-level analysis, we combine datasets of technology adoption, balance sheet, and patent data, which cover 1970–1993.

Technology Adoption Data. We use technology adoption data constructed in Choi and Shim (2022a) and Choi and Shim (2022b). They collect and digitize technology transfer contracts from the National Archives of Korea. The data encompasses all the technology transfers that occurred between Korean firms and foreign firms from 1962 to 1993. Korean firms were required to submit these contracts to the government when importing technology from foreign countries. The dataset contains information such as the names of the Korean firm (buyer) and the foreign firm (seller), as well as the contract's date and duration. Additionally, it includes details about the technology being transferred, the contents of the contract, and the adoption fee. The adoption fee is comprised of a fixed fee and a royalty rate.

Firm-level Balance Sheet Data. We use firm-level balance sheet data from Choi and Shim (2022a) who utilize two different data sources. The first source involves digitizing firm-level data from the Annual Reports of Korean Companies, which is provided by the Korea Productivity Center. This data comprises surveys conducted on firms with more than 50 employees, representing approximately 70% of the manufacturing sector's value-added share. The second data source is KIS-VALUE, which begins in 1980 and covers firms with assets exceeding 3 billion Korean Won (equivalent to 2.65 million dollars in 2015). This dataset is collected by a private company and encompasses firms subject to external editing.

Korean patent office data. In order to assess the level of innovation among Korean firms, we rely on patent data obtained from the Korean Intellectual Property Office. This dataset covers patents registered in Korea by both domestic and foreign firms and spans from the year 1945 onwards. It provides a comprehensive record of all patents registered in the country during this period.

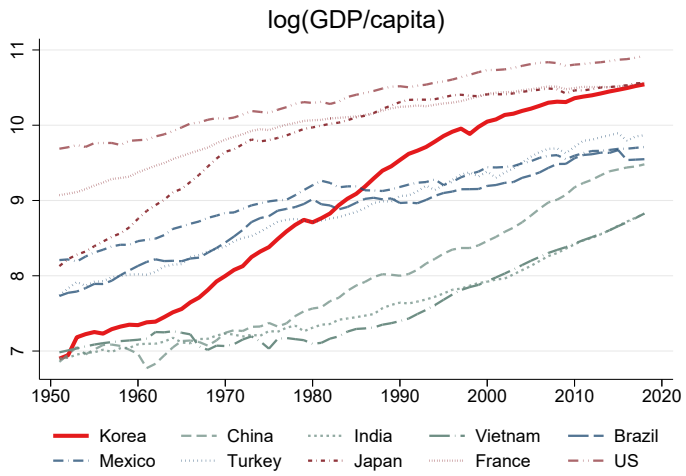


Figure 1: Log (GDP per capita)

Notes: This figure shows log(GDP per capita) across different countries over time. GDP data is from Maddison project (Bolt and Van Zanden, 2020; Cha et al., 2020)

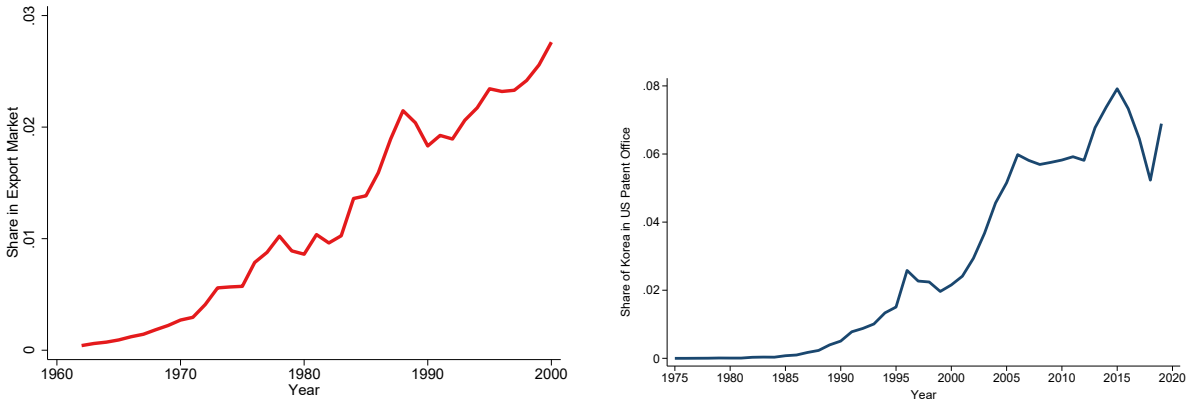
4 Stylized Facts

4.1 Growth Pattern of South Korea

GDP per Capita. First, we consider the aggregate economic growth in South Korea. The red line in Figure 1 shows the log of GDP per capita in Korea over time, comparing it with other countries. Initially, Korea had a similar GDP per capita to low-income countries like China, India, and Vietnam. However, during the 1980s, Korea experienced significant economic growth and caught up with some middle-income countries such as Brazil, Mexico, and Turkey. In the 2010s, Korea's GDP per capita further increased and caught up with high-income countries like Japan, France, and the United States. This observation highlights Korea's remarkable economic development and its transition from a low-income country to a high-income country over the years. This rapid growth has been known as "growth miracle" along with other east Asian countries including Taiwan, Hong Kong, and Singapore (Lucas, 1993).

Share of Korea in Export Market and Patent. Next, we show that Korean firms have expanded share in trade and innovation. Figure 2 illustrates the share of Korean firms in export and patents. Specifically, we calculate the total value of export by Korean firms and divide it by the total value of export in the World. The market share of Korean firms has experienced significant growth,

rising from less than 0.04% in 1962 to 2.7% in 2000.[13] This suggests that the Korean firms have gained competitiveness in the global market, which substantially contributed to the rapid growth.



A. Share in Export Market B. Share in USPTO

Figure 2: Share of Korean Firms in Export and Patents

Notes: Panel A plots the share of export value of Korea in the total export. The data is from Feenstra et al. (2005). Panel B shows the share of patents registered by Korean firms in the entire patents in the United States Patent and Trademark Office (USPTO).

Similarly, the share of patents registered by Korean firms in the United States Patent and Trademark Office (USPTO) has shown remarkable expansion, increasing from 0.001% in 1977 to 6.8% in 2019. We use patent data from USPTO since the high quality patents tend to be registered in the United States. In 2019, Korea ranked 4th in terms of the number of patents following the US, Japan, and China. This indicates that Korean firms have become more innovative, which significantly contributed to the country's growth, particularly as Korea transitioned from a middle-income to a high-income nation.

Market and Labor Concentration in Korea over Time. The evolution of market and labor concentration in Korea is depicted in Figure 3. The figures demonstrate a significant increase in concentration as the country has developed over time. In particular, the market share of the top 10 firms has risen from 5% in 1972 to 25% in 2011. Similarly, the labor share of these top 10 firms has increased from 3% to 8%. Choi et al. (2023) show that the main driver of Korean growth was "superstar" firms which has substantially increased productivity over time. While this concentration has caused inefficiencies including increasing product and labor market share, reallocation of

[13] In the same time period, GDP share of Korea has grown from 0.03% to 1.7% in 2000.

A. Sales Share

B. Employment Share

Figure 3: Share of Top 10 Firms in Sales and Employment

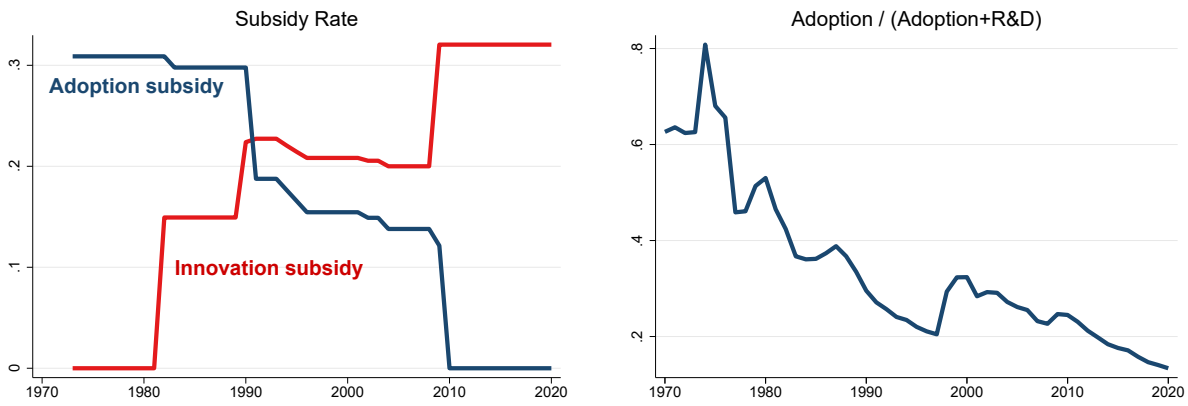
Notes: In this analysis, we focus on the top 10 firms based on sales. Panel A of Figure 3 presents the sales of these top 10 firms as a share of the total gross output. Panel B showcases the employment provided by these top 10 firms as a proportion of the total gross employment. The data for the top firms is sourced from firm-level datasets, while the gross output and employment are obtained from the Input-Output table.

labor and capital towards these "superstar" firms has contributed to a rapid growth of GDP and welfare.

4.2 Government Policies in South Korea

Adoption and Innovation Subsidy Rate over Time. An important industrial policy in South Korea was to subsidize technological investment. In particular, the Korean government subsidized adoption and innovation through tax credits. Specifically, firms received tax credit for adoption payment or R&D expenditure. The policy started by subsidizing adoption first when the technology gap with foreign firms were large. Then, it gradually shifted towards innovation subsidy as Korean firms caught up with foreign firms.

Panel A in Figure 4 displays the adoption subsidy rate as a navy line and the innovation (R&D) subsidy rate as a solid red line in Korea over time. We calculate the subsidy rate using the formula from Bloom et al. (2002). The adoption subsidy was introduced in 1973, and the figure shows that the subsidy rate has gradually decreased over the years. In contrast, the R&D subsidy was initiated in 1982, and the figure demonstrates that its rate has increased steadily over time. Panel B in Figure 4 plots the adoption expenditure share. The share has decreased over time, which suggests firms were relying more on adoption at the early periods of development, and they gradually switched to innovation over time.



A. Subsidy Rate B. Expenditure Share

Figure 4: Adoption and Innovation Subsidy Rate and Expenditure

Notes: Panel A plots the adoption subsidy rate in the navy line and the innovation (R&D) subsidy rate in the solid red line in Korea over time. We calculate the innovation and adoption subsidy rate using using the formula from Bloom et al. (2002) using tax credit rate and corporate tax rate. Tax credit rate is from https://glaw.scourt.go.kr, R&D tax credit rate and corporate tax rate is from Choe and Lee (2012). Panel B plots adoption / (adoption + R&D). Adoption expenditure is the gross payment by Korean firms to foreign firms for sharing industrial processes, designs, and licensing for patents and trademarks.

The relative advantages of adoption and innovation vary according to the technology gap with foreign firms. When the gap is significant, domestic firms stand to gain substantial knowledge from foreign counterparts. However, as this gap narrows, the potential for learning diminishes. In extreme cases where a domestic firm surpasses a foreign firm in technology, adopting foreign tech would not boost productivity. Choi and Shim (2022a) have indeed found that the bigger the productivity gap between domestic and foreign firms, the greater the productivity growth following technology adoption. However, this correlation is not as pronounced in the case of productivity growth after innovation.

The relative cost of adoption also fluctuates with the technology gap, due to strategic interaction between domestic and foreign firms. If a Korean firm's productivity lags far behind a Japanese firm, advancements by the Korean firm pose little threat to the Japanese firm's market share due to its minor presence. As the gap narrows, marginal improvements in the Korean firm could significantly encroach on the Japanese firm's global market share, thus affecting their profits. To compensate for this potential loss, the Japanese firm would likely charge a higher price for its technology. This is corroborated by Choi and Shim (2022a), who found that technology transfer prices are higher when the productivity gap between domestic and foreign firms is smaller.

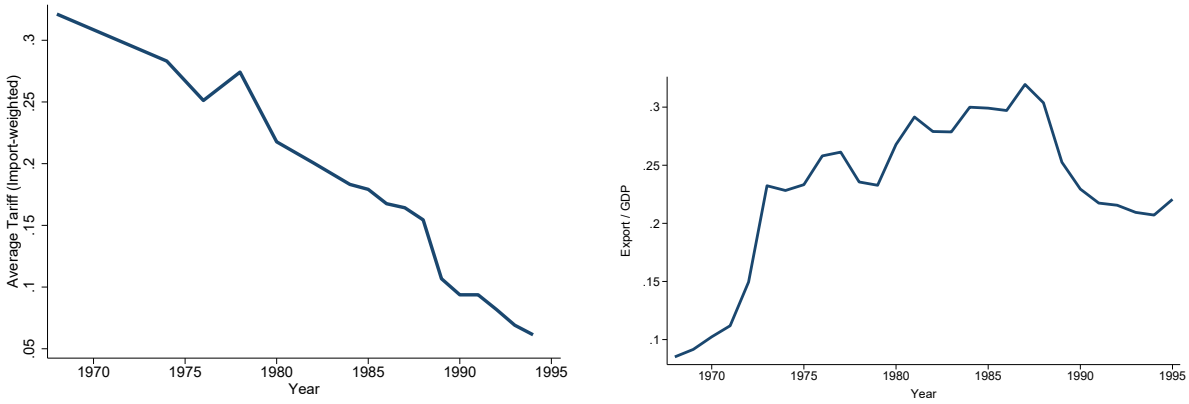
As domestic firms close the productivity gap with foreign firms, the relative benefit of adoption diminishes while the cost rises, naturally driving firms to shift from adoption to innovation. However, government intervention is required to harness knowledge spillovers from these processes. Choi and Shim (2022a) observed that when a Korean firm adopted technology, even firms not directly involved increased their patent citations of the adopted technology, signaling knowledge spillover. This suggests technological investment generates positive externalities, which firms don't internalize, leading to underinvestment in adoption and innovation. The externality's magnitude would correlate with productivity gains from adoption and innovation. Since adoption yields greater productivity gains in early developmental stages, initial policy should favor adoption subsidies. As the technology gap narrows and innovation yields greater productivity gains, policy should shift to subsidizing innovation more than adoption, consistent with actual policies.

Choi and Shim (2022a) evaluate the state-dependent technology policy in South Korea, which initially subsidized adoption when the technology gap was large, and later subsidized innovation as the gap diminished. They find this policy improved welfare by 4.8% compared to scenarios without subsidies, outperforming time-invariant policies that only subsidized either innovation or adoption. The success lies in the policy's ability to align firms' investments closer to a socially optimal level. Additionally, Choi and Shim (2022a) determine the optimal policy would commence by subsidizing adoption by 55%, and pivot to innovation subsidy when the GDP per capita approaches half that of the frontier country's GDP per capita.[14]

Average Tariff over Time. Another important policy in South Korea was trade policy. Panel A in Figure 5 plots the average import tariff in Korea, calculated using product-level import tariffs, which are then aggregated using the import value as the weight. The average import tariff rates have decreased from more than 30% in 1968 to 5% in 1994 as the country has developed over time. This reduction in tariffs is attributed to two major reforms (Connolly and Yi, 2015). The first reform removed import tariffs on input and capital goods, provided they were used to produce export goods. This export-oriented policy incentivized firms to use foreign inputs to export goods. The second reform involved engagement in the General Agreements on Tariffs and Trade (GATT). The two most significant global tariff reductions regarding GATT were Kennedy round (1964) and

[14]Japan is used as the benchmark frontier country.

Tokyo Round (1973), which contributed to the decrease in Korea's import tariffs.



A. Average Tariff Rate B. Export Share in GDP

Figure 5: Average Import Tariff and Market Share of Korea

Notes: Panel A plots the average import tariff rate, which is weighted by import value. Panel B plots the value of export divided by GDP.

Panel B in Figure 5 depicts the export share in GDP. As tariffs decreased, the share of exports in GDP rose from 8% to 22%. This increase can be attributed to the enhanced productivity of Korean firms, enabling them to compete with foreign firms in the global market, and an overall global decrease in tariffs, facilitating exports to other countries. Connolly and Yi (2015) found that trade policy accounts for 17 percent of productivity growth in the manufacturing sector, emphasizing the critical role of imported capital and intermediate goods in this growth.

Sector-Specific Subsidy on Heavy Manufacturing Sector. Also, Korean government promoted heavy manufacturing sector in the 1970s. Panel A in Figure 6 displays the tax rates on marginal returns to capital over time. From 1973 to 1979, the tax rates were significantly lower in heavy manufacturing compared to other sectors. This demonstrates that the government prioritized heavy manufacturing sector over other sectors. Also, the government subsidized heavy manufacturing firms to adopt foreign technology in the same time period. On top of the adoption tax credit which was discussed in the previous section, it subsidized other expenses including the establishment of new factories or the acquisition of capital goods.

Panel B in Figure 6 illustrates the share of value added by the heavy manufacturing sector in Korea and in other countries. The figure shows an increase in the share of heavy manufacturing

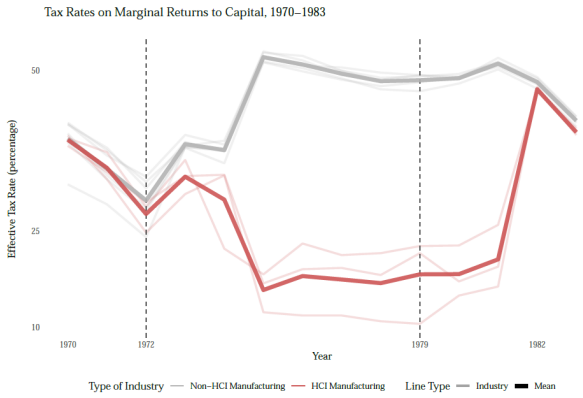
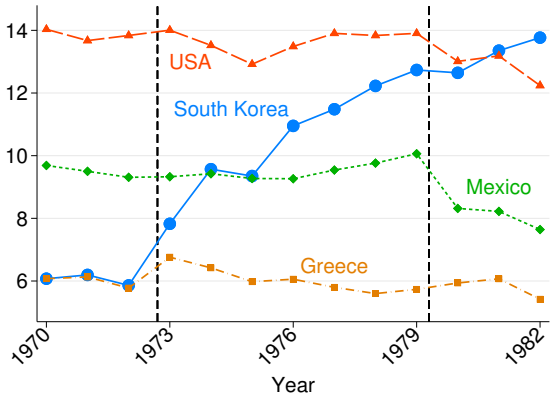


Figure A2: Tax Rates on Marginal Returns to Capital, 1970-1983, by 2-digit Manufacturing Industry.

A. Capital Tax Rate



B. Heavy Manufacturing Share of GDP (%)

Figure 6: Sector-specific Subsidy and Value Added Share

Notes: Panel A plots the tax rates on marginal returns to capital from Lane (2022). Panel B plots the share of value added of heavy manufacturing sector in GDP across different countries.

from 6%, which was similar to that of Greece, to 14%, surpassing the share in the US. Lane (2022) find that this temporary policy shifted South Korea's comparative advantage towards heavy manufacturing, also benefiting downstream sectors. Choi and Shim (2022b) find that through local spillovers and complementarity, this temporary policy permanently shifted the economy towards more industrialized one, with higher heavy manufacturing GDP shares. Liu (2019) theoretically shows that the government has an incentive to prioritize subsidizing upstream sector because distortions in upstream sector accumulate toward downstream sectors through input-output linkages. This suggests that the sector-specific industrial policy in South Korea have generated positive aggregate effects.

5 Conclusion

In this note, we investigate how international trade and appropriate policies can foster economic development, facilitating a transition from a low-income to a high-income country. We commence by reviewing the literature, which presents substantial evidence that openness to trade enhances technological upgrading and productivity at the firm level, as observed in developing countries liberalizing trade. Numerous studies indicate that competitive pressure from the global market incentivizes firms to enhance their products or production processes. Yet, the effects are hetero-

geneous across firms: firms lagging significantly behind foreign firms in terms of productivity respond minimally, while technologically advanced firms exhibit a stronger response. This implies that the benefits from foreign competition can materialize after a certain level of development.

Next, we concentrate on South Korea's case, presenting stylized facts and outlining the policies implemented by the government. South Korea transformed from a low-income to a high-income country within 50 years, a phenomenon often referred to as the "growth miracle" (Lucas, 1993). As the country developed, it expanded its share in goods export and patents. Furthermore, the comparative advantage gradually shifted towards the heavy manufacturing sector, as evidenced by the changes in industry and export shares. That said, there has been a noticeable increase in market and labor concentration over time.

The South Korean government implemented several key policies during this period of growth. Initially, the technology policy focused on subsidizing the adoption of foreign technologies during the early stages of development. As the country matured economically, this policy shifted from subsidizing foreign technology adoption to fostering domestic innovation. Concurrently, the government consistently reduced import tariffs over time, further integrating the country into the global economy. Another noteworthy strategy was the temporary subsidy provided to the heavy manufacturing sector during the 1970s. We collate various studies demonstrating that these three policies collectively played a significant role in driving South Korea's economic miracle, avoiding being trapped in middle-income levels.

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