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# Product Scope Adjustment to the China Shock: Competition at Home and Abroad

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# Product Scope Adjustment to the China Shock: Competition at Home and Abroad*

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**Abstract**

How does China's rise affect exporters' product scope when they compete with Chinese firms at home and abroad? Using Korean plant-level data, we find that both domestic import penetration and export competition in third markets reduce product scope. Specifically, export competition dampens new product creation, while import penetration accelerates the destruction of existing products. Eventually, both forms of competition lead to resource reallocation toward core products, highlighting distinct mechanisms through which global competition shapes product dynamics. We propose the disproportionate importance of the domestic market, the forward-looking nature of product creation, and creative destruction as potential drivers behind these responses.

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# 1 Introduction

Since China's accession to the World Trade Organization (WTO) in 2001, the share of world manufacturing exports originating in China increased from 8.6% in 2006 to 13.6% in 2018. Imports from China increased in 204 out of 223 countries between 2006 and 2018, growing 162.4% on average, and China has been the largest exporter of goods in the world since 2009.[1] Around the world, consumers gain from international trade by purchasing cheaper made-in-China products, whereas firms and workers, especially in tradeable sectors, face increased competition from China.

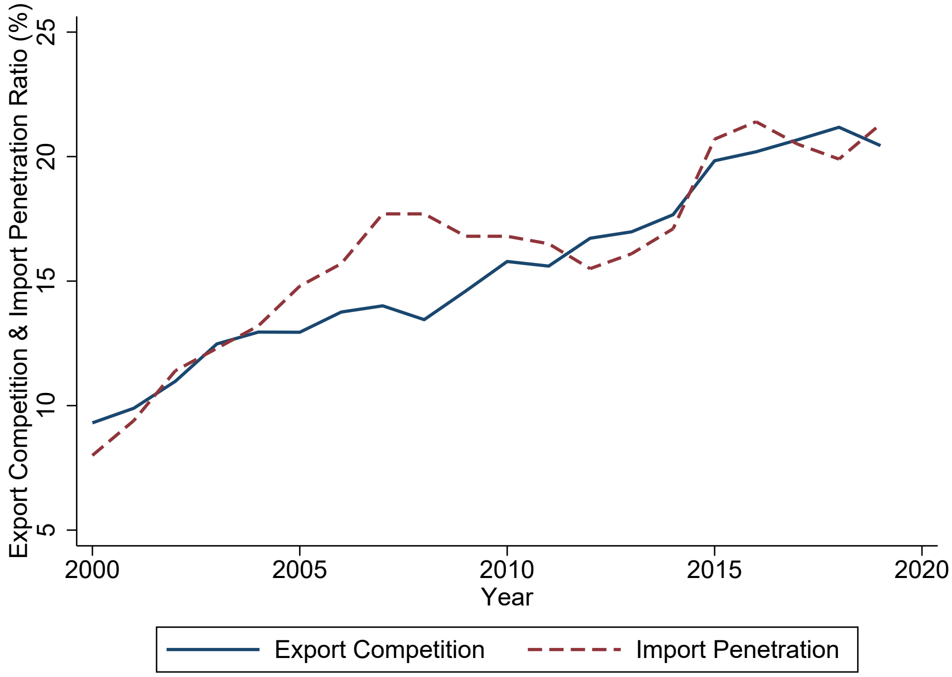
How do firms respond to competition with Chinese firms rising everywhere? In other words, how do firms respond to intensifying import penetration in the domestic market and to escalating third-market competition in export markets (henceforth, export competition) with Chinese competitors? The answers to this question are of great importance in this globalized world since competition with China is not just confined to the domestic market. Especially to firms that rely heavily on export markets, export competition with Chinese firms could be potentially as important as import penetration in their decision making.[2] However, despite its potential importance, export competition with China has been surprisingly under-explored.

We particularly think that the actual impacts of the China trade shock will be biased if researchers overlook the export competition channel. In this article, we overcome this limitation in the literature by considering both the import penetration and the export competition channels in a unified framework; and revisit the China trade shock using

[1] *Source*: UN Comtrade.

[2] Two examples from the media to spotlight export competition with Chinese firms in exports markets: (i) "[C]hinese wind-turbine makers have grown big on the back of their rapidly growing home market. Now they want to expand abroad, putting further pressure on Western wind-turbine makers, [...] In February, they signed a letter from the Brussels-based WindEurope industry group to the European Commission warning that they were losing ground as Chinese manufacturers expand across Asia, South America, and Africa (The Wall Street Journal, May 14, 2022); (ii) [W]ho is ahead in the battle to be the leading shipbuilding country in the world? [...] Worldwide, Clarkson reported that [...] China holds nearly 40 percent of the backlog while South Korea has about a third of the global order book. Shipbuilders in the two countries will continue to compete for all the new orders, while they also seek to distinguish themselves with new technologies. (The Maritime Executive, Aug 11, 2021).

Figure 1: The China Trade Shock in Korea from 2000 to 2019




*Notes:* The raw data come from the UN Comtrade. Import penetration is defined as the share of Chinese goods in Korea's total imports. Export competition is defined as the weighted average of Chinese import penetration in each country. The weight is defined as the share of Korea's export value to each country to Korea's total export value.

South Korean manufacturing plants. Korea offers an ideal setting to study this research question for the following reasons:[3] (i) as a small open economy, the exposure to export competition with Chinese firms should be pervasive among Korean manufacturers;[4] (ii) as a newly industrialized economy, the rise of Chinese firms should put substantial competitive pressure on Korean manufacturers whose technology levels are relatively close to those of Chinese competitors.[5] Indeed, Korean data suggest that export competition with China has continuously intensified highlighting its importance as shown in Figure 1.[6]

[3]Henceforth, throughout the paper, "Korea" is used to refer to the Republic of Korea (i.e., South Korea).

[4]The exports-to-sales ratio of firms in the Survey of Business Activity matched to exporting plants in the sample is as high as 28.3% on average. Moreover, around 20% of these firms earn more than 50% of revenues from abroad, highlighting their reliance on exports.

[5]di Giovanni et al. (2014) estimate that Korea is one of the top 10 most technologically similar countries to China.

[6]In Korea, the share of Chinese goods to total imported goods (import penetration) rose from 8.0 percent in 2000 to 21.3 percent in 2019. Over the same period, the average share of Chinese goods in Korea's

Moreover, from Korean exporters' perspective, the recent return of protectionist policies against China (e.g., the US-China trade war) has directly affected the competition environments in their export destination countries. Without considering the export competition channel, it would be difficult to evaluate the impacts of economic policies, let alone trade policies, on domestic firms. Accordingly, a better understanding of firms' adjustments to multi-faceted competition with Chinese firms in international trade will provide policymakers across the globe with better information in their decision making processes.

We pay particular attention to product scope adjustment of Korean manufacturing plants responding to both import penetration and export competition with China for three reasons. First, product creation and destruction are quite prevalent at the plant level. Our data show that 71.4% of Korean manufacturing plants engage in product switching activity,[7] and this prevalence is also commonly found in other countries (Bernard et al., 2010; Timoshenko, 2015). Second, since product scope adjustment implies the reallocation of resources within plants to their best use, what causes multi-product plants to adjust their product lines has important allocation implications. By taking advantage of the supply-driven, exogenous China trade shock, we are able to establish a causal inference on the product scope adjustment at the plant level in response to rising competition with China. Finally, because little is known about the impact of export competition with China, especially the differential impact of export competition and import penetration, exploring the product scope adjustment expands our understanding of the China syndrome. To our best knowledge, this article is the first such attempt to explore the differential impact of competition shocks at home and abroad on product switching behaviors.

export markets (export competition) increased from 9.3 percent in 2000 to 20.4 percent in 2019. Although these aggregate-level export competition and import penetration measures seem highly correlated over time, the correlation between *plant-level* export competition measure and import penetration measure we use throughout the paper is as low as -0.0067, underscoring the importance of distinguishing two types of competition that Korean plants faced during the period.

[7] Here, more specifically, product switching activity refers to the cases in which Korean manufacturing plants either dropped existing products or created new products between 2006 and 2018.

To explore the impact of the China shock on the product scope adjustment, we construct the *plant-level* measures of import penetration and export competition with China using the Mining and Manufacturing Survey (MMS) data from Statistics Korea, which include plant-product-level shipment information as disaggregated as 8-digit Korean Standard Industry Classification (KSIC). Specifically, we first define the *product-level* import penetration as the change in the share of imports from China relative to the size of the domestic market, similar to the standard import penetration measure in the literature (Autor et al., 2013; Acemoglu et al., 2016; Autor et al., 2020a). Then, we compute the effective exposure of a multi-product plant to multiple product-level import penetration using the product-level shipment as a weight. Compared to the commonly used product-level (or industry-level) shocks, which typically rely on a single product with the largest shipment, our plant-level import penetration measure captures the effective level of competition that each plant experiences more precisely by considering all products that multi-product plants produce.

Advancing this approach further, we consider an extra dimension to construct the *plant-level* measure of export competition since Korean exporters compete against Chinese exporters not only in their domestic market but also in their export markets: the new dimension—exporters can sell their products to multiple export destination countries. Specifically, we define the product-level export competition with China considering this new dimension building on Kang (2025) and compute the effective exposure of a multi-product plant to this product-level export competition using the product-level shipment similar to the import penetration measure. First, before accounting for multiple export markets, we measure the *product-level* competition with China in each export destination country as the change in the share of imports from China relative to the imports from Korea and China in that country. Then, the effective exposure to the rise of competition with China in multiple export markets is computed as a weighted sum of these Chinese shares using the importance of each destination country to Korean exports as a weight to construct the product-level export competition with China. Finally, similar to the import penetration measure, we incorporate the plant-level shipment information to reflect all products that multi-product plants manufacture to capture a precise intensity of export competition each plant perceives at the plant level.[8]

Equipped with these two plant-level measures of the China trade shock, we examine the impact of the China shock on the product scope adjustment between 2006 and 2018.[9] [10] The empirical evidence shows that Korean manufacturing plants reduce their scope of products facing more intense import penetration at home and, more importantly, export competition in third markets with China. However, the responses to the China shock are heterogeneous in that only exporting plants reduce their product line. We conjecture that there are three reasons for this observed pattern. First, since product switching activity requires substantial adjustment costs, exporters, who typically have more resources than non-exporters, can afford to engage in product restructuring behavior. Second, unlike non-exporters focusing on the domestic market, exporters are more likely to perceive competition in foreign markets as immediate threats because they are directly involved in exporting activity. Third, exporters may engage in product switching more actively to address heterogeneous changes in multiple markets that they sell.

[8]The most comparable, micro-level approaches, taking into account the multi-product dimension in measuring the China trade shock, has been done by Aghion et al. (2021) and Ding et al. (2022) at the firm level. They use firm-product-level information to compute the weighted sum of the China trade shock similar to our approach using French data and US data, respectively. However, Aghion et al. (2021) only focus on import penetration in the domestic market, and Ding et al. (2022) considers the increase of Chinese share of imports in a single market, Europe. In contrast, we consider all possible markets where competition with China occurs and directly compare the differential impact of import penetration and export competition to capture the complete effect of the China trade shock at the plant level.

[9]To identify the impact of the exogenous rise of China, we instrument the import penetration measure using other countries' imports from China as in Autor et al. (2013).

[10]The "China Shock" is commonly defined as the surge in China's manufacturing exports from 1990 to 2007, driven by productivity gains from economic reforms and WTO accession. In contrast, our paper examines 2006–2018. While this choice is partly motivated by data availability, a more fundamental reason is that the technology gap between South Korea and China narrowed substantially over this period, at least until very recently. While Korea dominated high-tech industries in the early 2000s and China served mainly as a low-cost manufacturing base, China's large-scale industrial policies, rising R&D investment, and rapid technological catch-up from the late 2000s onward enabled it to compete directly with Korea in medium- and high-technology sectors. As a result, China's export competition in the 2010s reflects not only low costs but also technological upgrading, making its impact on Korean firms fundamentally different from the earlier China Shock.

To better understand the product scope adjustment for exporters, equipped with the disaggregated datasets, we dissect the changes in the number of products into the creation of new products and the destruction of old products to explore the margin of adjustment. We find a stark contrast between the impacts of import penetration and export competition: (i) product creation declines only in response to tougher export competition; while in contrast (ii) product destruction increases only facing more intense import penetration. As economists have rarely paid attention to export competition, the differential impacts of export competition and import penetration on the margin of product scope adjustment add new findings to the literature.

To understand the mechanisms behind the increase in product destruction due to import penetration, we notice a tendency that the domestic market is more likely to serve as a core market. Therefore, competitive pressure in the domestic market is more likely to threaten the survival of existing products. However, since export competition in non-core markets could be buffered by other markets, including the domestic market, it does not necessarily lead to the drop of products from a plant's product portfolio. In other words, product destruction seems to happen only if the core market is under threat.

Turning to the decrease in product creation due to export competition, we focus on the forward-looking nature of product creation activity. As tighter competition in export markets makes the introduction of new products more risky and/or less profitable, exporters react by decreasing the creation of new products that target export markets. This is especially relevant to Korean exporters because their domestic market is relatively small and thus export markets are crucial in their expansion in a forward-looking manner. Since export competition shrinks the effective size of export markets, it diminishes exporters' incentive to expand toward export markets by introducing new products to those markets. (Iacovone and Javorcik, 2010).

By the same logic, import penetration is expected to discourage new product creation targeting the domestic market. However, the insignificant impact of import penetration on product creation implies that there should be some countervailing forces. We speculate creative destruction as a potential explanation that offsets the downward pressure. More specifically, facing the rise of competition in the core domestic market, manufacturing plants drop products exposed to survival threats and introduce new products that are resilient to competition. Indeed, our results show that non-exporters, who are more likely to be threatened by the deteriorating domestic market, increase the creation of new products facing the import penetration shock, which may arise from the creative destruction channel that we hypothesize.

Finally, to understand the allocation consequences of this product scope adjustment to the China shock, we examine how import penetration and export competition affect the product diversification of Korean exporting plants. We find that import penetration decreases the product diversification of plants, which means that resources are reallocated toward core products. This result is consistent with the robust prediction of theoretical models in the literature in that multi-product firms drop the least productive products and focus on products they have comparative advantages with facing adverse conditions.

Moreover, we show that export competition with China also results in stronger product specialization of plants. This result is surprising since it is ex-ante not clear how export competition affects product diversification of plants. First, since the most competitive product in each market could be different, specialization in each market may not lead to specialization at the plant-level. Second, it is not clear how adding fewer new products affects the product diversification of plants. On the one hand, adding new products could increase product diversification since there are more products with positive shipment share. On the other hand, new products with better quality could dominate others, for instance, which increases product specialization instead.

## 2 Related Literature

Our study is related to two strands of literature in economics that have developed separately: (i) the China trade shock and (ii) multi-product firms. The unprecedentedly rapid growth of Chinese exports after its accession to the WTO has sparked active research in the impacts of the China trade shock in a variety of contexts. Not only have economists investigated the impacts of import penetration from China on labor markets (Autor et al., 2013; Acemoglu et al., 2016; Choi and Xu, 2020), innovation (Autor et al., 2020a; Bloom et al., 2016), political outcomes (Autor et al., 2020b), environmental outcomes (Choi et al., 2025), but they also have expanded our understanding beyond its direct import penetration channel by exploring offshoring to China (Mion and Zhu, 2013), exporting to China (Feenstra et al., 2019), and input-output linkages related to Chinese intermediate inputs (Caliendo et al., 2019; Aghion et al., 2021; Ding et al., 2022). However, export competition with China around the world, along with its measurement, mechanisms, and consequences, has been under-explored.

There are some papers that examine the impact of competition with China in third markets. For instance, how an increase in US imports from China affects Mexican outcomes such as labor markets (Utar and Ruiz, 2013; Mendez, 2015; Robertson et al., 2020), firm activities (Iacovone et al., 2011, 2013), female bargaining power (Majlesi, 2016), migration (Majlesi and Narciso, 2018), and crime (Dell et al., 2019) have been studied. More recently, Ding et al. (2022) study the impact of an increase in the Chinese share of imports in European markets on US firms' employment and sales.[11] However, all of these studies focus solely on one export market, the United States or Europe. To our best knowledge, the only two exceptions are Kang (2025) and Medina (2024), who take all export markets

[11] Technically speaking, since Ding et al. (2022) examine the impact of the change in the Chinese share of imports in Europe on US firms, it can be understood as the impact of export competition with China in Europe on US firms. However, the authors rely on the change in Europe not because of Europe's importance as an export market but because of its exogeneity to US firms' decision. In contrast, we emphasize the importance of other countries as export markets explicitly by considering the share of Korean exports to each country and the exporting behavior of plants.

and the relative importance of each market into account.[12] [13]

While Kang (2025) and Medina (2024) focus on innovation among Korean manufacturers and quality upgrading among Peruvian apparel firms, our focus lies in product scope adjustment. This emphasizes how producers reallocate resources through product addition and drop (extensive margin) and changes in product-level output (intensive margin). This form of adjustment is not only more prevalent than innovation,[14] but also crucial in understanding how firms enhance their competitive capacity and restructure their operations in response to external shocks.

At the same time, we show that export competition and import penetration affect different margins of product scope adjustment, highlighting the importance of distinguishing these two different shocks. Further, by studying the product scope adjustment, we bridge the China shock literature to another large literature investigating the product switching behavior of multi-product firms that has been developed in parallel.

Given that the significant share of sales (and exports) is accounted for by multi-product firms (Bernard et al., 2005, 2010), much attention has been paid to how multi-product firms respond to trade shocks both theoretically and empirically. Trade models robustly predict that multi-product firms drop the least efficient products and focus on core products facing more intense competition (Eckel and Neary, 2010; Bernard et al., 2010, 2011; Mayer et al., 2021). However, the empirical evidence is more nuanced. This churning effect is empirically supported in developed countries including U.S. (Bernard et al., 2011; Liu, 2010; Liu and Rosell, 2013), Canada (Baldwin and Gu, 2009), and France (Mayer et al., 2021). In contrast, Goldberg et al. (2010) show that dropping obsolete products rarely

[12] Beyond the China shock, Kang (2024) examines Korean manufacturing firms' responses to export competition arising from the 2004 and 2007 EU enlargements, considering all export destinations.

[13] In a broader context, Lim et al. (2022) also consider competition in foreign markets and develop a theory of competitive cascades, which emphasizes a quality segment of the market. They investigate how scale and competition in a quality segment ahead/behind firms affect their innovation decisions. They capture competition in export markets at the product level, whereas our measure of export competition is specifically designed to capture competition with Chinese firms in export markets at the plant level.

[14] Bernard et al. (2010) document the widespread nature of product switching, and it is well known that innovation is concentrated among a small subset of firms (Aghion et al., 2022; Kang, 2025).

happens in India, suggesting the importance of frictions.[15]

We add to this product switching literature in four meaningful ways. First, and most importantly, because we make the most of the supply-driven, exogenous China trade shock linking the China shock literature to the multi-product firms literature, our findings not only shed new light on these two separate lines of literature, but we are also able to establish *causal* relationships. Second, by differentiating the China trade shock into import penetration at home and export competition abroad, we are able to show the differential consequences of these two shocks on product churning behaviors at the plant level. That is, import penetration increases the destruction of existing products while export competition weakens the creation of new products. The differential impacts of import and export competition may give us a new way to think about why the existing empirical evidence has been mixed. Third, consistent with the (robust) predictions from trade models, we found that tighter competition induces the reallocation of resources toward core products, leveraging new types of trade shocks. Fourth, exploring more countries with different economic environments, specifically Korea in this paper, will be a meaningful addition to the multi-product firms literature.

[15]There have been a few studies to analyze the China shock from the perspective of a multi-product firm, while not focusing on product switching activity. Examples include firm-product technical efficiencies (Dhyne et al., 2017), product differentiation (Hombert and Matray, 2018), and employment (Hyun et al., 2022), to name a few. Different from this line of research, using Korean data, we focus on analyzing the impacts of the China trade shock on the plant-level product scope adjustment — both creation and destruction. Our study investigates how efficiently a plant responds to the external shock by reallocating its resources within a plant. More importantly, we introduce the new concept of export competition with China in the global market and analyze its impact on the product scope adjustment at the plant level.

# 3 Data

## 3.1 Data Sources

Our primary dataset is the Mining and Manufacturing Survey (MMS) from Statistics Korea for the period between 2006 and 2018,[16] an annual plant-level panel survey.[17] The variables in the MMS include general information about plant activities such as shipments, employment, wage bills, value-added, and tangible capital. Importantly, the MMS also includes shipments of each 8-digit level Korean Standard Industry Classification (KSIC) product that a plant manufactures. This disaggregated product-level shipment information allows us to analyze product switching behaviors of plants.[18] Moreover, this plant-product-level information is used to generate precise measures of import penetration and export competition with China that each plant faces during the sample period.

We supplement the MMS data with plant-level export information collected by Korea Customs Service (KCS).[19] The KCS data include plant IDs with a positive amount of export and the rank of some countries to which the plants export. By matching the two datasets, we are able to investigate differential responses between exporters and non-exporters to competition with Chinese firms, especially Korean exporters' competition with Chinese firms in other countries.

To capture rising competition with Chinese firms, we use international trade flows data, which are originally sourced from the United Nations Commodity Trade Statistics Database (UN Comtrade). The UN Comtrade provides standardized official trade statis-

[16]The sample period starts in 2006 because the disaggregated product-level shipment information is available from 2006 for this project. Admittedly, the information is available even before 2006 from Statistics Korea. However, we were able to get access to the restricted product-level information as early as 2006. Additionally, we can identify the value, but not the quantity, of a product.

[17]Before 2008, the survey collected plant-level information from plants hiring at least 5 employees. However, the survey criteria were changed in 2008, and it then reports only plants with at least 10 employees. As the datasets of 2006 and 2007 contain plants hiring 5-9 employees, we drop the plants with 5-9 employees in 2006 and 2007 to make it consistent across years.

[18]Hur and Yoon (2018) also used the MMS dataset, over the period 2008-16 to investigate the impact of US-Korea FTA on Korean firms' product churning and dynamics.

[19]The KCS database is confidential. Permission to use the dataset through purchase was arranged between the authors and KCS.

tics reported by countries reflecting 99 percent of world merchandise trade. It covers over 200 reporting countries and more than 6,000 different products at the 6-digit Harmonized System (HS) product level. We match the 6-digit HS product code in UN Comtrade to the product code in the MMS data, which is reported at the 8-digit Korean Standard Industry Classification (KSIC) product level, by using the 5-digit Industrial Statistics Analysis System (ISTANS) product code developed and managed by Korean Institute for Industrial Economics and Trade (KIET).[20] More specifically, we retrieve bilateral UN Comtrade data from the ISTANS website,[21] which converts a 6-digit HS product to a 5-digit ISTANS product. Then, we link the 8th revision and the 10th revision KSIC codes in the MMS data to 5-digit ISTANS codes using the concordance table provided by KIET. Through this procedure, we can construct consistent product codes that enable us to assign trade shocks to plant-level shipment information in a precise manner. Appendix A describes the data sources more in detail.

## 3.2 Measuring Plant-Level Trade Shocks

Equipped with the detailed datasets, we measure *plant-level* competition with China's rising share of manufacturing products in the world from two perspectives: i) import penetration at home and ii) export competition in third markets. Typically, the China trade shock is defined at the industry- or region-level import penetration in a domestic market (Autor et al., 2013; Acemoglu et al., 2016). However, in such measures, it would be difficult to answer the product adjustment mechanism (i.e., our main research question) in response to the China shock because plants, not industries or regions, ultimately adjust a product portfolio. Hence, we depart from measuring the China shock at the industry- or region-level, but gauge competition with China at the more disaggregated level, i.e., the plant level. Moreover, taking advantage of the plant-product-level dataset, which shows

[20] KIET is an affiliate of Korean Ministry of Trade, Industry, and Energy.

[21] http://www.istans.or.kr.

the composition of each plant's shipments by product, we further incorporate the multi-product dimension when measuring competition with China.

**Import Penetration** More specifically, we compute the weighted sum of import penetration in each product at the plant level, where the weight is defined as a product's share of total shipments in each plant. Combining this detailed multi-product feature at the plant level, import penetration for a plant $i$ between 2006 and 2018 is defined as follows:

$$\Delta IP_i = \sum_k \frac{y_{ik,06}}{y_{i,06}} \frac{\Delta M_{k,06-18}^{CNtoKR}}{Y_{k,06}}, \tag{1}$$

where $y_{ik,06}$ is plant $i$'s shipment of product $k$ in 2006, $y_{i,06}$ is the total shipment of plant $i$ in 2006, $Y_{k,06}$ is the total Korean shipment of product $k$ in 2006, and $\Delta M_{k,06-18}^{CNtoKR}$ is the change in Korea's total imports of product $k$ from China between 2006 and 2018.

The import penetration in equation (1) may yield endogeneity issues to establish causality if unobserved error terms simultaneously affect the import penetration and the outcome variable (i.e., omitted variable bias). Also, the outcome variable may impact the import penetration (i.e., reverse causality). To mitigate such endogeneity concerns, similar to the methodology adopted in the literature in (Autor et al., 2013; Acemoglu et al., 2016), we construct an instrument variable as follows:

$$\Delta IPADH_i = \sum_k \frac{y_{ik,06}}{y_{i,06}} \frac{\Delta M_{k,06-18}^{CNtoOTH}}{Y_{k,06}}, \tag{2}$$

where $\Delta M_{k,06-18}^{CNtoOTH}$ is the change in other countries' imports of product $k$ from China between 2006 and 2018.[22]

**Export Competition** In addition to measuring import penetration at the plant level,

[22] We use the imports in Australia, Denmark, Finland, Germany, Japan, New Zealand, Spain, and Switzerland to construct an instrument variable following Autor et al. (2013).

in this paper, we depart from the existing studies by considering export competition with China in third markets.[23] For instance, suppose that Korean firms export a certain product to a third country. In the same product market in the third country, if Chinese firms start to penetrate the third-country product market, then the Korean firms will face competitive pressures, just as they encounter rising competition from Chinese firms in Korea. We think this export competition is particularly important for firms relying heavily on export markets and/or that are similar to Chinese competitors in terms of the level of production technology. In this regard, export competition with China is expected to be another competition margin to Korean firms in addition to import penetration from China in their domestic market. However, only few studies have investigated competition with China in export markets despite its potential importance.

To gauge export competition with China, we build on the export competition measure originally developed in Kang (2025) who uses the weighted sum of competition in third countries. By using a more disaggregated dataset at the plant-product level, we construct export competition with China for a plant $i$ between 2006 and 2018 as follows:

$$\Delta XC_i = \sum_k \frac{y_{ik,06}}{y_{i,06}} \sum_S \frac{X_{k,06}^{KRtoS}}{\sum_{S'} X_{k,06}^{KRtoS'}} \frac{\Delta X_{k,06-18}^{CNtoS}}{X_{k,06}^{CNtoS} + X_{k,06}^{KRtoS}}, \tag{3}$$

where third country $S$ (or $S'$) refers to all possible destination countries other than China and Korea. $X_{k,06}^{KRtoS}$ and $X_{k,06}^{CNtoS}$ are Korea's total exports and China's total exports of product $k$ to third country $S$ in 2006, respectively. $\Delta X_{k,06-18}^{CNtoS}$ is the change in China's total exports of product $k$ to third country $S$ between 2006 and 2018.

The measure in equation (3) is constructed as a weighted sum of the change in China's

[23]Here, third markets (or countries) refer to any countries other than China and Korea. Note that export competition defined in this paper is clearly different from an export shock as a result of the new market opportunities used in Dauth et al. (2014), Feenstra et al. (2019), and Choi and Xu (2020). In these papers, instead of capturing competition, the export shock measures foreign demand shocks that drive exports from Germany, the US, and Korea, respectively. Note further that it is also different from competition induced by positive export demand shock as in Aghion et al. (2022). In their paper, increased demand in export markets attracts the entry of firms, which thereby intensifies competition. However, our export competition focuses on competition between Korean exporters and Chinese exporters in third markets, mostly driven by the Chinese spectacular export growth.

share in total imports from China and Korea in a third market between 2006 and 2018 using two weights: (i) the share of each product $k$ for plant $i$; and (ii) the importance of each market $S$ to Korea. More specifically, it takes into account plant $i$'s reliance on product $k$, the importance of market $S$ for Korea's total exports of product $k$,[24] and the growth of China's total exports of product $k$ to market $S$. We normalize the change in China's total exports in each third country with its total imports from China and Korea to emphasize the substitution between the two countries in market $S$.

Notice that the time variation of this measure comes only from China's total exports to third country $S$, which is irrelevant with the behavior of Korean plant $i$. Our key identifying assumption for a valid research design is the exogeneity of this change in third countries, which is similarly assumed by Autor et al. (2013) for their instrument variable and validated by Borusyak et al. (2022). Accordingly, we consider this measure of export competition as reflecting an exogenous shock.

## 3.3 Measuring Plant-Level Product Scope Adjustment

We aim to explore how competition with China both in the domestic market and export markets affects resource allocation within a plant through product switching behaviors. Since more intense competition imposes downward pressure on profits, one of the natural responses to escape from competition is to reallocate resources toward products with less fierce competition. To examine whether competition with China incurs such product churning consequences, following Bernard et al. (2010), we measure the change in the number of products (either at the 5-digit level or the 8-digit level). In addition, we de-

[24] The reliance on market $S$ for Korean export product $k$ is the key component that delineates between an instrument for import penetration in equation (2) and export competition in equation (3). For some reason Korean firms export a product $k$ to a particular country $S$ relatively more than country $S'$. This relationship may originate from fixed costs associated with the entry into a new export market, including information costs, regulation barriers, and setting up distributional channels, all of which are specific to each export market. Hence, Korean firms' export destination markets can differ across products. After this weight is combined with China's total exports of product $k$ to market $S$, the export competition measure then captures competition with Chinese firms in third markets, which is different from import penetration at home.

compose the change in the number of products into the creation of new products and the destruction of existing products to analyze whether the margin of adjustment differs by the type of competition.

More formally, the change in the number of products in response to competition with China at the plant level can be attributed to two different margins in a dynamic setting as follows:

$$\Delta N_i = New_{i,06-18} - Dropped_{i,06-18}, \tag{4}$$

where $\Delta N_i$ is the change in the number of products that plant $i$ manufactures between 2006 and 2018; $New_{i,06-18}$ is the number of new products for plant $i$ added between 2006 and 2018; $Dropped_{i,06-18}$ is the number of existing products for plant $i$ discarded between 2006 and 2018.[25] [26]

For instance, suppose that plant A producing one KSIC-5-digit product, Electronic Integrated Circuits (32112) in 2006, exited the market between 2006 and 2018; while plant B producing three KSIC-5-digit products, Electronic Integrated Circuits (32112), Apparatuses for Switching, Protecting Electrical Circuits Used in Power Distribution Systems (31201), and Wire Telecommunication Apparatuses (32201) in 2006, switched to produce two KSIC-5-digit products, Electric Lamps and Bulbs (28410) and Ballasts for Lamps (28113), in 2018. Then, the changes in the number of products are -1 for both plants A and B, respectively, which does not reveal the different product switching behaviors between the two plants. However, by decomposing the change in the number of products into product creation and product destruction, we are now able to distinguish how the two plants responded differently. To be specific, the number of product creations is 0 for

[25] In practice, the number of products of exiting plants is set to be zero to take into account the exit of plants during the sample period. To put it another way, we are able to capture the extensive margin adjustment. In contrast, although there are plants that entered the market during the sample period, we disregard these plants because the measures of the trade shock cannot be defined for them.

[26] Kang et al. (2026) adopt a similar decomposition approach. Using Korean firm-level data on chemical substances, they decompose changes in chemical usage into the adoption of new chemicals and the discontinuation of existing ones. They find that, in response to tighter environmental regulations, firms primarily reduce overall chemical usage by curbing the introduction of new hazardous substances rather than by eliminating those already in use.

plant A and 2 for plant B, whereas the number of product destructions is 1 for plant A and 3 for plant B, respectively.

In addition, to examine whether this product switching activity results in the reallocation of resources across products within plants, we use the Entropy index of product diversification (the inverse of specialization) following Baldwin and Gu (2009). The change in the Entropy index of plant $i$ between 2006 and 2018 is defined as follows:

$$\Delta E_i = \sum_{k}^{N_{i,18}} s_{ik,18} \ln(1/s_{ik,18}) - \sum_{k}^{N_{i,06}} s_{ik,06} \ln(1/s_{ik,06}), \tag{5}$$

where $s_{ik,t}$ denotes plant $i$'s shipments share of product $k$ at time $t$; $N_{i,t}$ refers to the total number of products of plant $i$ at time $t$. The measure of product diversification $E_{i,t}$ is, by construction, zero when only a single product is produced and is maximized at $ln(N_{i,t})$ when shipments are evenly spread across $N_{i,t}$ distinct products. In this regard, a negative value of $\Delta E_i$ indicates an increase in specialization.[27]

### 3.4 Summary Statistics

Table 1 shows the mean, standard deviation, and the number of observations for the key variables used in the analysis. We categorize plants in the sample based on their exporting status in 2006 and thus the summary statistics are presented as the full sample, exporters, and non-exporters, respectively. There are 27,969 manufacturing plants in our sample (11,604 plants are exporters; 16,365 plants are non-exporters).[28] Among the total manufacturing plants in the sample in 2006, 13,341 plants (6,144 exporters; 7,197 non-exporters) remained in the sample in 2018.[29] To put in another way, the survival rate between 2006 and 2018 is 47.7 percent for entire plants (52.9 percent for exporters; 44.0 percent for non-exporters). Note that the survival rate is about 9 percentage points higher for exporters

[27] Note that the product diversification measure, $E_{i,t}$, is defined only for surviving plants.

[28] We drop the mining sector from the MMS, which covers both the mining and the manufacturing sector.

[29] This means that the rest 14,628 plants (5,460 exporters; 9,168 non-exporters) had stopped operation and exited the market between 2006 and 2018.

than non-exporters.

Panel A of Table 1 presents variables related to product scope adjustment. Columns (1), (2), and (3), i.e., the full sample, show that on average the number of products that each plant produces decreases by 0.638 from 1.209 between 2006 and 2018. This change is due to the destruction of old product by 0.812, which is partly offset by the creation of new product by 0.174. The comparison between exporting plants and non-exporting plants reveals that exporting plants engage more actively in both product creation and product destruction than non-exporting plants do (see columns (4) through (9)). Exporters drop 0.024 more products and create 0.064 more products than non-exporters between 2006 and 2018. Combining product creation and destruction, the number of products decreases by 0.615 for exporters and by 0.655 for non-exporters, respectively. The measure of product diversification ($\Delta E$) also reveals that exporters (-0.027) reallocate resources towards core products more than non-exporters (-0.011) do, conditional on survival.

Noticeably, while non-exporting plants appear to engage more actively in product switching behavior by just looking at the change in the number of products, the opposite is true in that product turnover in terms of both product creation and product destruction has been more prevalent for exporters. This is the reason why it would be important to separate the product creation from the product destruction when we investigate plant-level product scope adjustment.

Panel B of Table 1 also shows that exporters and non-exporters are heterogeneous. On average, exporting plants produce more, have more capital, hire more employees, generate more value-added, and are older than non-exporting plants in 2006. That is, exporters tend to have more resources than non-exporters, and the differences are quite noticeable in magnitude.

Panel C of Table 1 presents variables related to the China trade shock during the sample period. On average, import penetration along with its instrument and export competition at the plant level all increase during the sample period. This is true for both

Table 1: Summary Statistics

| Sample: | 1. Full | | | 2. Exporters | | | 3. Non-Exporters | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mean | SD | OBS | Mean | SD | OBS | Mean | SD | OBS |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| *Panel A. Dependent Variables* | | | | | | | | | |
| $\#\ of\ Products$ (2006) | 1.209 | 0.570 | 27,969 | 1.277 | 0.674 | 11,604 | 1.160 | 0.477 | 16,365 |
| $\Delta N$ | -0.638 | 0.795 | 27,969 | -0.615 | 0.875 | 11,604 | -0.655 | 0.733 | 16,365 |
| $Dropped_{06-18}$ | 0.812 | 0.699 | 27,969 | 0.826 | 0.766 | 11,604 | 0.802 | 0.647 | 16,365 |
| $New_{06-18}$ | 0.174 | 0.450 | 27,969 | 0.211 | 0.503 | 11,604 | 0.147 | 0.407 | 16,365 |
| $\Delta E$ | -0.018 | 0.270 | 13,341 | -0.027 | 0.294 | 6,144 | -0.011 | 0.248 | 7,197 |
| *Panel B. Control Variables* | | | | | | | | | |
| Log capital per capita | 10.583 | 1.364 | 27,911 | 10.726 | 1.281 | 11,583 | 10.482 | 1.412 | 16,328 |
| Log wage per capita | 10.019 | 0.384 | 27,969 | 10.101 | 0.366 | 11,604 | 9.962 | 0.386 | 16,365 |
| Log value-added | 14.476 | 1.269 | 27,793 | 14.902 | 1.366 | 11,526 | 14.175 | 1.101 | 16,267 |
| Age | 10.615 | 9.223 | 27,969 | 12.587 | 10.208 | 11,604 | 9.217 | 8.173 | 16,365 |
| *Panel C. Competition Measures and Instrument* | | | | | | | | | |
| $\Delta IP$ | 0.118 | 0.280 | 27,969 | 0.141 | 0.294 | 11,604 | 0.102 | 0.268 | 16,365 |
| $\Delta XC$ | 0.317 | 0.661 | 27,969 | 0.305 | 0.659 | 11,604 | 0.325 | 0.663 | 16,365 |
| $\Delta IPADH$ | 0.451 | 1.172 | 27,969 | 0.553 | 1.406 | 11,604 | 0.377 | 0.966 | 16,365 |

*Notes:* The table presents the mean and standard deviation (SD) of the main variables used in the empirical analysis. OBS denotes the number of observations. The sample is restricted to the manufacturing sector. $\Delta$ refers to the change between 2006 and 2018. In Panel A, the number of products is measured at the KSIC-5-digit level. $\Delta E$ is a measure of product diversification, which is defined only for surviving plants. In Panel B, all variables are measured at the plant level in 2006. In Panel C, $\Delta XC$ is divided by 10 to make it comparable to $\Delta IP$.

exporters and non-exporters. Consistent with the broader measures of import penetration and export competition defined at the country level (i.e., Korea) shown in Figure 1, plant-level measures of the China trade shocks increase between 2006 and 2018.

# 4 Main Results

## 4.1 Empirical Strategy

We relate plant-level changes in the number of products to changes in plant-level exposures to both Chinese import penetration and export competition in third-country markets. The regression equation is as follows:

$$\Delta N_i = \alpha + \beta_1 \Delta IP_i + \beta_2 \Delta XC_i + \delta X_i + \psi_{IND(i)} + \varepsilon_i, \tag{6}$$

where $i$ indicates plant and $IND$ denotes industry. The dependent variable, $\Delta N_i$, is the change in the number of products that plant $i$ produces between 2006 and 2018. $\Delta IP_i$ ($\Delta XC_i$) is import penetration (export competition) for a plant $i$ between 2006 and 2018. To account for plant-level heterogeneity, we add $X_i$, a vector of plant-level control variables in 2006. Industry fixed effects $\psi_{IND(i)}$ are included at the 4-digit level where industry denotes to which plant $i$'s product with the largest shipment value belongs in 2006.

Our coefficients of interest are $\beta_1$ and $\beta_2$. The first coefficient, $\beta_1$, denotes the impact of Chinese import penetration on plant-level outcomes; the second coefficient, $\beta_2$, captures the impact of export competition with China on plant-level outcomes. To identify the causal effect of rising competition with China on product switching behavior, we employ a two-stage least-squares (2SLS) strategy that accounts for the potential endogeneity issue. More specifically, the endogenous variable $\Delta IP_i$ is instrumented by $\Delta IPADH_i$ to capture the exogenous component of Chinese imports. The export competition variable, $\Delta XC_i$, gauges the exogenous component of China's rising comparative advantage and falling trade costs. Estimates are weighted by the number of employees in each plant in 2006. Standard errors are clustered at the firm level to account for potential correlations across plants within multi-plant firms.

## 4.2 The First-Stage Relationship

Before presenting the main estimation results in equation (6), we check whether there is a sufficient degree of association between the endogenous explanatory variable ($\Delta IP_i$) and the instrument ($\Delta IPADH_i$). Table 2 shows the first-stage estimation results. In column (1), we regress the endogenous variable $\Delta IP_i$ on the instrument $\Delta IPADH_i$ and control variables along with industry fixed effects; in column (2), we include $\Delta XC_i$ additionally as a regressor. All coefficients of $\Delta IPADH_i$ are positive and statistically significant at the one percent level across columns. The Kleibergen-Paap F-statistics against the null of weak identification is 303.06 for column (1) and 302.24 for column (2), both of which are well above the Stock and Yogo critical values. Therefore, we reject the null hypothesis that the instrument is irrelevant in the first-stage regression.

Table 2: First-Stage Results

| | Dependent Variable: $\Delta IP_i$ | |
|---|---|---|
| | (1) | (2) |
| $\Delta IPADH_i$ | 0.211*** | 0.211*** |
| | (0.012) | (0.012) |
| $\Delta XC_i$ | | 0.010*** |
| | | (0.002) |
| 1st stage F-statistics | 303.060 | 302.237 |
| Observations | 27,735 | 27,735 |

*Notes:* All models include plant-level control variables (i.e., log capital per capita, log wage per capita, log value-added, and age) and ISTANS 4-digit industry level fixed effects. Standard errors are clustered at the firm level. All estimates are weighted by the number of employees of each plant in 2006. The first-stage F-statistics refers to Kleibergen-Paap F-statistics. *** p<0.01, **p<0.05, * p<0.1.

### 4.3 2SLS Results

Having established the relevance condition of our instrumental variable strategy, we now present the second-stage results that identify the impact of import penetration and export competition on the product scope at the plant level. Table 3 shows the 2SLS estimation results. We begin by estimating equation (6) with the import penetration channel only using an ordinary least squares (OLS) method. The OLS coefficient of column (1) is -0.358 and is statistically significant at the five percent level, revealing that there is a negative correlation between import penetration and the number of products at the plant level. In column (2), we estimate the same empirical specification as in column (1), but using a

2SLS method where we instrument $\Delta IP_i$ with $\Delta IPADH_i$. The 2SLS coefficient of column (2) is -0.620 and is still statistically significant at the five percent level.[30] The statistically significant 2SLS estimate allows us to establish a *causal* relationship. Quantitatively, a one standard deviation increase in import penetration is predicted to reduce the number of products by 0.174 at the plant level.[31]

Table 3: Product Churning, Import Penetration, and Export Competition

| | Dependent Variable: $\Delta N_i$ | | | | |
|---|---|---|---|---|---|
| Estimation Method: | OLS | IV | OLS | OLS | IV |
| | (1) | (2) | (3) | (4) | (5) |
| $\Delta IP_i$ | -0.358** | -0.620** | | -0.353** | -0.616** |
| | (0.144) | (0.309) | | (0.143) | (0.308) |
| $\Delta XC_i$ | | | -0.140** | -0.134** | -0.129** |
| | | | (0.060) | (0.059) | (0.058) |
| 1st stage F-statistics | | 303.060 | | | 302.237 |
| Observations | 27,735 | 27,735 | 27,735 | 27,735 | 27,735 |

*Notes:* All models include plant-level control variables (i.e., log capital per capita, log wage per capita, log value-added, and age) and ISTANS 4-digit industry level fixed effects. Standard errors are clustered at the firm level. All estimates are weighted by the number of employees of each plant in 2006. Columns (2) and (5) report the 2SLS results instrumenting $\Delta IP_i$ with $\Delta IPADH_i$. The remaining columns report the OLS results. The first-stage F-statistics refers to Kleibergen-Paap F-statistics. *** p<0.01, **p<0.05, * p<0.1.

Turning to the export competition channel, in column (3), we begin by relating the export competition shock and the number of products without the import penetration channel. The coefficient of -0.140 is statistically significant at the five percent level. Quantitatively, a one standard deviation increase in export competition is predicted to reduce the number of products by 0.093 at the plant level.[32] While the product churning effect has been investigated in the context of import penetration in the *domestic market*, to our knowledge, the finding that *export competition* decreases the number of products is new to

[30]Comparing the two estimates, the OLS estimate appears to be biased towards zero.

[31]A one standard deviation increase in import penetration is equal to 0.280 (see Table 1). Hence, the treatment effect is calculated as follows: -0.620 $\times$ 0.280 = -0.174.

[32]A one standard deviation increase in export competition is equal to 0.661 (see Table 1). Hence, the treatment effect is calculated as follows: -0.140 $\times$ 0.661 = -0.093.

the international trade literature. To further explore the robustness of the export competition channel, in column (4), we use both the import penetration variable and the export competition variable and perform an OLS regression. The results are barely changed, relative to the specifications in columns (1) and (3), respectively.

Finally, in our most preferred specification, we perform a 2SLS regression, including both the import penetration and the export competition variables. Column (5) shows that both import penetration from China and export competition with China in third countries decrease the number of products. Both coefficients are statistically significant. Quantitatively, a plant that experiences a one standard deviation higher import penetration from China decreases the number of products it produces by 0.172. Similarly, a plant facing a one standard deviation higher export competition with China decreases the number of products it produces by 0.085.

When the mean value of the change in import penetration (0.118) and export competition (0.317) in Table 1 are considered, these coefficients imply that the average plant (in terms of import penetration and export competition) decreases 0.073 product and 0.041 product facing stronger import penetration and export competition, respectively. Since the number of products that manufacturing plants in the sample produce at the beginning is 1.209 on average, these results suggest that the average plant decreases the number of products by 9.4% facing tougher competition with China.[33]

All in all, we confirm two channels of product churning at the plant level: i) import penetration in the domestic market; ii) export competition in third markets.[34] Put another way, Korean manufacturing plants respond to competition with China by reducing the number of products they manufacture to escape from competition. This core finding is not only consistent with the results in the literature (Bowen and Wiersema, 2005; Liu, 2010) such that plants reallocate their resources to more efficient products facing negative import penetration shocks, but it also sheds new light on the unexplored channel through

[33]The following back-of-the-envelope calculation is used: (0.073+0.041) / 1.209 = 0.094.
[34]The first channel is traditional, whereas the second channel is new in the literature.

which plants reshuffle their product portfolio in response to export competition shocks.[35]

# 5 Dissecting the Product Scope Adjustment

In order to better understand the responses of Korean manufacturing plants facing more intense competition with Chinese firms at home and abroad, we dissect the product scope adjustment further. First, we examine the heterogeneity between plants by focusing on the exporting status to explore which plants are more likely to engage in product churning behaviors. Second, we decompose the change in the number of products into the creation of new products and the destruction of existing products to analyze the margin of adjustment at the plant level.

## 5.1 Exporters versus Non-Exporters

While our core results of product churning in Section 4.3 are based on all Korean manufacturing plants, we expect to see differential adjustment patterns across exporters and non-exporters for at least three reasons.[36] First, exporters tend to have more resources than non-exporters. This may allow exporters to respond more actively to competitive shocks, including both import penetration and export competition, since product churning requires costs, which include R&D investment, market investigation efforts, and time, all of which make it harder for plants with fewer resources, such as non-exporters, to adjust their product scope. Therefore, exporters are expected to engage in more active product churning behaviors.

Second, exporters and non-exporters may perceive competitive pressures in third markets differently. More specifically, regarding export competition with China, Korean exporters are expected to be more susceptible to export competition because they are di-

[35] Appendix B shows that analysis at a more disaggregated (8-digit KSIC) level yields qualitatively similar results.

[36] Hereafter, exporters refer to plants that export in 2006.

rectly involved in exporting activity amid rising competition with Chinese products in third markets. In contrast, the export competition may have little effect on non-exporters since they do not participate directly in export markets.[37] In this regard, we expect that exporters respond strongly to export competition than non-exporters do.

Third, exporters are likely to produce more varieties and switch products more frequently than non-exporters, even conditional on observable characteristics This is because they sell in multiple markets with diverse consumer preferences and regulatory frameworks. To meet these heterogeneous demands, exporters produce more varieties and adjust their product lines more frequently, especially since market preferences and regulations (e.g., tariffs, safety standards) change in an unsynchronized manner across different export markets.

To investigate this, we estimate equation (6) for exporters and non-exporters separately and report the results in Table 4.[38] Panels A and B show the estimation results for exporters and non-exporters, respectively. In column (5) of Panel A., the most preferred specification, the two coefficients of our interest are both negative and statistically significant. That is, both import penetration from China and export competition with China in third countries decrease the number of products for Korean exporters. Quantitatively, a one standard deviation increase in import penetration from China is associated with a decrease in the number of products by 0.300. Similarly, a one standard deviation increase in export competition with China is associated with a decrease in the number of products by 1.213.[39]

When the mean value of the change in import penetration (0.141) and export competition (0.305) for exporters in Table 1 are considered, these coefficients imply that the av-

[37]In other words, for non-exporters, export competition in third markets can be perceived as a competitive threat—competition that has not occurred directly but has the potential to occur.

[38]The Kleibergen-Paap F-statistics against the null of weak identification are 416.12 for column (2) of Panel A, 414.21 for column (5) of Panel A, 75.33 for column (2) of Panel B, and 75.19 for column (5) of Panel B, all of which are well above the Stock and Yogo critical values. Therefore, the relevance conditions are all satisfied.

[39]To be specific, the magnitude is 1.5 (7.4, respectively) times higher in the case of import penetration (export competition, respectively).

Table 4: Exporters, Non-Exporters, and Competition with China

| | Dependent Variable: $\Delta N_i$ | | | | |
|---|---|---|---|---|---|
| Estimation Method: | OLS | IV | OLS | OLS | IV |
| | (1) | (2) | (3) | (4) | (5) |
| *Panel A.* Exporters | | | | | |
| $\Delta IP_i$ | -0.624** | -1.115** | | -0.568** | -1.021** |
| | (0.245) | (0.493) | | (0.231) | (0.467) |
| $\Delta XC_i$ | | | -1.960** | -1.894** | -1.841** |
| | | | (0.773) | (0.755) | (0.737) |
| 1st stage F-statistics | | 416.116 | | | 414.208 |
| Observations | 11,503 | 11,503 | 11,503 | 11,503 | 11,503 |
| *Panel B.* Non-Exporters | | | | | |
| $\Delta IP_i$ | 0.038 | 0.051 | | 0.037 | 0.051 |
| | (0.075) | (0.134) | | (0.075) | (0.134) |
| $\Delta XC_i$ | | | 0.014 | 0.014 | 0.014 |
| | | | (0.023) | (0.023) | (0.023) |
| 1st stage F-statistics | | 75.331 | | | 75.194 |
| Observations | 16,226 | 16,226 | 16,226 | 16,226 | 16,226 |

*Notes:* All models include plant-level control variables (i.e., log capital per capita, log wage per capita, log value-added, and age) and ISTANS 4-digit industry level fixed effects. Standard errors are clustered at the firm level. All estimates are weighted by the number of employees of each plant in 2006. Columns (2) and (5) report the 2SLS results instrumenting $\Delta IP_i$ with $\Delta IPADH_i$. The remaining columns report the OLS results. The first-stage F-statistics refers to Kleibergen-Paap F-statistics. *** p<0.01, **p<0.05, * p<0.1.

erage exporting plant (in terms of import penetration and export competition) decreases 0.144 product and 0.562 product facing stronger import penetration and export competition, respectively. Since the number of products that exporters in the sample produce at the beginning is 1.277 on average, these results suggest that the average exporting plant decreases the number of products by 55.3% facing tougher competition with China.[40]

In column (5) of Panel B, the most preferred specification, the two coefficients are very close to zero and statistically indistinguishable from zero, indicating that stronger competition with China does not result in statistically meaningful product churning activities for non-exporting Korean manufacturing plants in the sample. It appears that product

[40]The following back-of-the-envelope calculation is used: (0.144+0.562) / 1.277 = 0.553.

churning effects are mostly driven by exporters rather than non-exporters, as expected.[41]

## 5.2 Product Creation and Destruction

Because only exporters respond to increased competition from China at home and abroad, we now zoom in on the product scope of exporters. Thanks to the detailed plant-product-level datasets, we are able to track 5-digit product composition at the plant level in a consistent manner between 2006 and 2018. Hence, in order to better understand the margins of adjustment at the plant level, we decompose the change in the number of products into (i) the creation of new products and (ii) the destruction of existing products. That is, we repeat the analysis with two new dependent variables—the number of new products and the number of dropped products, respectively, between 2006 and 2018.

Table 5 shows the estimation results. We present the product creation margin results in Panel A and the product destruction margin results in Panel B. In column (5) of Panel A, the preferred specification, the coefficient of import penetration is statistically insignificant, while the coefficient of export competition is statistically significant at the one percent level. The coefficient of export competition is -0.879, indicating that a one standard deviation increase in export competition is predicted to reduce the number of new products by 0.579 at the plant level.

The product destruction margin results stand in striking contrast to the product creation margin results. In column (5) of Panel B, the preferred specification, the coefficient of import penetration is statistically significant at the five percent level, while the coefficient of export competition is statistically insignificant. The coefficient of import penetration is 1.005, indicating that a one standard deviation increase in import penetration is predicted to destroy the number of existing products by 0.295 at the plant level.

[41] Appendix B shows that analysis at a more disaggregated (8-digit KSIC) level yields qualitatively similar results. Also, to ensure that our results are not driven by end-of-period turbulence—such as the imposition of Section 301 tariffs and associated trade diversion effects in 2017–2018—we re-estimate our baseline specifications using a restricted sample covering 2006–2015. Appendix C reports the results based on this alternative sample period, which are broadly consistent with our main findings.

Table 5: Product Creation and Product Destruction

| Estimation Method: | OLS | IV | OLS | OLS | IV |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| *Panel A.* Dependent Variable: $New_{i,06-18}$ | | | | | |
| $\Delta IP_i$ | -0.125* | -0.061 | | -0.099 | -0.016 |
| | (0.070) | (0.090) | | (0.067) | (0.083) |
| $\Delta XC_i$ | | | -0.881*** | -0.869*** | -0.879*** |
| | | | (0.257) | (0.255) | (0.254) |
| *Panel B.* Dependent Variable: $Dropped_{i,06-18}$ | | | | | |
| $\Delta IP_i$ | 0.499** | 1.054** | | 0.469** | 1.005** |
| | (0.214) | (0.436) | | (0.202) | (0.415) |
| $\Delta XC_i$ | | | 1.079 | 1.025 | 0.961 |
| | | | (0.675) | (0.661) | (0.643) |
| 1st stage F-statistics | | 416.116 | | | 414.208 |
| Observations | 11,503 | 11,503 | 11,503 | 11,503 | 11,503 |

*Notes:* All models include plant-level control variables (i.e., log capital per capita, log wage per capita, log value-added, and age) and ISTANS 4-digit industry level fixed effects. Standard errors are clustered at the firm level. All estimates are weighted by the number of employees of each plant in 2006. Columns (2) and (5) report the 2SLS results instrumenting $\Delta IP_i$ with $\Delta IPADH_i$. The remaining columns report the OLS results. The first-stage F-statistics refers to Kleibergen-Paap F-statistics. *** p<0.01, **p<0.05, * p<0.1.

These results indicate that product creation and product destruction are differently affected by each type of shock. The product creation responds to export competition with China in third countries, whereas import penetration does not affect the product creation at the plant level. However, product destruction increases as import penetration from China escalates, whereas export competition does not impact the product destruction decision of plants.[42]

# 6 Exploring Mechanisms

The natural follow-up question is then *why* import penetration and export competition have different impacts on product creation and product destruction margins. We pro-

[42]Our core results remain robust when accounting for gross flows of product creation and destruction; detailed evidence is reported in Appendix D.

pose the disproportionate importance of the domestic market, a forward-looking aspect of product creation, and creative destruction as potential drivers.

## 6.1 Survival Threats versus Restructuring Threats

With respect to product destruction, plants may drop their products only if competition pressure is large enough for the survival of the product. In this regard, from the perspective of our empirical evidence in Table 5, stronger import penetration in a domestic market appears to be associated with threats to the survival of products, whereas export competition in third markets does not. We illuminate the importance of the domestic market as a potential reason for this difference.

It is well documented in the literature that even exporters rely heavily on their domestic markets. For instance, using French firm-level data, Eaton et al. (2011) document that French firms rely more on their domestic market compared to the ideal reliance. In a dynamic setting, Iacovone and Javorcik (2010) found that firms enter foreign markets with a single variety that is already sold in the domestic market before they expand, showing the importance of the domestic market. Based on this empirical evidence, a standard monopolistic competition framework like Melitz (2003) and the multi-product model like Mayer et al. (2014) also impose a structure that firms sell in their domestic market first because the profits earned from foreign markets should be large enough to cover exporting costs.[43]

We indeed observe a heavy reliance on the domestic market consistent with this literature among Korean manufacturing firms using an auxiliary dataset, the Survey of Business Activity (SBA).[44] While our main dataset does not allow us to examine whether or not a domestic market is the core market for Korean manufacturing plants, firms in the

[43]Exporting costs, including fixed costs, transportation costs, tariffs, and non-tariff trade barriers, make the unit profits from export markets smaller than those from the domestic market.

[44]SBA covers firms employing at least 50 full-time employees and reporting a capital stock value of at least 300 million Korean won (about 314,110 USD using the 2006 exchange rate). More detailed information about the SBA can be found in Appendix A.

Table 6: Exports-to-Sales Ratio of Manufacturing Firms in 2006

| | Mean | SD | p10 | p25 | Median | p75 | p90 | OBS |
|---|---|---|---|---|---|---|---|---|
| Exports-to-Sales Ratio | 0.162 | 0.261 | 0 | 0 | 0.013 | 0.224 | 0.600 | 5,142 |
| Exports-to-Sales Ratio (Exporters) | 0.283 | 0.291 | 0.009 | 0.041 | 0.167 | 0.455 | 0.771 | 2,951 |

*Notes:* This table summarizes the exports-to-sales ratio of firms in the Survey of Business Activity (SBA) matched to the Mining, and Manufacturing Survey (MMS). Exporters are defined as firms with positive exports in 2006. SD, p10, p25, p75, and p90 indicate the standard deviation, the tenth percentile, the twenty-fifth percentile, the seventy-fifth percentile, and the ninetieth percentile, respectively, of the exports-to-sales ratio in 2006.

SBA matched to the subset of our data suggest that the reliance on the domestic market is quite substantial, as shown in Table 6. As of 2006, the average exports-to-sales ratio is 0.162 (0.283) for matched firms (exporters), which shows that the domestic market is relatively more important. Furthermore, since small plants in our sample that are expected to rely more on the domestic market are not matched to firms in the SBA, the actual dependence on the domestic market could be even stronger.

This disproportionate reliance on the domestic market, together with the findings in the literature, suggests that the domestic market might be a core market even for exporters. Accordingly, import penetration induces them to discard products affected by competitive pressures in their core market (domestic market).

In contrast, even when export competition in the non-core market (periphery markets) may lead exporters to scale down their production, it does not necessarily force them to drop their products completely. This is because other markets, including their domestic market, could buffer the adverse shock. In other words, even if stronger competition in one of the export markets forces a plant to stop selling a product to that country, the plant may continue selling that product in other countries. In contrast, more intense competition in the core domestic market might not be buffered by export markets. To put it differently, export competition would be considered a *restructuring threat*, whereas import penetration would be perceived as a *survival threat*.

## 6.2 Risks of New Product Addition versus Creative Destruction

Turning to product creation activity, why does export competition decrease the addition of new products? Essentially, introducing new products is a forward-looking behavior under uncertainty (Albornoz et al., 2012; Ruhl and Willis, 2017; Eaton et al., 2021), which requires additional costs such as an innovation cost or a fixed cost of production (Bernard et al., 2010, 2011; Eckel and Neary, 2010; Qiu and Zhou, 2013; Mayer et al., 2021; Arkolakis et al., 2021). Therefore, plants would introduce new products only if they expect to generate sufficient profits from those products.

From this point of view, our empirical evidence in Table 5 indicates that exporters decrease product creation activity as tighter competition in export markets makes new products more risky and/or less profitable. This is an intuitive result, especially because Korean exporters are expected to target large export markets to achieve economies of scale when introducing new products, given their relatively small domestic market. As export competition shrinks the effective size of export markets, it diminishes exporters' incentive to expand in export markets by introducing new products to those markets (Iacovone and Javorcik, 2010).

Then, why does import penetration have an insignificant impact on product creation activity? More intense import competition could also prevent plants from creating new products since not all new products target export markets. The insignificant impact of import penetration on product creation implies that there should exist countervailing forces that offset the discouraging impact. We speculate the *creative destruction* as a potential driver that could offset the downward pressure. More specifically, facing tougher competition in their core domestic market, plants could drop their existing products under survival threats and introduce new products that are less vulnerable to competition. This creative destruction activity could offset the downward pressure of import penetration on product creation.[45]

[45] Bloom et al. (2013) show that dropping products can release the resources trapped in the old products,

Table 7: Product Creation of Non-exporters

| | Dependent Variable: $New_{i,06-18}$ | | | | |
|---|---|---|---|---|---|
| Estimation Method: | OLS | IV | OLS | OLS | IV |
| | (1) | (2) | (3) | (4) | (5) |
| $\Delta IP_i$ | 0.145*** | 0.142*** | | 0.146*** | 0.142*** |
| | (0.049) | (0.055) | | (0.049) | (0.055) |
| $\Delta XC_i$ | | | -0.020** | -0.022** | -0.021** |
| | | | (0.010) | (0.010) | (0.010) |
| 1st stage F-statistics | | 75.331 | | | 75.194 |
| Observations | 16,226 | 16,226 | 16,226 | 16,226 | 16,226 |

*Notes:* All models include plant-level control variables (i.e., log capital per capita, log wage per capita, log value-added, and age) and ISTANS 4-digit industry level fixed effects. Standard errors are clustered at the firm level. All estimates are weighted by the number of employees of each plant in 2006. Columns (2) and (5) report the 2SLS results instrumenting $\Delta IP_i$ with $\Delta IPADH_i$. The remaining columns report the OLS results. The first-stage F-statistics refers to Kleibergen-Paap F-statistics. *** p<0.01, **p<0.05, * p<0.1.

If this creative destruction force is at work, we expect the effect to be more pronounced for non-exporters than exporters because non-exporters are more likely to perceive import penetration as a survival threat. Table 7 supports this hypothesis, showing that the impact of import penetration on non-exporters' product creation is positive and statistically significant at the one percent level for all specifications.[46]

Interestingly, column (5) also shows that the impact of export competition on product creation activity is negative and statistically significant. This implies that Korean non-exporting plants reduce their creation of new products targeted at export markets in anticipation of increased competition with China in those markets.[47] However, although

thereby facilitating innovative activities.

[46]Note that we do not find such positive impacts of product creation in response to import penetration in the case of exporters in Panel A of Table 5.

[47]While the negative and statistically significant effect of export competition on product creation among non-exporters, reported in Table 7, may appear puzzling at first glance, several plausible mechanisms can rationalize this finding. First, indirect exposure within industries may play an important role. Even firms that do not directly export can be affected when their industry peers face intensified competition from Chinese exporters. Such pressures may depress overall profitability, alter technological strategies, and weaken expectations about market growth at the industry level, thereby reducing non-exporters' incentives to engage in new product development. Second, many non-exporters can be viewed as potential exporters, particularly in a relatively small and highly open economy like South Korea. If firms anticipate entering foreign markets in the future, intensified export competition may reduce the expected returns to devel-

significant, the magnitudes of the coefficients are much smaller than those for exporters (-0.879) and close to zero, indicating a weaker response by non-exporters, as expected.[48]

In summary, import penetration poses a survival threat to the core market, leading to the destruction of existing products and encouraging the introduction of new products as a way to escape from competition. In contrast, since export competition does not necessarily threaten the survival of products, this creative destruction mechanism does not appear to operate as strongly.

# 7 Resource Allocation Consequence

The previous results indicate that exporting plants adjust their product scope, facing more intense competition with China at home and abroad through increased product destruction and decreased product creation. In order to understand the product scope adjustment to competition with China to the fullest, we examine whether and how this product scope adjustment is accompanied by the reallocation of their resources. Specifically, we investigate how the China trade shock affects product diversification.

Given that import penetration leads to the destruction of old products, we expect import penetration to decrease product diversification[49] at the plant level for two reasons. First, resources previously used for dropped products would be reallocated to other products which plants have comparative advantages. Indeed, this is consistent with the robust prediction by the theoretical models of multi-product firms in the literature (Eckel and Neary, 2010; Bernard et al., 2010, 2011; Mayer et al., 2021). Second, since tougher competition makes less efficient products less profitable, firms reallocate resources away from

oping new products. From this perspective, the negative coefficient likely captures a deterrence effect on prospective exporters, rather than an effect on firms that are permanently oriented toward the domestic market. In light of these mechanisms, we interpret the result in Table 7 not as evidence of a direct product creation effect of export competition on purely domestic firms, but rather as reflecting broader spillover and expectation effects that extend beyond current exporters.

[48] Our core results remain robust when accounting for gross flows of product creation; detailed evidence is reported in Appendix D.

[49] This is equivalent to an increase in product specialization.

their peripheral products to their core products.[50] Indeed, dropping an old product is an example of reallocating resources away from the old product to other products.

To further investigate the mechanism behind the drop in product of existing products, we identify core and peripheral products of a plant using product-level shipment shares in 2006. For each plant, the core product is defined as the product with the largest shipment share, while all remaining products, if any, are classified as peripheral products. By construction, each plant has one core product, and multi-product plants have at least one peripheral product. To assess whether changes in import penetration and export competition exert stronger effects on the discontinuation of peripheral products, we restrict the analysis to multi-product plants.

Accordingly, we decompose the total number of dropped products at plant $i$ into core and peripheral components:

$$Dropped_i = Dropped_i^{core} + Dropped_i^{peri}$$

Table 8 reports the 2SLS estimation results using the newly defined product-drop measures as dependent variables. The estimates indicate that the vast majority of product discontinuation occurs along the peripheral margin: approximately 85.5% of total product drops are attributable to peripheral products.[51] These findings are consistent with the literature on multi-product firms (Eckel and Neary, 2010; Mayer et al., 2014, 2021) and underscore the mechanism emphasized in our analysis, whereby firms primarily adjust to competitive shocks by shedding peripheral products rather than their core offerings.

In contrast, the impact of export competition on product diversification is ex-ante not clear. First, since export competition does not lead to the destruction of old products, the reallocation of resources previously allocated to dropped products would not happen.

[50] This adjustment at the intensive margin is emphasized by Mayer et al. (2014) and Mayer et al. (2021).

[51] Since plants drop either core or peripheral products, the coefficient in column (1) equals the sum of the coefficients in columns (2) and (3). The decomposition shows that 85.5% (= (2.935 / 3.431) $\times$ 100) of product drops are due to peripheral products.

Table 8: Distinguishing Product Drops of Multi-product Plants

| Dep. Var | $Dropped_i$ | $Dropped_i^{core}$ | $Dropped_i^{peri}$ |
|---|---|---|---|
| Est. Method: | IV | IV | IV |
| Sample: | Exporters | Exporters | Exporters |
| | (1) | (2) | (3) |
| $\Delta IP_i$ | 3.431*** | 0.496** | 2.935*** |
| | (1.306) | (0.216) | (1.127) |
| $\Delta XC_i$ | 2.349 | -0.001 | 2.351 |
| | (1.478) | (0.215) | (1.434) |
| 1st stage F-statistics | 209.808 | 209.808 | 209.808 |
| Observations | 2,253 | 2,253 | 2,253 |

*Notes:* All analyses in the tables are restricted to the multiproduct exporting plants to assess the impact of import penetration and export competition on peripheral products discontinuation. All models include plant-level control variables (i.e., log capital per capita, log wage per capita, log value-added, and age) and ISTANS 4-digit industry level fixed effects. Standard errors are clustered at the firm level. All estimates are weighted by the number of employees of each plant in 2006. All columns report the 2SLS results instrumenting $\Delta IP_i$ with $\Delta IPADH_i$. The first-stage F-statistics refers to Kleibergen-Paap F-statistics. *** p<0.01, **p<0.05, * p<0.1.

Second, similar to the import penetration in the domestic market, tougher competition in each export market may result in the concentration toward products with comparative advantages in each export destination. However, this change at each destination may not automatically lead to the concentration of resources toward core products at the plant level. If a plant's most competitive product in each export market is different,[52] heightened competition in each export destination may reshuffle the plant's product portfolio in a non-trivial way. Third, it is ambiguous as to how production creation would affect product diversification. On the one hand, adding a new product could increase product diversification because the share of new products among the plant's shipments is positive; On the other hand, it is possible that adding a new product could result in specializing in the new product.

[52] The Spearman rank correlation between a firm's global product rank and a firm's product rank in each destination is 0.68 in France (Mayer et al., 2014) and 0.860 in Brazil (Arkolakis et al., 2021), indicating this possibility.

Table 9: Product Diversification

| | Dependent Variable: $\Delta E_i$ | | | | |
|---|---|---|---|---|---|
| Estimation Method: | OLS | IV | OLS | OLS | IV |
| | (1) | (2) | (3) | (4) | (5) |
| $\Delta IP_i$ | -0.255*** | -0.299* | | -0.249*** | -0.286* |
| | (0.079) | (0.171) | | (0.077) | (0.167) |
| $\Delta XC_i$ | | | -0.256* | -0.236* | -0.233* |
| | | | (0.133) | (0.128) | (0.125) |
| 1st stage F-statistics | | 168.173 | | | 167.264 |
| Observations | 6,107 | 6,107 | 6,107 | 6,107 | 6,107 |

*Notes:* All models include plant-level control variables (i.e., log capital per capita, log wage per capita, log value-added, and age) and ISTANS 4-digit industry level fixed effects. Standard errors are clustered at the firm level. All estimates are weighted by the number of employees of each plant in 2006. Columns (2) and (5) report the 2SLS results instrumenting $\Delta IP_i$ with $\Delta IPADH_i$. The remaining columns report the OLS results. The first-stage F-statistics refers to Kleibergen-Paap F-statistics. *** p<0.01, **p<0.05, * p<0.1.

In Table 9, we estimate equation (6) using the change in the Entropy index defined in (5) as the dependent variable. For all specifications, the import penetration coefficients are negative and statistically significant as expected. More interestingly, all export competition coefficients are also negative and significant at the ten percent level. Although it is ex-ante not clear, the empirical evidence suggests that both import penetration and export competition lead to the reallocation of resources toward core products.[53]

Table 10: Summary of the Results

| | Number of Products | Product Creation | Product Destruction | Product Diversification |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Import Penetration | $(-)$ | $\cdot$ | $(+)$ | $(-)$ |
| Export Competition | $(-)$ | $(-)$ | $\cdot$ | $(-)$ |

Collectively, the results indicate that product creation, product destruction, and resulting product diversification are differently affected by each type of shock (see Table 10).

[53]We further address a potentially confounding demand-side effect of the destination market in export competition measure by controlling for (i) a measure that captures demand shocks originating from destination markets and (ii) relying on gravity-equation-based instruments. Please refer to Appendix E for more details. Our core results are broadly consistent with these alternative approaches.

These distinct impacts of import penetration and export competition on different margins of adjustment at the plant level are noticeable findings from at least two perspectives. First, partly due to data limitations, it would have been difficult to decompose the product churning effect into product creation, product destruction, and product diversification. Second, more importantly, economists have paid little attention to the role of export competition in product churning effects. Our results shed new light on the literature.

# 8 Conclusion

We examine how Korean manufacturing plants adjust their product scope in response to increasing competition with China, both in the domestic and export markets, using detailed product shipment and export data. Using the exogenous measure of export competition and the instrumental variable for import penetration, we find causal evidence that export competition with China, in addition to import penetration from China, reduces the product scope of Korean plants between 2006 and 2018, particularly for exporters. Importantly, we also show that export competition and import penetration affect different margins of adjustment: export competition reduces product creation, while import penetration increases product destruction, both contributing to the contraction of product scope. Together, these effects lead Korean plants to reallocate resources toward their core products when facing more intense competition with China. Our analysis contributes to the literature on the China shock and multi-product firms by documenting how Korean manufacturers adjust their product scope in response to different dimensions of Chinese competitive pressure, using China's rise as a natural experiment, by precisely measuring both import penetration and export competition.

Our findings open several avenues for future research on product scope adjustments and the nuanced effects of export competition. First, the reallocation of resources toward core products is not just a static adjustment but also has dynamic implications for firms' long-term productivity. As producers focus on products where they have a comparative advantage, they may optimize their allocation of resources in R&D, worker training, capital investment, and managerial efforts to enhance their core competencies. In turn, this process can foster productivity growth over time. Understanding whether, how, and why such reallocation influences long-term productivity remains an open question, warranting future theoretical and empirical investigation.

Second, to deepen understanding of the link between competition shocks and product-switching behavior—including the underlying mechanisms—further evidence from diverse contexts is essential. The analysis should extend beyond the China trade shock and Korea, especially given the growing availability of high-quality microdata in other countries. While we suggest that the core-periphery market structure of exporting plants as a source of the differential effects of export competition and import penetration, alternative mechanisms cannot be ruled out. Broader cross-country evidence could help distinguish among them and test the generalizability of our findings.

Third, while our analysis focuses on plant-level product scope adjustments in response to shocks originating in multiple markets, firms may also respond by reallocating products across destination markets when competitive pressure rises. In particular, producers may shift products toward destinations where competition is relatively weaker. Although our data do not allow us to examine destination-specific product switching, future research along this dimension could shed light on an additional and potentially important margin of adjustment.

Finally, future work can examine the impact of export competition and import penetration on employment and other economic outcomes. Understanding their impact on job creation and destruction, labor reallocation, and wage adjustments could provide valuable insights for trade policy and labor market responses. At the same time, exploring between-firm reallocation in response to these shocks—such as entry, exit, or market repositioning—can shed light on broader industrial restructuring, market share shifts, and the evolution of firm dynamics beyond the intra-firm adjustments. Together, these lines of inquiry would deepen our understanding of how competition shocks reshape market dynamics.

**Declaration** During the preparation of this work the authors used ChatGPT in order to check the grammar. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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# Appendix

## Appendix A Dataset Descriptions

**Mining and Manufacturing Survey**

The Mining and Manufacturing Survey (MMS) is an annual plant-level dataset compiled by Statistics Korea that covers establishments operating in the mining and manufacturing sectors. The survey covers, on average, 70,000 plants with ten or more employees. A key advantage of the MMS is that it uses a consistent plant-level identification code, which allows researchers to track plants and to link the MMS to other administrative datasets.

The MMS collects detailed plant-level information, including industry classification, year of establishment, employment, wage bills, tangible capital, and value added. Additionally, it contains *confidential* plant-product-level data. Products in the survey are classified at the 8-digit level of the Korean Standard Industrial Classification (KSIC) and matched to the producing plant. For each plant-product pair, it provides several market outcomes, including shipments. Using this granular plant-product level data, we construct plant-level product variables at the 5-digit level by aggregating 8-digit products with the same 5-digit code.

**Survey on Business Activity**

The annual Survey on Business Activity (SBA) is conducted by Statistics Korea. Since 2006, the survey has covered 13,000 or more firms with 50 or more employees and collected information about firm-level economic activities in Korea—such as employment, number of plants, tangible and intangible assets, sales, exports, and profits. Similar to the MMS, the SBA provides a unified firm-level identification code linked to each firm's plants. This consistent identification structure enables users to merge firm-level information from the SBA with plant-level data from the MMS.

### Plant-Level Export Status Data

The plant-level export status data is a non-public dataset maintained by the Korean Customs Service (KCS). The dataset traces the export status of each plant in Korea and its export destinations annually. Note that it reports no product-destination-level information, such as shipments; we only identify whether a plant exports.

### Harmonization

Since we use multiple datasets—MMS, SBA, plant-level export status dataset, and UN Comtrade product-level trade dataset—from different sources, we harmonize different product classification systems to construct a consistent dataset. We begin by identifying modifications in the product classification system during our sample period. The KSIC, managed by Statistics Korea, has undergone two major revisions since 2006. While most modifications involve renaming products or reassigning codes at the 5-digit level, several products have been integrated with other products or divided into new products. These structural changes, which involve $N$-to-1 matching or 1-to-$N$ matching, generate nontrivial product-class matching problems across versions.

To overcome this issue, we use the ISTANS 5-digit product classification to link KSIC products at the 5-digit level. The ISTANS classification is published by the Korea Institute for Industrial Economics and Trade (KIET) and provides a consistent mapping of 5-digit ISTANS products to the corresponding 5-digit KSIC classes across all KSIC versions. In addition, UN Comtrade data classified at the 6-digit HS level are harmonized to the ISTANS 5-digit product classification.

## Appendix B Product Adjustment at the 8-digit KSIC Level

Equipped with our dataset that classifies products as disaggregated as the KSIC 8-digit level, we examine how plants adjust their product scope in response to stronger import penetration and export competition at the 8-digit product level. By doing so, we are able to capture more detailed product-switching activities that may not be captured at the 5-digit level. We conjecture that the product scope adjustment of plants is more prevalent at the 8-digit level than at the 5-digit level. At the same time, we expect the number of products to decrease, facing both import penetration and export competition shocks, consistent with our main analysis at the 5-digit level.

Table B.1: Product Adjustment at the 8-Digit KSIC Level

| Corresponding Table | [3] | | [4] |
|---|---|---|---|
| Dependent Variable | $\Delta N_i$ | $\Delta N_i$ | $\Delta N_i$ |
| Estimation Method: | IV | IV | IV |
| Sample: | All | Exporters | Non-exporters |
| | (1) | (2) | (3) |
| $\Delta IP_i$ | -1.119* | -1.884* | 0.105 |
| | (0.668) | (1.027) | (0.139) |
| $\Delta XC_i$ | -0.176* | -2.434** | 0.024 |
| | (0.095) | (1.216) | (0.028) |
| 1st stage F-statistics | 302.237 | 414.208 | 75.194 |
| Observations | 27,735 | 11,503 | 16,226 |

*Notes:* All models include plant-level control variables (i.e., log capital per capita, log wage per capita, log value-added, and age) and ISTANS 4-digit industry level fixed effects. Standard errors are clustered at the firm level. All estimates are weighted by the number of employees of each plant in 2006. Columns (1), (2), and (3) report the results of the full, exporting, and non-exporting samples. All columns include the 2SLS results instrumenting $\Delta IP_i$ with $\Delta IPADH_i$. The first-stage F-statistics refers to Kleibergen-Paap F-statistics. *** p<0.01, **p<0.05, * p<0.1.

Table B.1 illustrates how manufacturing plants in Korea adjust the number of products facing competition with China at the 8-digit product level. Consistent with the results in Column 5 of Table 3, Column (1) shows that plants with stronger import penetration and export competition contract their product scopes at the 8-digit product level. All coefficients are larger than those in Column 5 of Table 3 in absolute value, reflecting the extra product switching activities captured at the 8-digit level. The results imply that a plant that experiences one standard deviation stronger import penetration shock (export competition shock) reduces the number of 8-digit products it produces by 0.313 (0.116), which is larger than the reduction of the number of 5-digit products by 0.174 (0.093).

**Exporters versus Non-Exporters**

Similar to the main analysis at the 5-digit product level, plants in the sample are partitioned into exporters and non-exporters to examine whether product switching activities are more pronounced on exporting plants at the 8-digit product level.

Column (2) presents the results in accordance with the analysis on exporting plants at the 5-digit level. The coefficients ensure stronger responses of exporting plants to greater competition with China at the 8-digit level. Again, all coefficients are larger in absolute value than the corresponding coefficients in the 5-digit product analysis, analogous to the results in Column (1).

Column (3) shows that both import penetration coefficients and export competition coefficients are statistically indistinguishable from zero for non-exporting plants. Consistent with results in Panel B of Table 4, stronger competition with China does not result in statistically meaningful product churning activities for non-exporting Korean manufacturing plants in the sample.

## Appendix C Alternative Sample Period

Some may argue that our results are driven by the choice of the end period, during which Section 301 tariffs and trade diversion effects were particularly salient. While the gross creation and gross destruction results reported in Appendix D suggest that our main results are robust when not only end-period switching, but also gross switching activity over the sample period, is taken into account, we use an alternative sample period from 2006 to 2015. This restriction ensures that our main findings are not driven by end-of-period trade policy turbulence.

Table C.1: Robustness Check: Alternative Sample Period (2006-2015)

| Corresponding Table | [3] | | [4] | [3] | | [4] |
|---|---|---|---|---|---|---|
| Dependent Variable | $\Delta N_i$ | $\Delta N_i$ | $\Delta N_i$ | $\Delta N_i$ | $\Delta N_i$ | $\Delta N_i$ |
| Estimation Method: | IV | IV | IV | IV | IV | IV |
| Sample: | All | Exporters | Non-exporters | All | Exporters | Non-exporters |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $\Delta IP_i$ | -0.471* | -0.789** | 0.052 | -0.471** | -0.789** | 0.062 |
| | (0.243) | (0.371) | (0.052) | (0.240) | (0.365) | (0.055) |
| $\Delta XC_i$ | -0.318*** | -0.510*** | -0.048 | -0.318*** | -0.510*** | -0.044 |
| | (0.114) | (0.170) | (0.034) | (0.113) | (0.168) | (0.034) |
| $\Delta Xsize_i$ | | | | 0.004 | -0.002 | -0.085* |
| | | | | (0.238) | (0.457) | (0.049) |
| 1st stage F-statistics | 291.465 | 379.645 | 51.937 | 278.647 | 358.780 | 50.695 |
| Observations | 27,735 | 11,503 | 16,226 | 27,735 | 11,503 | 16,226 |

*Notes:* All models include plant-level control variables (i.e., log capital per capita, log wage per capita, log value-added, and age) and ISTANS 4-digit industry level fixed effects. Standard errors are clustered at the firm level. All estimates are weighted by the number of employees of each plant in 2006. Columns (1) and (4) report the results of the full sample. Columns (2) and (5) report the results of the exporting sample. Columns (3) and (6) report the results of the non-exporting sample. All columns include the 2SLS results instrumenting $\Delta IP_i$ with $\Delta IPADH_i$. The first-stage F-statistics refers to Kleibergen-Paap F-statistics. *** p<0.01, **p<0.05, * p<0.1.

Table C.1 reports the estimation results. Column (1) corresponds to column (5) of Table 3. Although the coefficient magnitudes change, both import penetration from China and export competition with China in third-country markets continue to reduce the number of products, consistent with our main findings. Columns (2) and (3) correspond to column (5) of Panel A and Panel B of Table 4, respectively. The results remain robust when restricting the sample period: import penetration from China and export competition in third-country markets reduce product scope for Korean exporters, while stronger competition with China does not lead to statistically significant product churning among non-exporting Korean manufacturing plants. Finally, in columns (4) through (6), we add export-market demand shifter, measured by $\Delta X size_i$, as a control variable; the results remain unchanged.

# Appendix D Product Creation and Destruction Using Gross Flows

We use long differences as our baseline because product switching in manufacturing reflects medium- to long-run adjustment rather than short-run fluctuations. Introducing or discontinuing products involves time and costs and responses to competition shocks unfold gradually over time. Nevertheless, our approach may overlook within-period product churning. To address this concern, we construct the following variables that capture gross product creation and destruction within the sample period:

$$Gross\ Destruction_i = \sum_{t=2006}^{2017} \sum_{k} \mathbb{1}\{\text{“product } k \text{ produced in } t \text{ disappears in } t+1\text{"}\},$$

$$Gross\ Creation_i = \sum_{t=2006}^{2017} \sum_{k} \mathbb{1}\{\text{“product } k \text{ not produced in } t \text{ appears in } t+1\text{"}\}$$

By definition, these variables allows us to capture gross creation (ever appears after 2006) and gross destruction (ever disappears before 2018) within our sample period.

### Gross Product Creation and Destruction for Exporting Plants

Table D.1 reports the estimation results for exporting plants using gross measures of product adjustment, corresponding to Column (5) of Table 5. Columns (1) and (2) show that higher import penetration significantly reduces the number of existing products, consistent with the results based on the two-point product-drop measure reported in Panel B of Column (5) in Table 5. Turning to gross product creation, Column (4) shows that after controlling for export-market demand shocks, export competition significantly reduces the number of newly introduced products. This result is qualitatively similar to the findings in Panel A of Column (5) in Table 5, indicating that export competition discourages product creation even when measured using gross flows.

Table D.1: Robustness Check: Gross Product Creation and Destruction for Exporting Plants

| Dependent Variable | $Gross\ Destruction_i$ | | $Gross\ Creation_i$ | |
|---|---|---|---|---|
| Estimation Method: | IV | IV | IV | IV |
| Sample: | Exporters | | Exporters | |
| | (1) | (2) | (3) | (4) |
| $\Delta IP_i$ | 1.228** | 0.987** | 0.207 | 0.112 |
| | (0.486) | (0.478) | (0.180) | (0.166) |
| $\Delta XC_i$ | 1.119 | 0.999 | -0.722 | -0.770* |
| | (0.747) | (0.688) | (0.456) | (0.432) |
| $\Delta Xsize_i$ | | 1.015 | | 0.402 |
| | | (0.672) | | (0.319) |
| 1st stage F-statistics | 414.136 | 424.900 | 414.136 | 424.900 |
| Observations | 11,503 | 11,503 | 11,503 | 11,503 |

*Notes:* All analyses in the table are restricted to the exporting plants. All models include plant-level control variables (i.e., log capital per capita, log wage per capita, log value-added, and age) and ISTANS 4-digit industry level fixed effects. Standard errors are clustered at the firm level. All estimates are weighted by the number of employees of each plant in 2006. All columns report the 2SLS results instrumenting $\Delta IP_i$ with $\Delta IPADH_i$. The first-stage F-statistics refers to Kleibergen-Paap F-statistics. *** p<0.01, **p<0.05, * p<0.1.

### Gross Product Creation for Non-exporting Plants

Table 7 shows that for non-exporting plants, import penetration is associated with a positive effect on product creation, whereas export competition exerts a negative effect on product creation activity. Table D.2 below repeats the analysis using gross flow measures, and the core results remain robust.

Table D.2: Robustness Check: Gross Product Creation for Non-exporting Plants

| Dependent Variable | $Gross\ Creation_i$ | |
|---|---|---|
| Estimation Method: | IV | IV |
| Sample: | Non-exporters | |
| | (1) | (2) |
| $\Delta IP_i$ | 0.240** | 0.264** |
| | (0.097) | (0.098) |
| $\Delta XC_i$ | -0.058** | -0.053** |
| | (0.026) | (0.025) |
| $\Delta Xsize_i$ | | -0.197** |
| | | (0.099) |
| 1st stage F-statistics | 75.176 | 72.039 |
| Observations | 16,226 | 16,226 |

*Notes:* All analyses in the table are restricted to the non-exporting plants. All models include plant-level control variables (i.e., log capital per capita, log wage per capita, log value-added, and age) and ISTANS 4-digit industry level fixed effects. Standard errors are clustered at the firm level. All estimates are weighted by the number of employees of each plant in 2006. All columns report the 2SLS results instrumenting $\Delta IP_i$ with $\Delta IPADH_i$. The first-stage F-statistics refers to Kleibergen-Paap F-statistics. *** p<0.01, **p<0.05, * p<0.1.

# Appendix E Controlling for Demand Shifters

### Controlling for Destination-market Demand Shifters

To isolate the pure supply-side competition effect from destination-market demand shifters, we construct a measure that captures demand shocks originating from the destination $S$ as follows, modifying the measure developed by Aghion et al. (2022):

$$\Delta Xsize_i = \sum_k \frac{y_{ik,06}}{y_{i,06}} \sum_S \frac{X^{KRtoS}_{k,06}}{\sum_{S'} X^{KRtoS'}_{k,06}} \Delta_g M^{S\backslash KR}_{k,06-18},$$

where the last term, $\Delta_g M^{S\backslash KR}_{k,06-18}$, represents the Davis-Haltiwanger growth rate of product-$k$-specific demand in destination market $S$ originating from countries other than Korea. In addition to our baseline analysis, we re-estimate the main regression model including $\Delta Xsize_i$ to control for demand shifters in destination market $S$.

Table E.1: Robustness Check: Controlling for the Demand Shifter

| Corresponding Table | [3] | [4] | | [5] | | [7] | [9] |
|---|---|---|---|---|---|---|---|
| Dependent Variable | $\Delta N_i$ | $\Delta N_i$ | $\Delta N_i$ | $New_{i,06-18}$ | $Drop_{i,06-18}$ | $New_{i,06-18}$ | $\Delta E_i$ |
| Estimation Method: | IV | IV | IV | IV | IV | IV | IV |
| Sample: | All | Export | Non-export | Export | Export | Non-export | Export |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| $\Delta IP_i$ | -0.538** | -0.875* | 0.041 | 0.016 | 0.892** | 0.146*** | -0.301* |
| | (0.298) | (0.465) | (0.136) | (0.089) | (0.409) | (0.056) | (0.172) |
| $\Delta XC_i$ | -0.121* | -1.769*** | 0.012 | -0.863*** | 0.906 | -0.021** | -0.235* |
| | (0.053) | (0.685) | (0.023) | (0.251) | (0.590) | (0.010) | (0.058) |
| $\Delta Xsize_i$ | -0.404 | -0.613 | 0.086 | -0.137 | 0.477 | -0.033 | 0.058 |
| | (0.038) | (0.655) | (0.065) | (0.127) | (0.600) | (0.044) | (0.099) |
| 1st stage F-statistics | 281.824 | 424.900 | 72.039 | 424.900 | 424.900 | 72.039 | 176.166 |
| Observations | 27,735 | 11,503 | 16,226 | 11,503 | 11,503 | 16,226 | 6,107 |

*Notes:* All models include plant-level control variables (i.e., log capital per capita, log wage per capita, log value-added, and age) and ISTANS 4-digit industry level fixed effects. $\Delta Xsize_i$ controls the export-market demand shock. Standard errors are clustered at the firm level. All estimates are weighted by the number of employees of each plant in 2006. Column (1) reports the results of the full sample. Columns (2), (4), (5), and (7) report the results of the exporting sample. Columns (3) and (6) report the results of the non-exporting sample. All columns report the 2SLS results instrumenting $\Delta IP_i$ with $\Delta IPADH_i$. The first-stage F-statistics refers to Kleibergen-Paap F-statistics. *** p<0.01, **p<0.05, * p<0.1.

Table E.1 reports the estimation results. Across all columns, even after controlling for demand shifters in destination market $S$, we continue to find qualitatively similar effects of import penetration and export competition.

**Constructing an Instrument that Captures Supply Shocks from China**

To further address potential demand shocks contained in $\Delta XC_i$, we first run the following gravity regression to capture exporter-by-product supply shock:

$$ln(export)_{rskt} = \lambda_{rkt} + \gamma_{skt} + \pi_{rs} + u_{rskt},$$

where $ln(export)_{rskt}$ is the log export value of product $k$ from exporter $r$ to importer $s$ in year $t$, $\lambda_{rkt}$ is exporter $r$-product $k$-year $t$ fixed effect, $\gamma_{skt}$ is importer $s$-product $k$-year $t$ fixed effect, and $\pi_{rs}$ is exporter $r$-importer $s$ fixed effect. To distinguish the supply shock from China for product $k$ during our sample period, we define

$$\Delta\lambda_{CHN,k} = \lambda_{CHN,k,2018} - \lambda_{CHN,k,2006}$$

and construct an instrumental variable at the plant level as follows:

$$\Delta\lambda_i = \sum_k \frac{y_{ik,06}}{y_{i,06}} \Delta\lambda_{CHN,k}.$$

Equipped with both $\Delta\lambda_i$ and $\Delta IPADH_i$ as instruments, we estimate 2SLS regressions to compare the results with our baseline specifications. Table E.2 reports the estimation results. Although some coefficients lose statistical significance in certain specifications, the overall patterns remain broadly consistent with our main findings.

Table E.2: Robustness Check: Instrumenting $\Delta XC_i$ with FEs from Gravity Regression

| Corresponding Table | [3] | | [4] | | [5] | [7] | [9] |
|---|---|---|---|---|---|---|---|
| Dependent Variable | $\Delta N_i$ | $\Delta N_i$ | $\Delta N_i$ | $New_{i,06-18}$ | $Drop_{i,06-18}$ | $New_{i,06-18}$ | $\Delta E_i$ |
| Estimation Method: | IV | IV | IV | IV | IV | IV | IV |
| Sample: | All | Export | Non-export | Export | Export | Non-export | Export |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Panel A. Without $\Delta Xsize_i$ | | | | | | | |
| $\Delta IP_i$ | -0.483* | -0.607 | 0.051 | 0.018 | 0.625 | 0.142** | -0.289* |
| | (0.270) | (0.437) | (0.133) | (0.093) | (0.383) | (0.056) | (0.169) |
| $\Delta XC_i$ | -4.701* | -9.983* | 0.361* | -1.559* | 8.424 | -0.167 | -0.190 |
| | (2.793) | (6.001) | (0.207) | (0.848) | (5.650) | (0.115) | (0.557) |
| 1st stage F-statistics | 31.290 | 49.110 | 16.196 | 49.110 | 49.110 | 16.196 | 27.169 |
| Observations | 27,735 | 11,503 | 16,226 | 11,503 | 11,503 | 16,226 | 6,107 |
| Panel B. With $\Delta Xsize_i$ | | | | | | | |
| $\Delta IP_i$ | -0.448 | -0.528 | 0.045 | 0.042 | 0.570 | 0.144** | -0.301* |
| | (0.279) | (0.494) | (0.135) | (0.098) | (0.434) | (0.056) | (0.175) |
| $\Delta XC_i$ | -4.569* | -9.623* | 0.337 | -1.450* | 8.173 | -0.158 | -0.243 |
| | (2.669) | (5.677) | (0.216) | (0.859) | (5.334) | (0.120) | (0.499) |
| $\Delta Xsize_i$ | -0.201 | -0.399 | 0.048 | 0.121 | 0.278 | -0.017 | 0.058 |
| | (0.294) | (0.548) | (0.075) | (0.126) | (0.498) | (0.046) | (0.098) |
| 1st stage F-statistics | 28.838 | 52.253 | 13.555 | 52.253 | 52.253 | 13.555 | 34.424 |
| Observations | 27,735 | 11,503 | 16,226 | 11,503 | 11,503 | 16,226 | 6,107 |

*Notes:* All models include plant-level control variables (i.e., log capital per capita, log wage per capita, log value-added, and age) and ISTANS 4-digit industry level fixed effects. Panel A reports the results without the export-market demand shock $\Delta Xsize_i$. Panel B reports the results with the export-market demand shock $\Delta Xsize_i$. Standard errors are clustered at the firm level. All estimates are weighted by the number of employees of each plant in 2006. Column (1) reports the results of the full sample. Columns (2), (4), (5), and (7) report the results of the exporting sample. Columns (3) and (6) report the results of the non-exporting sample. All columns report the 2SLS results instrumenting $\Delta IP_i$ and $\Delta XC_i$ with $\Delta IPADH_i$ and $\Delta\lambda_i$. The first-stage F-statistics refers to Kleibergen-Paap F-statistics. *** p<0.01, **p<0.05, * p<0.1.