Heterogeneous Globalization: Offshoring and Reorganization*

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Abstract

Trade liberalization with low-wage countries increases competition for domestic producers but also creates new offshore opportunities. This paper finds that firms exploit these opportunities in low-wage countries by sourcing lower-price varieties of the same goods they manufacture at home. Instead of ceasing domestic production of those goods, offshoring firms reorganize their domestic activities by shifting production into higher-price varieties, shedding production workers, and increasing both the share and level of employment in technology occupations. These patterns are consistent with comparative advantage motives for the production of vertically differentiated varieties across countries. Moreover, we show that offshoring-driven low-wage imports are associated with industry-level growth, in contrast to the negative employment effects of competing import flows. This divergence highlights the heterogeneous effects of globalization and calls for incorporating a vertical dimension of product differentiation into frameworks of offshoring.

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1 Introduction

Increased imports from low-wage countries, and Chinese imports in particular, have reduced manufacturing employment in developed economies.[1] Low-wage imports have also been associated with decreased wages, rising inequality, worsening health, and political polarization.[2] Even as manufacturing employment has declined, however, the share of manufacturing real value-added in GDP has been relatively steady, with significant growth in some of the same industries that experienced soaring imports. In the United States, this is typified by the computer and electronics industry, which has experienced dramatic quality improvements boosting its real output even as Chinese imports surged (Fort et al., 2018).

In the face of rising low-wage imports, some firms shrink or fail entirely, while others switch industries (Bernard et al., 2006; Bloom et al., 2019), increase innovation (Bloom et al., 2016; Gutiérrez and Philippon, 2017), upgrade quality (Khandelwal, 2010; Hombert and Matray, 2018), or focus on core products (Bernard et al., 2011). These responses have been interpreted as the effect of increased competition on domestic firms. For some domestic producers, however, the same changes in trade costs or foreign productivity growth that lead to increased import competition may also present an opportunity to reorganize their production processes and lower costs by relocating certain activities abroad.

This paper studies firms' decisions to offshore production to low-wage countries, and the impact of these decisions on domestic production and employment. We exploit a unique Danish survey to show that, after offshoring, firms increase their imports of the same detailed goods they produce domestically. Most offshoring firms continue domestic production of the same goods they import, with domestic varieties having higher prices that rise after offshoring begins. Offshorers do reduce total employment by shedding production workers at home, but they increase both the share and level of employment in technology-related occupations. These patterns suggest that offshoring emerges as a response to firm-level comparative advantage incentives for the production of vertically differentiated varieties across countries, and that offshoring raises the relative demand for domestic innovation-related workers.

Prior work on offshoring has often relied on imports or foreign affiliate activity to infer firms' production relocation decisions.[3] Using a unique firm-level survey that covers the large majority of manufacturing output in the Danish economy, we identify firms that offshore their main activity to

[1] Autor et al. (2013) and Pierce and Schott (2016) provide evidence for the US. Negative effects of Chinese imports on employment are also documented by Mion and Zhu (2013) for Belgium, Ashournia et al. (2014) and Utar (2018) for Denmark, Malgouyres (2017) for France, Balsvik et al. (2015) for Norway, and Thewissen and van Vliet (2017) for the OECD.

[2] For example, Autor et al. (2014), Pierce and Schott (2020), Autor et al. (2020b), and Che et al. (2017).

[3] Early work uses imported inputs at the industry level (Feenstra and Hanson, 1999; Hummels et al., 2001; Johnson and Noguera, 2017). Offshoring is also inferred from multinationals' affiliate activities (Harrison and McMillan, 2009; Muendler and Becker, 2010; Kovak et al., 2017). Yeats (2001) measures imports of products with the words "parts" or "components." Fort (2017) identifies US firms' purchases of contract manufacturing services offshore.

both affiliated and unaffiliated firms between 2001 and 2006.[4] The survey shows that nine percent of Danish firms offshored during this period, with the New Member States of the EU (NMS) and China as the top two destinations. We link the survey data to detailed import *and* production data collected under the same classification system to analyze precisely how importing and domestic manufacturing evolve after offshoring.

As expected, offshoring firms disproportionately increase their imports from the offshore location. Unlike the typical assumption that offshoring necessarily entails imported intermediate inputs, offshorers' import growth is concentrated in goods they also produce domestically: 91 percent of their import growth occurs in the same detailed eight-digit Combined Nomenclature (CN8) products that the firm produces in Denmark. By contrast, non-offshorers' imports and import growth are concentrated in products that they never produce domestically. This sharp divergence in the composition of imports forms the basis for our firm-by-product (Harmonized System six-digit - HS6/CN6) measure of offshoring: the share of a firm's produced-good imports from a region in its total imports. Our measure is available for all manufacturing firms, has both intensive and extensive-margin variation, controls for overall firm growth, and can be constructed for any region or time period.

Despite growth in imports of the same goods they produce at home, domestic production at these same offshoring firms does not fall. In fact, offshorers also grow their domestic production of goods they import from low-wage locations. To understand why firms produce the same goods in multiple locations, we analyze differences in unit values across locations. Within a firm-product (CN8), unit values of domestically produced varieties are almost 60 percent higher than those for imported varieties, with unit values for imports from NMS and China being the lowest.

We also study the evolution of unit values of domestically-produced varieties post offshoring. After the firm begins to import a particular good from the NMS or China, the unit value of its domestic variety rises, even as its production quantity falls. These patterns are reminiscent of prior work that shows firms respond to trade liberalization by focusing on core products (Mayer et al., 2014; Bernard et al., 2011). However, our results highlight a new margin of adjustment: offshorers specialize in their core competency goods, but expand their production and vertical scope by manufacturing them in multiple countries. This paper, to our knowledge, is the first to document the combination of increased domestic production and increased imports by offshoring firms in detailed product categories. Offshoring firms exploit new low-wage production opportunities and vertically differentiate their production by location.

The increase in offshoring firms' produced-good imports and their continued domestic production of the same products may seem at odds with prior work that defined offshoring as imports of intermediate inputs that the firm sources from the lowest-cost location. However, a broader view

[4]The survey was conducted on a 2005 frame and the firms surveyed account for 80 percent of Danish manufacturing production in that year. About half of offshoring is to related parties.

of the production process is one in which manufacturing entails not only physical transformation activities, but also design, engineering, product development, marketing, and distribution. Under this view, imports of produced, or "final," goods also capture fragmentation of production, with the pre- and post-production stages occurring in different countries from manufacturing stages. We observe precisely these types of compositional shifts in firm employment: offshoring firms' shares of technology and support workers rise, while production worker shares fall.

To provide causal evidence on the effects of low-wage offshoring, we construct an instrument that captures production-cost savings opportunities for Danish firms in the NMS, their main offshoring location. The NMS underwent significant reforms starting in the 1990s as part of the planned EU accession in 2004 and 2007. We measure changes in NMS comparative advantage over this period using (HS6) product-level variation in the region's market share gains in the rest of the world. Since offshorers' import growth is concentrated in products they initially produced, we calculate a firm-specific measure of exposure using the firm's initial period production by product. Five-year changes in NMS market shares in the rest of the world are strong predictors of growth in Danish firms' share of produced-good imports from the region, even when we separately control for import penetration from NMS and China into Denmark.

Both the IV and reduced-form results indicate that, although offshoring decreases firms' total employment via a reduction in production workers, it also entails reallocation into technology-related occupations. Offshorers reorganize their activities and employment to increase their shares of workers in technology (e.g., R&D and engineering) and support (e.g., customer service) occupations. Reallocation is most pronounced for tech workers, who increase not only in shares but also in levels, and is matched by anecdotal evidence on Danish firms' responses to the integration of Eastern Europe. For example, the Danish pump manufacturer Grundfos, opened two pump manufacturing plants in Hungary in 2000 and 2001, while focusing on developing and producing pumps with new digital monitoring systems at a Danish plant.[5] We also find that offshoring opportunities increase the share of workers that switch into tech occupations within the firm, suggesting a key role for the firm in occupational changes.

Our findings provide a potential explanation for the divergence between employment and real output observed in some industries with rising imports. Typicaly import competition is characterized as a negative demand shock, i.e. all imports from low-wage countries represent import competition, regardless of whether they are imported by domestic producers. However, offshoring gives firms the option of sourcing lower quality varieties from low wage countries, shifting towards innovation and high quality production at home, while still focusing on their core products. This

[5]This information is based on publicly available information, see `https://www.grundfos.com/about-us/news-and-press/news/grundfos-opens-competence-centre-in-hungary.html`. Examples of this vertical differentiation in production are not limited to Denmark. After China joined the WTO, Cummings offshored production of its low-end diesel engines there, while continuing production of the high-end, turbo diesel engines in the United States. In their study of quality-adjusted prices, Byrne et al. (2017) note that firms source production of lower-price and less technologically advanced semiconductors in China relative to the ones produced in Taiwan.

reorganization potentially allows offshoring firms to grow over time, both globally and domestically. To the extent that offshored varieties are lower quality or less technologically advanced, they may compete less with domestic varieties than other types of imports.

To assess these channels, we revisit the relationship between low-wage imports and industry employment by splitting import penetration into two components: the produced-good import share and the import share for non-produced goods. As above, we define produced-good imports as imports of HS6 products that the importing firm also produced domestically in that year. While overall import penetration is negatively correlated with industry employment from 1998 to 2008, as found in numerous previous studies, the two components exhibit opposite patterns. Non-produced good import penetration is negatively and significantly correlated with industry employment and output, capturing the increase in competitive pressure from low-wage imports. By contrast, produced-good import penetration, reflecting imports under the control of domestic manufacturers, is positively correlated with industry output. These heterogeneous responses to the integration of China and the NMS suggest that imports from low-wage countries may capture different phenomena with distinct implications for domestic employment and growth.

This paper contributes to several strands of literature. First, we add to a large body of work on the motives of offshoring. These studies largely focus on imports of intermediate inputs, because input trade can both raise productivity (Amiti and Konings, 2007; Grossman and Rossi-Hansberg, 2008; Halpern et al., 2015; Antràs et al., 2017; Blaum et al., 2018; Boehm et al., 2019), and rationalize the rising skill premium in all countries (Feenstra and Hanson, 1999). We find that Danish firms exploit newly integrated low-income countries to produce vertically differentiated varieties of the same goods they manufacture at home. These produced-goods imports reveal another form of offshoring that extends the insight from (Feenstra and Hanson, 1999) to show that final-good trade can also explain rising skill premia in developing countries, and aligns more closely with export-platform FDI models. While a small set of those models predict that firms will export back to their home markets (Tintelnot, 2017; Antràs et al., 2022; Head and Mayer, 2019; Wang, 2019), those predicted flows have not received much attention. We show that these produced-good imports are sizable and relate to systematic variation and changes in prices suggestive of vertical differentiation in production across space.[6] Our results points to offshoring due to comparative advantage motives for the production of vertically differentiated varieties, instead of the horizontal proximity-concentration tradeoff that has been the focus of export-platform models.

We also complement work that considers the impact of offshoring on domestic employment and specialization. Hummels et al. (2014) find that offshoring lowers the average low-skilled worker's wage and increases wages in high-skill, less routine-task occupations. While their focus is on individual worker wage changes within job spells at importers, we consider the changes in occupational

[6]Prior work has documented systematic differences in unit values across locations (Schott, 2004) and over time (Schott, 2008); we augment those findings by showing *within-firm* price differences across locations and over time that relate to firms' offshoring to low-wage countries.

structure that arise from new low-wage offshoring opportunities. We find that offshorers' reorientation towards higher price varieties is accompanied by reductions in production-worker occupations and increased employment in technology occupations, some of which occurs as workers switch occupations within the firm. These results complement theoretical and structural work on how offshoring fosters specialization across production tasks (Antràs et al., 2006; Rodríguez-Clare, 2010; Arkolakis et al., 2018), and suggests an important role for the firm in facilitating these transitions.

Finally, we contribute to a literature that examines the relationship between trade liberalization and innovation. Again focusing on imported inputs, Bøler et al. (2015) find that R&D and offshoring are complementary, since both activities require fixed costs and lead firms to grow. We show that offshorers also increase workers in innovation-related occupations without a change in firm scale. Other papers study the relationship between low-wage imports and innovation using changes in industry-level import penetration to document both positive (Bloom et al., 2016) and negative (Autor et al., 2020a) effects. The current explanation for these differing results is an "escape competition" motive, with heterogeneous effects depending on where firms lie on the technology frontier (Aghion et al., 2005). Khandelwal (2010), Amiti and Khandelwal (2013), and Hombert and Matray (2018) provide evidence of vertical differentiation within products in response to increased industry imports from low-wage countries, which they also interpret as an attempt to escape competition. We decompose the aggregate import penetration measure into two components, one due to offshoring and a second with all other imports, and show that only the latter is associated with declining industry employment and production.[7] In fact, imports due to offshoring are associated with growth in industry production, highlighting the potential for heterogeneous responses arising not only from firms 'escaping competition', but also from some firms 'exploiting opportunities'. Recognizing the latter is crucial both for an accurate assessment of the effects and best-policy responses to globalization, and to inform models of innovation.

The rest of the paper proceeds as follows. In Section 2 we describe the new offshoring survey and additional data on imports, output, and employment. Section 3 exploits the survey data to analyze how offshoring relates to firm-level imports and domestic production patterns. In Section 4 we introduce a new measure of offshoring and exploit foreign changes in comparative advantage to provide causal evidence on the effects of offshoring on firms' domestic employment composition. Section 5 revisits the industry relationship between low-wage imports and employment. The last section concludes.

[7]While some work documents opposite effects of import penetration in a firm's output versus input industries on its employment (Ding et al., 2020; Mion and Zhu, 2013), we are the first to show how produced-good imports affect firm reorganization. Those studies treat produced-good imports as import competition. Greenland et al. (2019) show that some firms grow in response to China's WTO accession while others shrink or exit (e.g., Apple and Dell versus Gateway), but they cannot identify the mechanisms behind these disparate effects.

2 Data

In this section, we describe the new offshoring survey as well as additional datasets on firms (industry, imports, sales, production, R&D and employment), products (imports, inputs, and domestic production) and workers (occupation).

2.1 Offshoring survey

We use a 2007 offshoring survey run by Statistics Denmark that asked firms about their offshoring decisions between 2001 and 2006. Statistics Denmark surveyed all firms with more than 50 employees that existed in 2005, and firms with 20-50 employees in selected industries.[8] The Danish survey achieved a response rate of approximately 98 percent, which translates to 4,161 firms.

The survey asked firms about their decisions to relocate, either in part or entirely, nine different business functions: core activity; distribution and logistics; marketing, sales and after sales services (including help desk and call center); ICT services; administrative and management functions; engineering work and other technical services; R&D; facility management (cleaning, security, food, etc...); and other functions. We focus on a firm's decision to offshore its core business activity to a foreign location, the most prevalent form of offshoring.[9] The survey instructions specify that a firm's core activity corresponds to its primary industry classification, and includes only those functions that were previously performed domestically, either by the firm itself or by another domestic firm. The offshoring question specifically excludes foreign activities that are new to the firm, i.e. a foreign subsidiary in a new line of business, which are covered separately.

The specific language in the survey asked firms whether they moved a particular activity to one or more of seven distinct regions.[10] These regions are "Old" EU countries (EU15), which comprise the countries that belonged to the EU prior to 2004; New Member States (NMS), which comprise the 12 countries that joined the EU in 2004 and 2007;[11] other European countries; China; India; other Asian countries and Oceania; US and Canada; Central America; and Africa. Firms were also asked whether they offshored their core activity within the same business group or to separate firms.

The survey therefore provides a direct measure of a firm's decision *to begin* offshoring between 2001 and 2006 to a particular region or regions. We focus solely on the relocation of the firm's core activity to a foreign country, regardless of whether this relocation occurred within or outside the boundary of the firm. In practice, the survey suggests that both integrated and outsourced

[8] Certain industries, such as government services were deemed less relevant for measuring offshoring.

[9] See Appendix Table A.1 for statistics on each activity.

[10] The actual Danish language is "...udflytning...", which literally translates to "move out." The precise question is presented in Appendix Figure D.1. The full survey is available here `https://www.dst.dk/da/Statistik/Publikationer/VisPub?cid=13110`.

[11] The 12 NMS countries are Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, and Slovenia, and Slovakia.

offshoring are important. Approximately 44 percent of firms that offshored their core activity did so to other foreign companies (with no ownership or less than 50 percent ownership). The remaining offshored to a partner with an ownership relationship.

2.2 Additional data sources

We combine the offshoring survey data with six different data sources on Danish firms and workers. We use the Firm Statistics Register (FirmStat), which is based on Value-Added Tax (VAT) administrative data, to gather information on firm sales, material expenditures, total employees, and industry (six-digit NACE). We use these data, which are available for the population of Danish firms, to construct a firm-level panel from 1998 to 2008.[12]

We augment the VAT data with product-level information about the values and quantities of firm production from manufacturing surveys (ProdCom). ProdCom data are available beginning in 1997 and cover all manufacturing firms with at least ten employees. They provide information on manufacturing firms' total sales, and crucially for our analysis, distinguish goods the firm manufactures from those that it simply repackages and resells. Our focus is on firms' *Sales of Own Goods*, since that category captures actual manufacturing and explicitly excludes resales and imports (see Appendix Figure E.1). For *Sales of Own Goods*, firms report the value and quantity of their production by ten-digit product codes, the first eight digits of which map to Combined Nomenclature (CN) product codes.

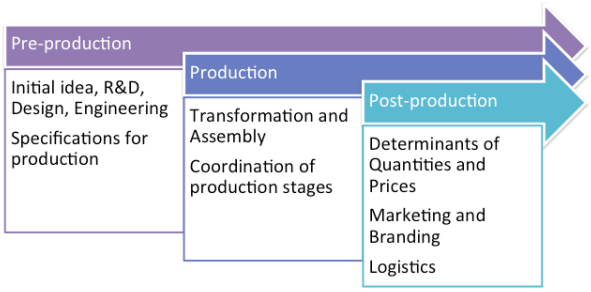
We also exploit a survey conducted by Statistics Denmark that collects manufacturing firms' purchases of intermediate inputs. These data are available for manufacturing firms with at least 50 employees. In principle these data are also available at the HS6 product level, though in practice firms often report only at the more aggregated HS4 industry level.

We link these data to the Danish Foreign Trade Statistics Register. The trade data are based on Customs declarations and cover all international trade transactions of Danish firms by CN8 product and destination or origin. A significant benefit of the Danish data is that products in the trade data are classified using the *same* CN8 codes as the production data. This is a unique feature of the Danish data that allows us to compare firms' production, imports, and exports at the detailed CN8 level without using any concordances. The CN classification system maps to the Harmonized System (HS) at the six-digit level allowing an easy link to public trade data. We use public data from Comtrade on HS6 exports from NMS to other countries in constructing an instrument in Section 4. We adapt the algorithm developed by Pierce and Schott (2012) to construct consistent HS6 codes from 1996 to 2008.

A critical element in our analysis is detailed information about the population of Danish individuals over the period 1998 to 2008 from the matched employer-employee data in the Integrated

[12]Some of the firm-level data continue past 2008 but we stop in 2008 to avoid the Great Recession, and because Danish occupation codes change substantially in 2009.

Figure 1: Complete stages of production activities



Notes: Figure depicts the full range of activities involved in the production of goods. Tech workers fit most closely in pre-production stages, production workers in the production stages, while support and sales occupations correspond to post-production stages; other blue collar are likely in both production and post-production stages.

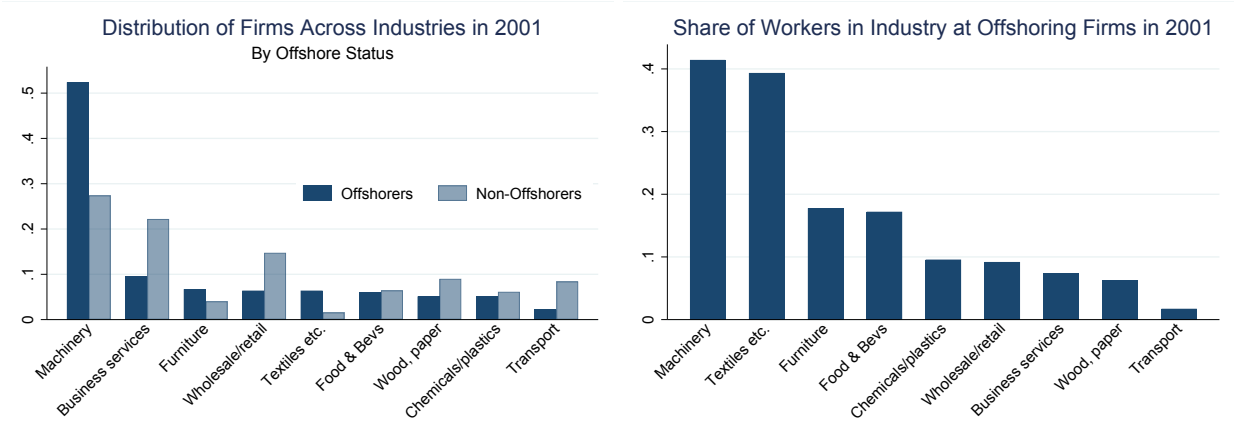
Database for Labor Market Research (IDA). These data cover the universe of the Danish population aged 15-74, including the unemployed and those outside of the labor force. They provide information on workers' gender, age, experience, tenure, wage, education level, and occupation. Workers are linked to the plant and firm where they are employed.

We use the IDA data to define worker occupation groups. Following Bernard et al. (2017), we exploit the detailed occupation codes to assign workers to seven distinct occupational categories based on what workers do: managers; production workers; technology workers (R&D workers, engineers, programmers, and technicians); support workers (office jobs, data entry, legal work, accounting, customer service); sales workers (sales, financing, and procurement); other blue collar workers (transportation and warehousing), and workers not elsewhere classified (NEC).[13] These categories allow us to map occupations to pre-production, production, and post-production activities, as depicted in Figure 1. Tech workers fit most closely in pre-production stages, production workers in the production stages, while support and sales occupations correspond to post-production stages; other blue collar workers are likely active in both production and post-production stages.

Finally, we merge in data from R&D surveys that span the period from 2000 to 2008. The coverage of these surveys varies depending on the year. Firms surveyed are supposed to represent the universe of potential innovators, which means in practice that specific innovative sectors and firms above a certain size threshold are targeted. While the full set of questions in each survey varies by year, we construct a panel of average R&D expenditure, as well as the share of R&D workers in total employment.

[13]Section H in the Appendix explains how we clean the occupation data and map the detailed ISCO codes to these aggregate categories.

Figure 2: Industry shares of offshoring firms and workers



(a) Offshorers and Non-Offshorers Across Sectors

(b) Offshorers' Worker Shares Within Sectors

Notes: The left panel shows how offshorers (dark bar) versus non-offshorers (light bar) are distributed across sectors. The right panel depicts the share of workers within an industry that work at offshoring firms. The bars in the left panel do not sum to one, since only the top 9 offshoring sectors are presented to minimize disclosure concerns.

3 Offshoring Firms

The availability of a direct survey measure of offshoring provides a unique opportunity to analyze the differences between offshoring and non-offshoring firms, both before and after they move their core activity abroad. This section details which industries are offshoring, where they are going and how offshoring relates to changes in firm imports and domestic production.

3.1 Offshoring firm activities across sectors and locations

A total of 380 (9.1 percent) firms relocate some of their core activity to a foreign country between 2001 and 2006, with the majority of these firms classified in manufacturing industries. The left panel of Figure 2 shows the distribution of offshoring firms across the top 9 offshoring sectors, using the firm's industry in 2001. The share of non-offshoring firms in each of these sectors is shown for comparison. Machinery is the largest broad manufacturing sector in Denmark and accounts for more than half of all offshorers versus a quarter of non-offshorers. The remaining offshoring firms are spread across other manufacturing services, as well as Wholesale/Retail and Business services.

The share of industry employment at offshoring firms is also highest in manufacturing. The right panel of Figure 2 shows the share of workers at firms that offshore in the same 9 sectors. About 40 percent of workers in the Machinery and the Textile and Apparel sectors work at firms that offshore from 2001 to 2006. At the other extreme are the Business Services and Transport sectors, where fewer than five percent of workers are employed by offshoring firms. In sum, offshoring firms are disproportionately active in manufacturing; and within manufacturing, the majority are in

machinery. In later sections of the paper, we restrict our sample to firms with production, thereby increasing the importance of the Machinery sector in our results. Among those firms, offshoring is more prevalent, with 16 percent of firms relocating their core activity abroad.

Table 1: Top offshoring destinations

Offshoring of core activity by detailed region

Region	Firm count	Share
New Member States (NMS)	139	0.37
NMS & China	66	0.17
China	60	0.16
Other	115	0.30
Total Offshorers	380	1.00

Notes: Table presents the foreign locations to which firms relocated their core activity between 2001 and 2006. "New Member States" count includes all firms that relocate to the 12 NMS (countries that joined the EU in 2004 or 2007), except those that also report relocating to China. "NMS & China" includes all firms that relocate their core activity to both NMS and China. "China" includes all firms that relocate to China, but not to the NMS. There are 4,161 firms in the survey.

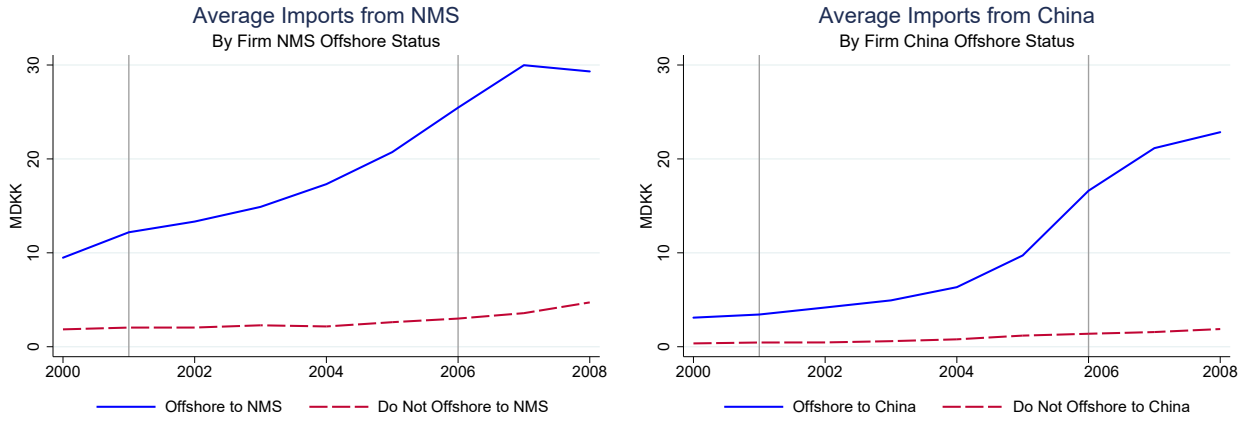
Table 1 provides information about offshoring destinations by region. Between 2001 to 2006, the majority of offshoring firms relocated their core activity to low-wage countries. The two main offshoring destinations are the group of 12 New Member States (NMS) that join the European Union (EU) in 2004 or 2007 and China. 54 percent of Danish offshoring firms report relocating their primary activity to the NMS. Approximately one third of these firms also offshore to China. An additional 16 percent offshore to China (but not to the NMS), making China the second most common destination with 33 percent of firms offshoring there. The primary region in "Other" consists of the 14 higher income countries besides Denmark that had previously joined the EU (Other regions with smaller shares included Other Asia, Other Europe, India, and US+Canada. See Appendix Table A.2).[14]

3.2 Imports and Domestic Production

Table 1 highlights the importance of low-wage countries in firms' offshoring activity from 2001 to 2006. We now exploit the merged offshoring survey, Customs import transactions, ProdCom production data, and input purchases data to analyze offshoring firms' import decisions across locations and product types. To keep things simple, the sample in this section is a balanced panel

[14]The patterns in Table 1 are similar in the sample of manufacturing firms.

Figure 3: Average Firm Imports from Offshore Region



Notes: Figure presents the weighted-average of firm imports from the New Members States (left panel) and from China (right panel). Offshoring firms are those that report locating their core activity to NMS (right panel) or to China (left panel) between 2001 to 2006. There are are 151 offshorers to NMS and 93 offshorers to China. The sample is a balanced panel of 1565 firms in the offshoring survey that exist from 2000 to 2008 and report production in ProdCom in at least one of these years.

of firms that are ever in ProdCom data.[15]

We first assess the extent to which offshoring relates to firm-level imports from those same countries. The left panel of Figure 3 plots the weighted average of firm imports from the NMS, for firms that offshore to NMS versus those that do not. NMS offshorers exhibit substantial growth in their average NMS imports over the period, while non-NMS offshorers' imports are relatively flat. The right panel of Figure 3 displays similar patterns for China. Average imports from China grow even faster over the offshoring period, beginning later than NMS imports and continuing past 2006. We estimate that the average growth rate of imports from NMS or China over the offshoring period is 74.5 log points higher for offshorers to those regions relative to non-offshorers.[16]

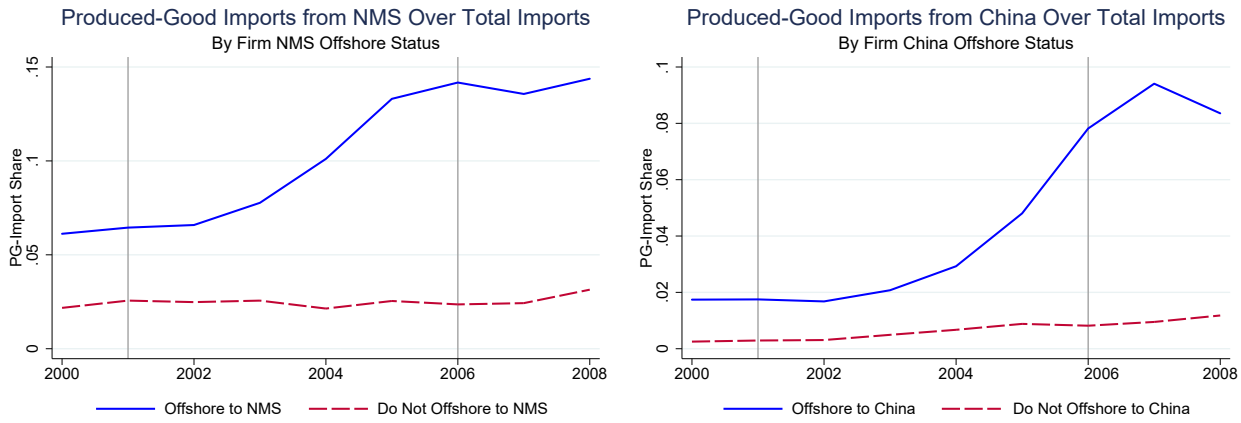
Having confirmed a strong relationship between firm offshoring to a destination and imports from that same location, we now explore the nature of these import flows and how they relate to firms' domestic manufacturing activities. Statistics Denmark collects both domestic production and trade transactions at the eight-digit level in the Combined Nomenclature (CN8). We can thus make direct comparisons of production and imports for detailed products without the need to concord across systems. We use the merged data to identify all imports of HS6 products in year t that the firm also produces in year t, which we refer to as 'produced-good imports.'[17] To ensure

[15] We focus on a balanced panel since the frame for the offshoring survey is based on firms that survived until 2005, so that it is not feasible to analyze entry and exit. We do allow firms to exit ProdCom, however, so that we can assess whether offshoring firms cease their domestic manufacturing activities.

[16] For the sample of firms in the offshoring survey, we regress the growth rate of their imports to NMS or China by firm f measured as $(imports_{f2006}^{region} - imports_{f2001}^{region})/(0.5(imports_{f2001}^{region} + imports_{f2006}^{region}))$ on a region fixed effect and an indicator equal to one if the firm offshores to that region.

[17] Both the production and import data are available at the more detailed CN8 level for Denmark. We report most results at the CN6/HS6 level to allow comparisons with work on other countries, and show that the patterns here

Figure 4: Firm Share of Produced-Good Imports from Offshoring Region



Notes: Left panel presents produced-good imports from NMS over total imports for firms that offshore to NMS versus those that do not. Produced-good imports are imports of HS6 products that the importing firm also produced domestically in the same year. Right panel presents produced-good imports from China over total imports for firms that offshore to China versus those that do not. There are are 151 offshorers to NMS and 93 offshorers to China. The sample is a balanced panel of 1565 firms in the offshoring survey that exist from 2000 to 2008 and report production in ProdCom in at least one of these years.

that we capture actual domestic manufacturing, we restrict our measure of domestic production to ProdCom's "Own Sales" variable. This category contains only goods manufactured by the firm in Denmark – it explicitly excludes traded goods and resales, which are collected separately under "Commercial Resales."

Figure 4 shows that offshoring firms' import growth from NMS and China occurs in the same detailed products that the firm also produces domestically. Firms that offshore to NMS increase their share of produced-good imports from the region almost threefold, while firms that offshore to China more than quadruple their produced-good import share from the country. By contrast, non-offshorers produced-good import shares from both regions are flat over the period.

The rise of produced-good imports by offshoring firms suggests they are transferring production to offshoring destinations, perhaps at the expense of domestic manufacturing. To evaluate the importance of these produced-good imports, we calculate how they relate to firms' domestic production activities. Table 2 reports weighted averages of firm production and imports at the beginning and end of the offshoring period by the production-and-import status of the good for all continuing firms. Row 1 reports average production and imports of HS6 products that the firm both produces and imports in year t. Row 2 reports production on goods that the firm does not import. To assess whether offshoring firms completely replace domestic production with foreign imports, Row 3 reports imports of non-produced goods in year t that the firm produced prior to offshoring (in 1999 or 2000). Row 4 reports average imports of products the firm does not produce, either prior to offshoring or in year t.

are robust to CN8 aggregation in Appendix Section B.1.

Table 2: Average production and imports by HS6 good production and import status, and by firm offshore status

HS6 Product Status in t			Avg Production		Avg Imports	
			2001	2008	2001	2008
Panel A: Offshoring Firms						
1	Produced	Imported	99	125	13	23
2	Produced	Not-Imported	38	25	0	0
3	Dropped	Imported	0	0	3	12
4	Not Produced	Imported	0	0	45	43
Total			137	150	62	78
Panel B: Non-Offshoring Firms						
1	Produced	Imported	66	88	5	9
2	Produced	Not-Imported	27	36	0	0
3	Dropped	Imported	0	0	1	5
4	Not Produced	Imported	0	0	31	44
Total			93	125	37	58

Notes: Table presents the weighted-average of firm production and imports in millions of Danish kroner by HS6 good import-and-production status by year. Row 1 captures goods that are both produced and imported by the firm in the same year. 'Dropped' corresponds to imports of goods that the firm produced in 1999-2000, prior to offshoring. Sample is a balanced panel of firms in the offshoring survey that exist from 2000 to 2008 and report production in ProdCom in at least one of these years. There are 257 offshoring firms and 1308 non-offshorers.

We highlight three key messages from Table 2. First, reinforcing the regional patterns in Figure 4, offshorers reorient towards produced-good imports relatively more than non-offshorers. Offshoring firms' produced-good imports grow from 21 to 29 percent of their total imports (41 percent growth versus just 15 percent growth for non-offshorers)[18] Second, and perhaps most surprisingly, offshoring firms continue, and even expand, domestic production of the same products they import, while they decrease production of the goods they do not import. By contrast, non-offshoring firms' production of imported and non-imported goods grow at the same rate. Finally, both offshorers and non-offshorers increase their imports of goods they produced in 1999 or 2000 but now only import, though these products are a small share of imports and grow faster for non-offshorers. These last two results suggest the link between domestic manufacturing and importing by offshoring firms is not simply one of shutting down domestic production and moving it abroad. Instead offshorers are

[18]Offshorers' share of imports that are produced goods grows from 21 (13/62) to 29 (23/78) percent, while non-offshorers' share grows from 14 (5/37) to 16 (9/58) percent. The higher initial levels of produced-good imports by offshorers consist of imports from the original EU15 countries. See Appendix E.2 for details.

increasing both domestic production and imports in the same narrowly defined goods.[19]

Imports of inputs versus produced goods A majority of offshoring studies focus on imported inputs, which they measure as either (a) all the firm's imports (Halpern et al., 2015; Antràs et al., 2017), (b) the firm's imports of goods in the *same* industry as the firm's outputs (Hummels et al., 2014), or (c) the firm's imports of goods *outside* the same industry as the firm's outputs as inputs (Mion and Zhu, 2013; Boehm et al., 2019). These methods clearly capture different elements (b and c are exact opposites), yet identifying input trade is crucial for assessing theoretical predictions on the effect of imported inputs on domestic outcomes such as employment and inequality. We compare our findings for produced-good imports to standard assumptions used to identify imported inputs by exploiting a novel survey that reports firms' input purchases at the HS4 industry level for manufacturers with at least 50 employees. We use the survey to flag all imports of CN8 products that belong to those input industries as potential imported inputs. We similarly flag all imports of CN8 products within the HS4 industries in which the firm produces as potential produced-good imports.

We summarize the key points here and provide a detailed analysis in Appendix Section B.2. Offshoring firms reorient their imports towards products that are classified in HS4 industries from which they both purchase inputs and produce domestically. In line with our results above, however, these imports are overwhelmingly concentrated in the same CN8 products the firm produces domestically. The vast majority (91 percent) of offshorers' import *growth* from 2001 to 2006 is driven by CN8 products that the firm both produces and imports in the same year. By contrast, this type of imports shrinks in importance for non-offshorers. Prior studies that used imports of goods within the firm's output industries as a proxy for imported inputs thus likely capture non-input trade flows, calling for an alternative interpretation of the mechanisms behind their results.

Our analysis reveals a relatively understudied form of production fragmentation. In contrast to most offshoring models in which firms use imported inputs to substitute for domestically-produced inputs, we show that offshoring firms produce the same goods domestically that they also source from abroad. These findings relate to models of horizontal export platform sales in which firms locate production in a foreign market from which they serve other regions including the home market. Our results suggest this type of offshoring occurs both inside and outside the boundary of the firm, and raises the question of why firms would import from low-wage countries the same goods that they continue to manufacture at home.

[19] A potential question about the measure of produced-good imports is whether it is robust to alternative aggregation levels. In Appendix B.2, we show that most imports of HS6 (HS4) products that the firm produces domestically consist of CN8 goods that the firm both produces and imports (79 percent for offshorers in 2006)

3.3 Vertical differentiation motive for offshoring

Firms may produce the same goods domestically that they also import from low-wage countries to exploit differences in countries' comparative advantage across vertically differentiated varieties. We assess the extent to which this type of vertical differentiation is evident in the data by exploiting detailed (CN8) product-level unit values available for both domestic production and imported goods.[20] We compare the unit values of the same CN8 product produced domestically and imported by the same firm in the same year by estimating:

$$log(UV_{fpct}) = \alpha_t + \gamma_{fp} + \beta Dom_{fpct} + \varepsilon_{fpct}, \quad (1)$$

where α_t are year fixed effects, γ_{fp} are firm-product (CN8) fixed effects, Dom_{fpct} is an indicator equal to one for the domestic variety, and $log(UV_{fpct})$ is the log of the unit value of the product by source country c. Standard errors are clustered by CN8 product.

We limit the analysis to a sample of firm-CN8 products from 2000 to 2008 with both production in Denmark and imports in the same year.[21] In these regressions, we focus on firms in the offshoring survey so that we can assess whether the *differences* in unit values also vary systematically for firms that report relocating their core activity to a foreign region. The firm-product fixed effects remove any firm-specific differences in costs, markups, or quality.

Table 3 presents the results from estimating equation (1) via OLS. The coefficient on domestically-produced varieties is large, positive, and statistically significant. Column 1 shows that, on average, domestic varieties' unit values are 60 log points higher than their imported counterparts within the same firm and year. This large difference favors the explanation that firms offshore lower quality versions of the goods they produce domestically.

We further highlight the potential role for vertical differentiation in offshorers' motives by interacting the domestic variety indicator with another indicator equal to one for firms that report offshoring in the survey. Column 2 in Table 3 reports the estimate for the interaction term. Consistent with the premise that firms relocate their main activity to access lower production costs, the interaction between the offshoring dummy from the survey and the domestic unit value shows that the price gap is 27 log points higher for firms that report relocating their core activity abroad.

The final column of Table 3 includes country or region-specific indicators for the imported varieties for the top three offshore regions. Prices of imports from China are 42 log points lower than than those for imports from all locations other than NMS, China and EU15, and NMS imports

[20] Unit values are well-known to be a problematic proxy for quality. The problems include variation in input costs across source countries and well as variation in markups. In this section, some of those issues are resolved or mitigated by the fact that we compare products under control of the same firm and include firm-product fixed effects.

[21] The unit value for the domestic variety comes from the ProdCom survey and represents the domestic factory gate price, while the unit value for the imported variety comes from the Danish customs data and represents the imported price.

Table 3: Comparison of domestic and import unit values for the same firm-product

Dependent variable - the log unit value of a CN8 product

	(1)	(2)	(3)
Domestic variety	0.596***	0.520***	0.566***
	(0.096)	(0.093)	(0.117)
Domestic × Offshorers		0.268**	0.205*
		(0.113)	(0.112)
China			-0.423***
			(0.066)
NMS			-0.200***
			(0.058)
EU15			0.123**
			(0.060)
Constant	3.966***	3.966***	3.946***
	(0.039)	(0.039)	(0.067)
R2	0.70	0.70	0.70
Year Fixed Effects	Yes	Yes	Yes
Firm-by-Product Fixed Effects	Yes	Yes	Yes
Observations	37,450	37,450	37,450

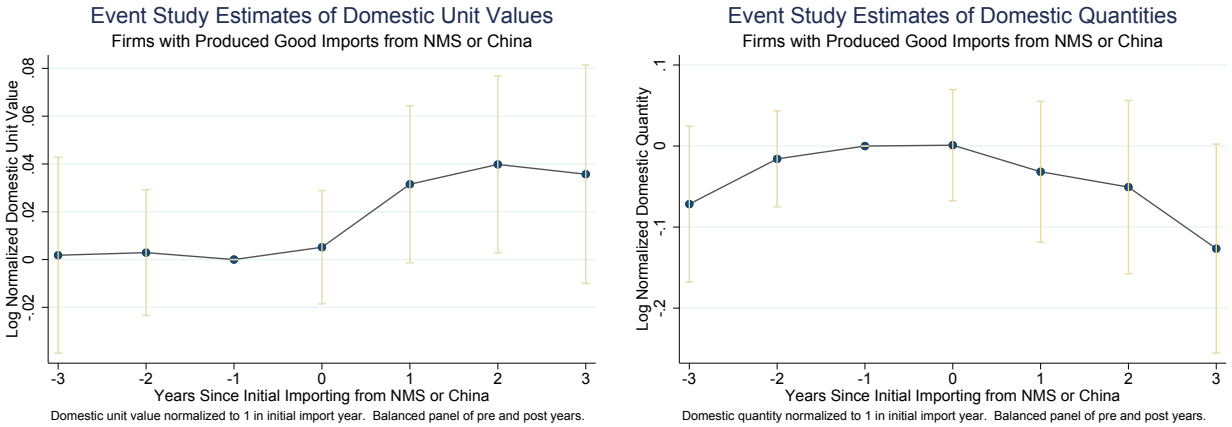
Notes: The sample includes all firm-product-year combinations from 2001-2008 where there is both domestic production and importing of the same CN8 product by the firm in the same year. The dependent variable is the log of the unit value. "Domestic" is a dummy for whether the variety is produced domestically; "Offshorer" is a dummy for whether the firm offshored its core activity during 2001-2006; "China", "NMS" and "EU15" are dummies for whether the imported variety comes from China, the NMS, or the EU15 respectively. Standard errors clustered by CN8 product. * p<0.10, ** p<0.05, *** p<0.01.

are 20 log points lower. By contrast, import unit values from the 14 EU countries are 12 log points higher. These patterns suggest quality differentiation within a detailed product category that differs systematically across countries, as seen by firms' semiconductor sourcing decisions (e.g. Byrne et al., 2017) or more generally (e.g., Schott, 2004, 2008), with firms offshoring production of especially low-quality versions to China and NMS countries.

The systematic variation in unit values across locations is consistent with lower-quality varieties being sourced from China and NMS, but relies on different data sources that may contain variation in markups. We now focus exclusively on the evolution of firms' domestic unit values pre- and post-importing for a particular CN8 product. If offshoring enables firms to focus on higher quality or more technologically advanced varieties at home, the unit value of domestically-produced offshored goods should rise after firms begin to import them.

To assess the extent to which offshoring firms' domestic prices change in conjunction with decisions to offshore, we estimate how firms' domestic unit values evolve in an event-study setting. We focus on firms that produce the same detailed product for at least 7 consecutive years, that also

Figure 5: Evolution of domestic unit values and quantities after offshoring



Notes: Left panel presents coefficient estimates from regressing the log of the domestic unit value, normalized to one in the initial import year, for a CN8 product that the firm produces at least two years without importing, begins to import from NMS or China in year 0, and continues to produce domestically for at least 3 more years. Right panel presents coefficient estimates for the log of normalized quantity for these same goods. Sample consists of 3,689 firm-product combinations. Standard errors clustered by CN8 product.

start importing the product during the period, and for which we observe at least three years of pre-importing and three years of domestic production after the initial importing. To address differences in magnitudes across unit values, we normalize unit values to one within each firm-product in the firm's initial import year, and estimate

$$log(UV_{fpt}) = \alpha_t + \sum_k \beta_k \Delta Imp_{fp,t+k} + \varepsilon_{fpt}, \tag{2}$$

where α_t denotes year fixed effects, $\Delta Imp_{fp,t+k}$ is a series of indicators that identify the firm's initial import year of the product, and (UV_{fpt}) is the normalized domestic unit value. To gain a sense of whether this increase reflects offshorers' ceasing domestic production of lower quality versions (e.g., as proposed in Schott, 2008), we estimate a variant of equation (2) using the log of the normalized quantity of the domestically-produced good as a dependent variable. We cluster the standard errors by CN8 product category.

Figure 5 presents the event study coefficients (also in Appendix Table C.1), and shows a clear increase in domestic unit values after firms begin offshoring the good. The right panel of Figure 5 depicts the evolution of the quantity of domestic production. Consistent with firms shifting production of their lower-quality versions to low-wage countries, the quantities of the domestically-produced varieties fall gradually over time, and are approximately 10 percentage points lower three years after offshoring begins. This pattern of rising unit values and falling quantity is consistent with firms focusing domestic production on higher quality or more technologically advanced varieties in their home market.

Market power, demand shocks, and data manipulation concerns Alternative explanations for the rising domestic unit values of the CN8 products that firms begin to import from NMS or China include firms exploiting importer market power or firm-product specific demand shocks. We assess these alternatives by examining the evolution of imported unit values and quantities for firms that produce a CN8 domestically and then begin to import the good. If firms start importing in response to positive demand shocks or are exerting market power on the imported variety, we would expect unit values of imported varieties to rise over time.

We show that produced-good import unit values fall, whereas their quantities rise after firms begin to import them (see Appendix Figure C.1). These results contrast sharply with the rising unit values and falling quantities for the domestic counterparts depicted above. The sharp distinctions in price and quantity dynamics for domestic versus imported varieties of the same CN8 good are consistent with firms offshoring production of lower-quality varieties to low-wage countries, and at odds with demand shocks or market power exploitation. The divergence in domestic versus imported quantities of a CN8 good that the firm both produces and imports is also reassuring evidence that firms are not importing products, relabeling them, and claiming to have produced them in Denmark. Instead, we observe a decline in the domestic production quantity while the import quantity rises.

We find that Danish firms exploit low-income countries to produce vertically differentiated varieties of the same goods they manufacture at home. These produced-good imports are distinct from imports of intermediate inputs and instead align more closely with a small set of export-platform FDI models, in which country-specific productivity advantages motivate firms to locate production of horizontal varieties abroad. While the production structure in those models implies that firms will re-export foreign varieties back to their home markets, the papers largely ignore that prediction in their analysis and quantification. Here, we show that these produced-good import flows are sizable, relate to systematic variation in prices suggestive of vertical differentiation in production across space, and are accompanied by rising prices of the firms' domestic production. These results point to offshoring due to comparative advantage motives for the production of vertically differentiated varieties, instead of the horizontal proximity-concentration tradeoff that has been the focus of prior work. In the next section, we assess how this type of offshoring causes firms to reorganize, affecting both the levels and composition of their domestic employment.

4 The Impact of Production Relocation on Domestic Employment

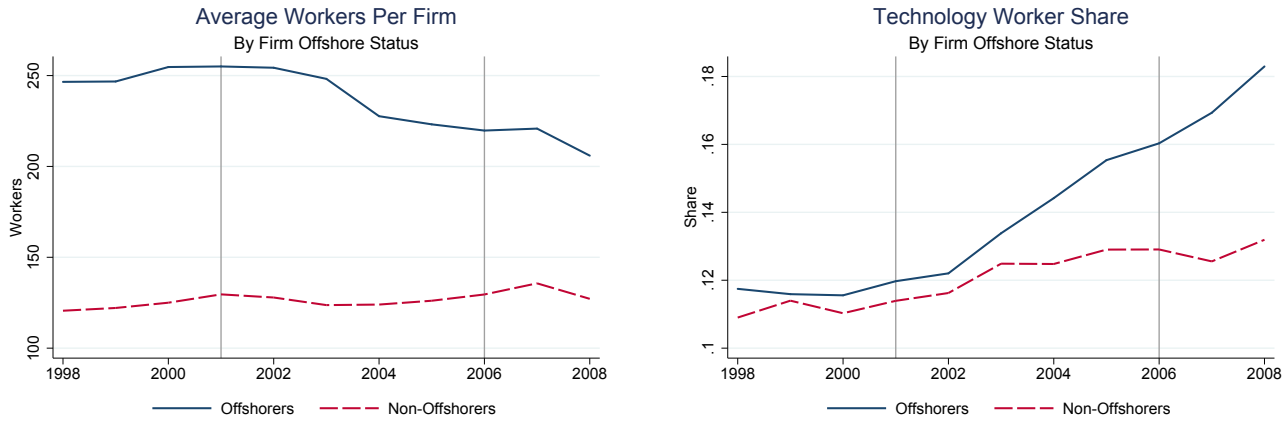
In this section, we study how firms' relocation of production to low-wage countries affects their domestic employment activities. First, we examine how firms that report offshoring in the survey compare to non-offshorers in their employment patterns over time and across occupations. Second,

we develop a new measure of offshoring for a firm to a region and an instrumental variable strategy to establish a causal link between firm-specific offshoring opportunities and subsequent reorganization. Since our new offshoring measure relies on production information from ProdCom, we continue to focus on a balanced panel of firms that are ever in ProdCom over the period.

4.1 Employment and occupation responses at offshoring firms

Prior research has used firm-level data to document negative employment consequences of offshoring, particularly for low-skill workers. The left panel of Figure 6 depicts the weighted average of firm employment by offshore status from the survey.[22] As expected, offshoring firms are much larger than non-offshorers at all points in time. However, offshoring firms reduce their average employment over the period while non-offshorers' average size trends upward, in line with results from other studies including those on Danish manufacturing (e.g., Hummels et al., 2014).

Figure 6: Employment by firms' offshore status



Notes: The left panel presents the weighted average of employment at firms that offshore to new foreign locations between 2001 to 2006 and those that do not. The right panel presents the weighted average of the share of tech workers by firm offshore status. Sample is a balanced panel of firms in the offshoring survey that exist from 1998 to 2008 and that appear in ProdCom at least once in this interval.

This decline in total employment masks important changes in employment composition across occupations at offshoring versus non-offshoring firms. The right panel of Figure 6 plots the share of technology workers within the firm over the same period. While tech worker shares are initially similar and trend upwards at both firm types starting in 2000, there is a clear break in this trend for offshorers in 2002 that is notably absent for non-offshorers. By 2008, offshoring firms have over 18 percent of their employment in tech occupations, versus only about 13 percent for non-offshoring firms.

To examine the full scope of firms' occupational changes, Table 4 presents weighted average

[22] Appendix Figure F.2 depicts a comparable pattern when non ProdCom firms are included.

Table 4: Employment type

Relative worker occupation shares by offshore status

Panel A: Offshoring firms	1998	2001	2006	2008
Production workers	1.07	1.04	1.00	0.96
Other blue collar	0.89	0.99	0.80	0.86
Tech workers	**1.02**	**1.01**	**1.12**	**1.21**
Support workers	0.96	0.99	1.06	1.10
Sales workers	0.93	0.94	0.99	1.00
Managers	0.84	0.84	0.89	0.91
NEC	0.85	0.79	0.82	0.68
Panel B: Non-offshoring firms				
Production workers	0.97	0.98	1.00	1.01
Other blue collar	1.04	1.01	1.07	1.05
Tech workers	**0.99**	**0.99**	**0.96**	**0.93**
Support workers	1.02	1.00	0.98	0.97
Sales workers	1.03	1.02	1.00	1.00
Managers	1.06	1.06	1.04	1.03
NEC	1.06	1.08	1.06	1.10

Notes: Table presents weighted average shares of firm employment by category divided by the weighted industry average of the employment share in that category. Production workers include a wide range of production activities across sectors; "Other blue collar" workers include transportation and warehousing jobs; Tech workers include R&D workers, engineers, programmers, and technicians; Support workers include office jobs, data entry, legal work, accounting, customer service; Sales workers include sales, financing, and procurement. Offshoring firms report relocating their primary activity to new foreign locations between 2001 to 2006, while non-offshorers do not. Sample is a balanced panel of firms in the offshoring survey that exist from 1998 to 2008 and that appear in ProdCom at least once in this interval.

employment shares across seven occupation categories over the period 1998 to 2008. We focus on the seven occupation categories described in Section 2.2: managers, technology, support work, sales, production work, other blue collar, and NEC. To control for industry compositional differences, we divide a firm's employment share in each category by the average employment share in the firm's primary two-digit NACE industry. A value of 1.0 indicates that the firm-level average is equal to the industry-level average.

There is one key message from Table 4. While offshoring and non-offshoring firms start with relatively similar shares of tech workers in 1998 that are close to their industry average (1.02 versus 0.99), the average share of tech workers rises dramatically for offshorers over the period, while it falls for non-offshorers. By 2008, offshoring firms have 21 percent higher shares of tech

workers than their industry average, while non-offshorers are well below their industry average (0.93). This shift towards technology workers for offshorers is accompanied by falling shares of production workers, while non-offshorers increase their production worker shares. Offshoring firms also increase their share of support workers from 0.96 of their industry average to 1.10, while non-offshorers decrease their share of support workers. The employment composition changes at offshoring firms are thus consistent with them re-orienting their domestic activities towards pre-production and post-production tasks related to manufacturing, as depicted in Figure 1.

It is possible that the rising share of tech workers at offshoring firms is due to their falling total employment. In Appendix Figure F.3 we show that the average number of tech workers grows throughout the offshoring period for offshoring firms. Offshorers' reorientation towards technology activities is a combination of rising employment in innovation-related occupations and a reduction in production workers. We next describe a new firm-level measure of offshoring and identification strategy to estimate the causal relationship between offshoring and the changing nature of work within the firm.

4.2 Produced-good import measure of offshoring

To identify the impact of offshoring on firm reorganization, we first introduce a new measure of offshoring for a firm to a region motivated by the analysis in Section 3.2: the ratio of a firm's HS6 produced-good imports from that region to its total imports. This measure captures the main source of offshoring firms' import growth in our sample, is available for all years and firms with production and trade data, and is not driven by firm-level shocks that scale with total import growth.

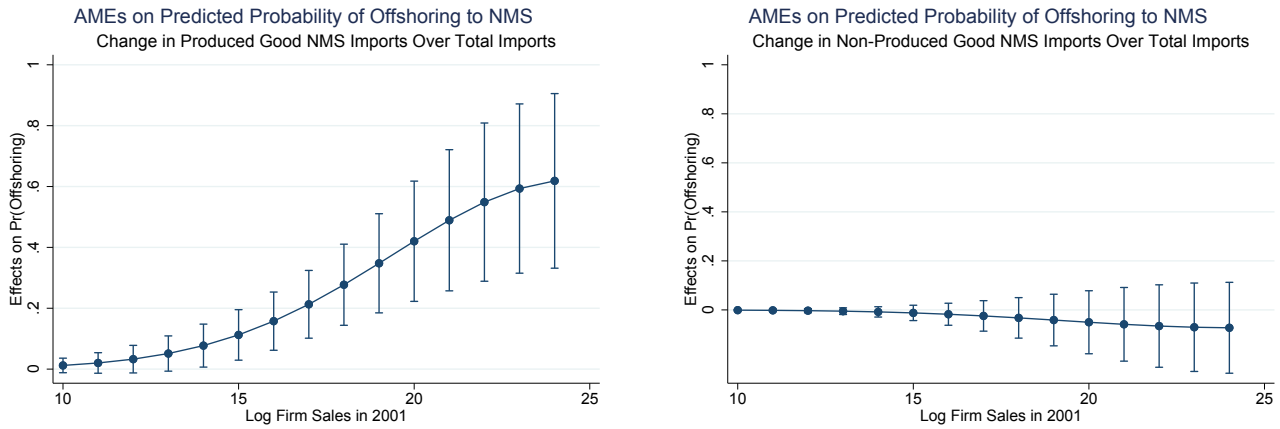
To provide additional support for the validity of this new measure, we estimate the probability that a firm reports offshoring to a region in the survey, as a function of the change in its produced-good import share. Specifically, we estimate:

$$Pr(\Delta Off_f^{NMS} = 1|X_f) = \alpha + \beta_{PG}\Delta\frac{PG\ Imports_f^{NMS}}{Imports_f} + \beta_s log(sales_f^{2001}) + Ind_f, \qquad (3)$$

where $\Delta\frac{PG\ Imports_f^{NMS}}{Imports_f}$ is the change in the firm's produced-good import share from 2001 to 2006, Ind_f are 2-digit NACE fixed effects, and $sales_f^{2001}$ is the firm's sales in 2001. We present the results from estimating the probability of offshoring to the NMS as it is the primary location to which Danish firms offshore, and our instrumental variable strategy focuses on that region.

Figure 7a reports the average marginal effects (AMEs) of changes in import shares on predicted offshoring to the NMS from 2001 to 2006. The AMEs are positive and significant across the entire range of firm sizes but strongest for the largest firms (see Appendix Table F.1 for the estimated coefficients). Figure 7b shows that changes in a firm's non-produced-good import shares from a

Figure 7: Offshoring and Produced-Good Imports



(a) Produced good import share (b) Non-Produced good import share

Notes: The left panel presents the average marginal effects of changes from 2001 to 2006 in a firm's produced-good imports from NMS over total imports on the probability that the firm reports relocating its core activity to NMS from 2001 to 2006, as a function of firm sales in 2001. The right panel presents the average marginal effects of changes from 2001 to 2006 in a firm's non-produced good imports from NMS over total imports on the probability that the firm reports relocating its core activity to NMS from 2001 to 2006. Produced-good imports are imports of HS6 goods that the firm produces domestically in that year. Sample is a balanced panel of firms in the offshoring survey that exist from 2001 to 2006 and that report production in ProdCom.

region are unrelated to the probability that it reports offshoring to that region.[23]

We next exploit this new firm-level measure to estimate the causal impact of offshoring on firms' employment, production, and workforce composition. Such an analysis is not possible with the binary offshoring indicator from the survey. In addition, it allows us to study offshoring decisions and outcomes at the product level for all manufacturing firms in Denmark over a longer time horizon.

4.3 Identification strategy

We analyze the impact of offshoring on two aspects of firms reorganization. First, we ask whether offshoring reduces firm employment and domestic output. The survey data show falling employment and constant, or rising, output at offshoring firms but do not establish the causality of those outcomes. The second focus is on the role of offshoring in changing the composition of the domestic workforce. In particular, we assess whether offshoring plays a role in increasing the tech worker share in employment and reducing the production worker share, as seen in the survey results. Reorganization of this type suggests that the innovative capabilities at offshorers are not reduced, and potentially enhanced, by a firm's ability to move some activities out of the domestic market.

We concentrate on offshoring to the New Member States (NMS), the main offshoring location for Danish firms. We measure firm-level offshoring as the change in the share of produced-good

[23]Similar results for China are presented in Appendix Figure F.1.

imports from the NMS in total imports, and estimate its relationship with changes in firm outcomes according to

$$\Delta FirmAttribute_{ft} = \alpha + \beta_{PG}\Delta\frac{PG\ Imports_{ft}^{NMS}}{Imports_{ft}} + Ind_{ft} + \varepsilon_{ft}, \tag{4}$$

using two stacked five-year difference panels for our full panel from 1998 to 2008. Firm attributes are firm size, occupation shares, and growth rates. Ind_{ft} are two-digit NACE fixed effects in the initial year of each panel, which control for differential trends across sectors. Since our aim in this section is to estimate the causal impact of offshoring, we identify a firm's produced-good imports based on its production in $t-1$ and t for each panel. We weight the regressions by firm employment in the initial year of each panel.[24]

To identify changes in offshoring due to factors exogenous to the firm, we construct an instrument based on the desirability of locating production in the NMS by exploiting changes in that region's comparative advantage across goods. Specifically, our shock is the five-year change in the NMS export share to the rest of the world (ROW), excluding Denmark, for a particular HS6 product. An increase of the export share by NMS signals increasing NMS comparative advantage.[25] We focus on this region since it constitutes the main offshore location for Danish firms and the member countries underwent significant reforms starting in the mid-1990s required to join the European Union (EU) in 2004 and 2007. These internal changes led to large shifts in the composition of their exports, and the five-year changes from 1998 to 2008 provide a reasonable first stage in predicting firms' produced-good import shares.

The export share changes are at the product level, but we require a firm-level instrument to predict changes in offshoring. In particular we aim to distinguish between offshoring activities of different firms in the same sector. To capture the extent to which a particular firm may exploit lower production costs in the NMS, we use each firm's production across HS6 products in an initial year to weight the product-level shocks. Specifically, we aggregate the change in the export share in product p to the firm level according to:

$$Shock_f^{NMS} = \sum_{p \in f} ProdShare_{fpt_0} \times \underbrace{\Delta\frac{Exports_p^{NMS}}{Exports_p^{World}}}_{\substack{\text{NMS comparative} \\ \text{advantage growth}}}, \tag{5}$$

[24] A potential concern with using product-level shares of produced-good imports rather than levels is we might understate offshoring for firms that only grow their imports of produced-goods. We use the share approach since it captures the changing composition of offshorers' imports documented in Section 3.2, controls for any aggregate shock to the firm that increases all imports, and is more likely to bias the results down.

[25] A potential issue with our instrument might arise if changing NMS comparative advantage were correlated with immigration flows from NMS to Denmark. Since Denmark did not allow for free movement of people from NMS until May 1, 2009 (Constant, 2011), this is unlikely to be an issue in our study.

where $ProdShare_{fpt}$ is a firm's initial HS6 production share in product p and $\frac{Exports_p^{NMS}}{Exports_p^{World}}$ is the share of NMS exports in total world exports of product p. We exclude Denmark as a destination from these export shares and lag the shares by two years to reduce the possibility that Danish firms' offshoring decisions drive changes in NMS export shares.[26] In the language of recent shift-share analyses, we treat the changes in NMS market shares as exogenous to Danish firms' domestic organizational decisions.

To assess whether our shock is an industry or firm-specific measure, we calculate the product-share variation across firms within industries. The average NMS offshoring firm produces 5.3 unique products, while the average non-NMS offshorer produces 3.4 products. For all firms, the average of the firm-level median product share is 0.48 for NMS offshorers and 0.57 for non-NMS offshorers.[27] This variation in firms' production shares across goods enables us to include industry fixed-effects in our specifications, thus controlling for any industry-level trends over the periods.

Since this measure of offshoring opportunities is based on product-level variation, we cluster the standard errors by the firm's main HS2 industry based on its sales. We also report the standard errors developed by Borusyak et al. (2022) in the appendix, which are similar to our clustered standard errors in the main text.

Our measure of foreign exposure differs from those used in Autor et al. (2013) and Hummels et al. (2014) in two ways. First, we follow Antràs et al. (2017) and use changes in NMS export shares to the ROW rather than level growth in exports, which reduces the possibility that the instrument is driven by correlated demand or technology shocks across countries. Second, our measure is available for all manufacturing firms based on their initial domestic production, instead of being limited to changes in particular country-product pairs of the firm's prior imports. Our approach thus captures both intensive *and* extensive margin changes in offshoring opportunities. We find that extensive-margin changes are particularly important for offshoring to newly integrated low-wage regions. In our sample, approximately ten percent of firms start importing the goods they produce domestically from the NMS, which is quite large relative to the 9 percent of all firms that report relocating their core activity to any country over the 2001 to 2006 period (see Table 1).

Using the firm-specific offshoring shock defined in equation (5), our first-stage regression is

$$\Delta \frac{PG\ Imports_f^{NMS}}{Imports_f} = \alpha + \beta_{Shock} Shock_f^{NMS} + Ind_{ft} + \varepsilon_f, \tag{6}$$

[26] We use the firm's production in $t-1$ and t to calculate its initial production shares to minimize noise from lumpy production. We are limited to lagging the export shares by two years due to a significant change in the HS classification system in 1996. In Appendix Figure I.1, we show that NMS exports to Denmark are a tiny fraction of their exports to the ROW, suggesting that Denmark is relatively unimportant in NMS aggregate activity.

[27] As an example of the variation we exploit, consider a hypothetical firm in the two-digit NACE industry "Manufacture of electrical equipment (27)." Potential HS6 products that firm could produce include: 850110 (Electric motors; of an output not exceeding 37.5W), 850151 (Electric motors; AC motors, multi-phase, of an output not exceeding 750W), and 850161 (Generators; AC generators (alternators), of an output not exceeding 75kVA).

where we predict changes in a firm's produced-good import share from NMS as a function of changing comparative advantage in that region in the mix of products that the firm made in the pre-period. The key identifying assumption is that NMS market share gains in a product are due to increased NMS productivity or decreased trade costs. The exclusion restriction requires that improvements in NMS comparative advantage in a firm's products only affect the firm's domestic activities through the offshoring decision.

A potential violation of the exclusion restriction is that improvements in NMS comparative advantage may also increase import competition from NMS into Denmark, which may affect both offshoring (Rodriguez-Lopez, 2014) as well as domestic employment or innovation (Utar, 2014; Bloom et al., 2016). China's rise in world markets may also be correlated with NMS changing market shares. While the two-digit industry fixed effects we include address any broad sector trends in import penetration, variation within sectors might bias our estimates. We therefore construct two measures of firm-level import penetration, one for imports from the NMS and one for imports from China, using the same HS6 detail we exploit to construct the instrument. Specifically, we measure changes in firm-specific import penetration as

$$\Delta ImpPen_f^{Source} = \sum_{p \in f} ProdShare_{fpt_0} \times \Delta \frac{Imports_{DKp}^{Source}}{Imports_{DKp}^{World} + DomProd_{DKp}}, \tag{7}$$

where the source regions are NMS and China, respectively, $Imports_{DKp}$ are imports of product p into Denmark, and $DomProd_{DKp}$ is Danish production of product p. We exclude each firm's own imports and production when calculating its import penetration measure. As when constructing the instrument, we weight changes in product-level import penetration using the firm's initial-period production across products. Directly controlling for these measures of import competition does not materially affect our first stage estimates, and we present robustness analyses of the reduced-form and second stage estimates with these controls in Table 8 and Appendix Table F.5. Our analysis therefore shows the effect of new offshoring opportunities, netting out any potential role for import competition.

4.4 Results

Results from the first stage estimation for two stacked five-year differences for 1998 to 2008 are presented in Table 5. Changes in the firm's product-weighted NMS export shares are positively and significantly correlated with changes in its share of produced-good imports from the NMS. This relationship holds even after controlling for import penetration from China and the NMS. Reassuringly, the coefficient estimate is relatively stable across all specifications, suggesting that import competition from the NMS into Denmark is sufficiently different from Danish offshoring to NMS to identify its effect. Since the instrument is constructed from product-level shocks, we cluster the standard errors by two-digit HS sectors. The Kleibergen-Paap F-Statistic in our baseline

Table 5: First Stage Estimates

Dependent variable is $\Delta PG\ ImpSh_f^{NMS}$				
	(1)	(2)	(3)	(4)
$\Delta ExportSh_f^{NMS}$	0.361***	0.333***	0.362***	0.334***
	(0.120)	(0.115)	(0.121)	(0.116)
$\Delta ImpPen_f^{NMS}$		0.183**		0.186**
		(0.077)		(0.076)
$\Delta ImpPen_f^{China}$			0.022	0.043
			(0.139)	(0.136)
KP-Fstat	8.994	8.302	9.005	8.278
R^2	0.052	0.056	0.052	0.057
Observations	5,159	5,159	5,159	5,159

Notes: Dependent variable is $\Delta PG\ ImpSh_f^{NMS}$, the change in the firm's produced-good import share from NMS, based on the firm's initial-period domestic production. $\Delta ExportSh_f^{NMS}$ is a firm-specific weighted average of the change in NMS market shares by product in ROW, based on the firm's initial-period domestic production shares. $\Delta ImpPen_f^{NMS}$ and $\Delta ImpPen_f^{China}$ are firm-specific measures of the change in import penetration from NMS and China, based on the firm's initial-period domestic production shares. The firm's own imports and production are excluded from the product-level import-penetration measures. Two stacked five year differences for 1998 - 2008. Regressions are weighted by employment and include industry (NACE2) and year fixed effects. Standard errors clustered by HS2 sector. * p<0.10, ** p<0.05, *** p<0.01

specification (Column 1) is of reasonable magnitude, at 9.0. To address potential concerns about weak instruments, we also report the reduced-form estimates and the Anderson-Rubin Chi-squared statistic in all the two-stage least squares (2SLS) estimates and focus on the reduced-form estimates in which we regress firm outcomes directly on the instrument.

Table 6 contains the main results on the effects of new offshoring opportunities on firm organization. We report OLS, reduced-form, and two-stage least squares estimates of equation (4) for changes in the log of firm employment and production, as well as changes in employment shares of tech, support, and production workers. The results are generally similar across specifications, although the magnitudes of the coefficients vary.

The OLS estimates are consistent with the descriptive evidence from the offshoring survey. Firms that increase their share of produced-good imports from the NMS by ten percentage points shrink their domestic employment by approximately 19 percent, while the value of their domestic production is unchanged. Consistent with offshoring firms increasing innovation as they reorient domestic production into higher-price, more technologically advanced varieties, the decline in total

Table 6: Firm Outcomes - Output, Employment, and Workforce Composition

A: OLS	Δ log Emp	Δ log Production	Δ Share of Workers in Tech	Support	Production
$\Delta PG\ ImpSh_f^{NMS}$	-0.192**	0.000	0.020***	0.040***	-0.070***
	(0.072)	(0.090)	(0.008)	(0.009)	(0.015)
R^2	0.044	0.071	0.029	0.042	0.052
B: Reduced Form					
$\Delta PG\ ImpSh_f^{NMS}$	-0.731**	-0.047	0.078**	0.088	-0.213**
	(0.371)	(0.976)	(0.033)	(0.059)	(0.089)
R^2	0.044	0.071	0.028	0.039	0.050
C: IV					
$\Delta PG\ ImpSh_f^{NMS}$	-2.024*	-0.130	0.215**	0.243*	-0.589**
	(1.169)	(2.665)	(0.099)	(0.140)	(0.257)
KP-Fstat	8.994	8.994	8.994	8.994	8.994
AR Chi-sq P-val	0.05	0.96	0.02	0.13	0.02
Observations	5,159	5,159	5,159	5,159	5,159

Notes: Dependent variables are the change in the firm outcome noted in column headers. $\Delta PG\ ImpSh_f^{NMS}$ is the change in the firm's produced-good import share from NMS, based on the firm's initial-period domestic production. $\Delta ExportSh_f^{NMS}$ is a firm-specific weighted average of the change in NMS market shares by product in ROW, based on the firm's initial-period domestic production shares. Panel C uses $\Delta ExportSh_f^{NMS}$ as an instrument. Regressions are based on 2 stacked five-year differences for 1998 - 2008, weighted by initial employment, and include industry (NACE2) and year fixed effects. Standard errors in panels B and C clustered by HS2 sector. * p<0.10, ** p<0.05, *** p<0.01.

employment is accompanied by a shift away from production workers and into technology and support-worker occupations.

Panels B and C of Table 6 present the reduced-form and IV estimates, which are driven by changes in NMS offshoring opportunities, as opposed to firms' endogenous offshoring decisions. The reduced-form and IV estimates point to a large impact of new low-wage offshoring opportunities on firms' domestic employment composition. Focusing on the reduced-form estimates, a one percentage point increase in offshoring leads to a 0.08 point increase in the share of tech workers. The average tech worker share increase over this period was only 0.01 points, so this is an economically large effect. That same increase in offshoring leads to a 0.21 point decline in the production worker share. Offshoring firms are not merely shrinking employment at home, they are changing what they do. These offshoring firms are reorganizing themselves to focus on non-manufacturing aspects of value-added creation by focusing on pre-production and post-production stages as shown in

Table 7: Firm Outcomes - Growth Rates and Switchers

A: OLS	Growth Rate of Workers in			Δ Share
	Tech	Support	Production	Tech Switchers
$\Delta PG\ ImpSh_f^{NMS}$	0.038	0.058	-0.221***	0.001
	(0.097)	(0.076)	(0.065)	(0.003)
R^2	0.023	0.035	0.064	0.054
B: Reduced Form				
$\Delta ExportSh_f^{NMS}$	0.889**	0.032	-1.033***	0.031**
	(0.400)	(0.475)	(0.385)	(0.015)
R^2	0.024	0.035	0.064	0.055
C: IV Estimates				
$\Delta PG\ ImpSh_f^{NMS}$	2.464*	0.088	-2.863**	0.086*
	(1.426)	(1.292)	(1.298)	(0.051)
KP-Fstat	8.994	8.994	8.994	8.994
AR Chi-sq P-val	0.02	0.95	0.01	0.04
Observations	5,159	5,159	5,159	5,159

Notes: Dependent variables are the growth rate of worker types denoted in column headers, defined as $\frac{(Occup_{f,t+5}-Occup_{f,t})}{0.5(Occup_{f,t+5}+Occup_{f,t})}$. Δ Share Tech Switchers is the change in the share of tech workers that switched into tech occupations within the firm. $\Delta PG\ ImpSh_f^{NMS}$ is the change in the firm's produced-good import share from NMS, based on the firm's initial-period domestic production. $\Delta ExportSh_f^{NMS}$ is a firm-specific weighted average of the change in NMS market shares by product in ROW, based on the firm's initial-period domestic production shares. Panel C uses $\Delta ExportSh_f^{NMS}$ as an instrument. Two stacked five year differences for 1998 - 2008. Regressions are weighted by initial employment and include industry (NACE2) and year fixed effects. Standard errors in panels B and C clustered by HS2 sector. * p<0.10, ** p<0.05, *** p<0.01.

Figure 1.

In Table 7, we examine growth rates in levels of the three types of workers to assess whether the growth in non-production worker shares is driven solely by falling total employment. We follow Davis et al. (1998) and define growth rates of worker types as $\frac{(Occup_{f,t+5}-Occup_{f,t})}{0.5(Occup_{f,t+5}+Occup_{f,t})}$ to allow for extensive margin changes in firm employment across occupations. In both the reduced-form and the IV estimates, the data indicate that new low-wage offshoring opportunities raise firm growth in tech-worker occupations, but decrease growth in production workers. Both the levels and shares of tech and production workers change in response to NMS offshoring. A 10 percentage point increase in NMS market shares in a firm's products leads to 0.09 point increase in its growth of tech workers. This effect is economically large when compared to the average growth of tech workers of 0.03.

The rise in the share and level of tech workers in offshoring firms is driven in part by occupation

switching within the firm. By tracking worker employment and occupation over time, we calculate the extent to which the same workers switch into a tech occupation within the firm. The final column of Table 7 shows that offshoring is positively associated with the share of tech workers that come from other occupations in the same firm. Focusing on the reduced-form estimates, which are the most precise, we find that a ten percentage point increase in offshoring opportunities leads to 0.003 point increase in the share of tech switchers. Since the average change in the share of these switchers is only 0.0004, this is an economically large effect, and highlights an important role for the firm in facilitating reallocation. Offshorers both hire new tech workers and shift existing workers into tech occupations.

4.5 Robustness

In this section, we include a number of controls to assess the robustness of our estimates. As discussed above, one concern is that our findings may be driven by import competition rather than offshoring. Our IV approach views offshoring as a positive choice by the firm to exploit changing comparative advantage in a destination country, rather than a negative response to increased competition in the home market. However, the same productivity improvements or trade cost reductions in NMS that make it an appealing offshore location may also lead to increased import competition from foreign firms. To ensure that our estimates reflect an "exploit opportunities" rather than an "escape competition" motive, we control directly for import penetration from NMS and China. To address the concern that foreign multinationals shifting production across borders into NMS from Denmark may drive our results, we include a dummy for foreign ownership. Finally, we include the level of employment in the initial year to control for any confounding effects of initial firm size.

Table 8 presents robustness of the reduced-form estimates, which we focus on here to minimize concerns about coefficient bias due to weak instruments. The IV estimates are similarly robust (Appendix Table F.5). The estimated coefficients on NMS offshoring opportunities are unchanged in sign, significance, and magnitude. Low-wage offshoring opportunities increase the level and share of tech workers in firm employment, while they decrease production workers. The estimated coefficient on NMS import competition is negative (though insignificant) for both tech worker shares and levels. In line with prior work, increased import competition from China is associated with a reduction in the share and level of production workers.

In sum, new offshoring opportunities lead firms to reallocate domestic workers towards pre- and post- production activities. This reallocation is strongest for technology and production workers. Tech workers increase in both shares and levels, while production workers fall in both dimensions. Some of these workers change occupation within the firm, and the increase in tech workers is evident even controlling for direct measures of import penetration from the NMS and China.

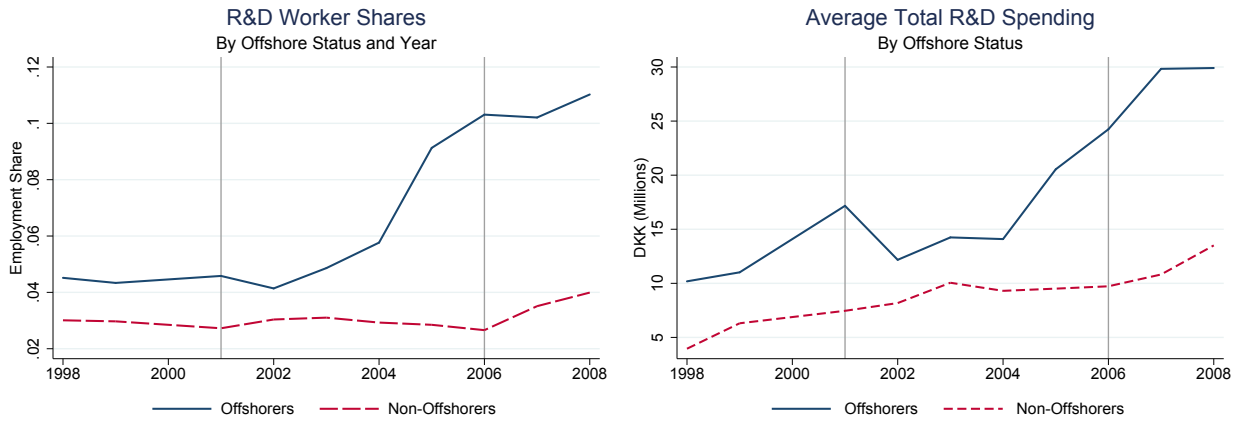
Table 8: Robustness of the Reduced-Form Estimates

	Δ log Emp	Δ log Production	Δ Share of Workers in Tech	Support	Production
$\Delta ExportSh_f^{NMS}$	-0.830**	-0.024	0.087**	0.101*	-0.234***
	(0.332)	(0.989)	(0.036)	(0.058)	(0.089)
$\Delta ImpPen_{i,NMS}$	-0.389	0.622	-0.016	0.023	0.000
	(0.335)	(0.843)	(0.010)	(0.029)	(0.045)
$\Delta ImpPen_{i,CN}$	-0.647	0.111	0.029	0.103*	-0.228**
	(0.401)	(0.548)	(0.037)	(0.059)	(0.094)
MNC	0.019	0.069	-0.006*	-0.006*	0.006
	(0.047)	(0.048)	(0.004)	(0.003)	(0.007)
$log(emp_f^t)$	-0.039***	0.007	0.003***	0.005***	-0.005**
	(0.010)	(0.020)	(0.001)	(0.001)	(0.002)
R^2	0.058	0.076	0.036	0.053	0.057
Observations	5,159	5,159	5,159	5,159	5,159

	Growth Rate of Workers in Tech	Support	Production	Δ Share Tech Switchers
$\Delta ExportSh_f^{NMS}$	0.877**	0.013	-1.205***	0.031**
	(0.411)	(0.446)	(0.346)	(0.015)
$\Delta ImpPen_{i,NMS}$	-0.241	0.047	-0.155	0.003
	(0.311)	(0.300)	(0.266)	(0.012)
$\Delta ImpPen_{i,CN}$	-0.174	-0.368	-1.079***	0.016
	(0.449)	(0.482)	(0.334)	(0.015)
MNC	0.002	0.009	0.052	0.000
	(0.048)	(0.042)	(0.053)	(0.001)
$log(emp_f^t)$	-0.011	-0.002	-0.054***	0.000
	(0.010)	(0.010)	(0.012)	(0.001)
R^2	0.025	0.036	0.093	0.056
Observations	5,159	5,159	5,159	5,159

Notes: Dependent variables in top panel are the change in the firm outcome noted in column headers. Dependent variables in bottom panel are the growth rate of worker types denoted in column headers, defined as $\frac{(Occup_{f,t+5}-Occup_{f,t})}{0.5(Occup_{f,t+5}+Occup_{f,t})}$. Δ Share Tech Switchers is the change in the share of tech workers that switched into tech occupations within the firm. $\Delta ExportSh_f^{NMS}$ is a firm-specific weighted average of the change in NMS market shares by product in ROW, based on the firm's initial-period domestic production shares. $\Delta ImpPen_f^{NMS}$ and $\Delta ImpPen_f^{China}$ are firm-specific measures of the change in import penetration from NMS and China, based on the firm's initial-period domestic production shares. The firm's own imports and production are excluded from the product-level import-penetration measures. Two stacked five year differences for 1998 - 2008. Regressions are weighted by initial employment and include industry (NACE2) and year fixed effects. Standard errors clustered by HS2 sector. * p<0.10, ** p<0.05, *** p<0.01.

Figure 8: R&D workers and expenditures by offshore status



Notes: Left panel plots the share of R&D workers over total workers. Right panel plots the weighted average of firms' R&D expenditures. Sample is a balanced panel of firms in the offshoring and R&D surveys. Offshoring firms are those that relocated their core activity to a foreign country between 2001 and 2006.

4.6 Increased R&D workers and expenditures by offshoring firms

Offshoring firms' reorganization towards technology occupations is consistent with them increasing innovation in Denmark, while exploiting low-cost opportunities in NMS and China. While we lack comprehensive data on firms' R&D expenditures, we can match about 38 percent of the offshoring firms to an R&D survey. Using these data, we find that offshoring firms' reorganization towards technology occupations is also accompanied by relative growth in their R&D employment spending.

The left panel of Figure 8 shows that offshoring firms increase their share of R&D workers, as explicitly defined in the R&D survey, over the offshoring period, while non-offshorers do not. This pattern corroborates our definition of tech workers available for all firms, and suggests that firms are indeed reorienting their domestic workforce towards innovation. The right panel depicts the weighted average of firms' total R&D spending which rises substantially over the period for offshoring firms and is largely unchanged at non-offshorers. In this smaller sample of firms we see evidence that the rise of technology-related employment is mirrored in the increase in innovation activities at offshorers.

5 Industry import penetration and employment

To complete our analysis on offshoring, we revisit studies on the impact of industry-level import competition on employment. An important contribution of this paper is to show that produced-good imports capture firms' offshoring decisions, and are thus distinct from the foreign import competition channel. One possibility is that all imports necessarily represent increased competi-

tion for domestic producers, regardless of whether they arise from offshored production or foreign competition. In light of the evidence on vertical differentiation in Section 3, however, offshoring firms' imports of lower quality varieties may not compete as directly with domestic producers. In addition, it should be clear that imports by offshoring firms will benefit those firms, which should increase industry output as activity is reallocated towards the offshoring firms, even if employment declines.

We first decompose a standard measure of import penetration into produced-good and non-produced good components. Specifically, we measure the change in import penetration as

$$\Delta ImpPen_{iT}^{R} = \Delta \frac{Imports_{iT}^{R}}{Imports_i + DomProd_i}, \tag{8}$$

where R denotes region (China or NMS), i denotes an HS4 industry, and T denotes the good-importer type. Product type T can be all imports (ALL), which corresponds to the standard measure of import penetration, produced-good (PG), which corresponds to imports of HS6 products that *the importer* also produces domestically in that year, or non-produced good (NPG), which includes all imports that are not produced by the importer. For example, imports of concrete pumps (HS 841340) by firms that produce those pumps in Denmark are PG imports, whereas imports of concrete pumps by firms that that do not manufacture those pumps in Denmark are NPG imports. By construction, the PG and NPG-good import components sum to the standard measure. We use the ten year change from 1998 to 2008 of these measures so that we can compare our results to prior work on the China shock.[28]

The three measures of changes in import penetration are correlated within a country, with NPG imports being more correlated with the standard measure. Comparing the penetration measures across sources, however, shows that NPG import penetration from China is negatively correlated with NPG imports from NMS. By contrast PG imports from both regions are positively correlated. These relationships suggest that Chinese and NMS exports generally differed across sectors, though Danish firms' offshoring decisions to both countries are correlated. Appendix Section G reports all these correlations, and shows that produced-good imports grow relatively more for products that are initially more tech-worker intensive and that have more dispersion in their unit values, consistent with offshoring arising from firms' motives to produce vertically differentiated varieties of the same goods as countries, as documented in Section 3.3.

We use these new measures of industry import penetration to assess whether increased offshoring has potentially distinct effects from other imports by estimating

$$\Delta log(outcome_i) = \alpha + \beta_{MNPG} \Delta ImpPen_{iNPG}^{R} + \beta_{MPG} \Delta ImpPen_{iPG}^{R} + \varepsilon_i, \tag{9}$$

[28] We follow Fort et al. (2018) and omit exports from the denominator since including them results in import penetration measures much greater than one for some sectors. These large shares likely reflect carry-along trade, as analyzed in Bernard et al. (2019).

where $\Delta log(outcome_i)$ is the log change in employment or production value in industry i from 1998 to 2008, $\Delta ImpPen^R_{iNPG}$ is the change in import penetration from low-wage region R (China or NMS) in industry i for non-produced goods over the same period, and $\Delta ImpPen^R_{iPG}$ is a comparable measure for produced-good imports. We aggregate imports, employment, and production to the HS4 level for 369 industries with positive production in Denmark.

Table 9 presents the results from estimating equation (9) via OLS. The top panel presents results for China. Consistent with past work, we find a large, negative, and statistically significant relationship between changes in industry employment and increased import competition from China. A ten percentage point increase in Chinese import penetration is associated with a 32 log point relative reduction in employment (column 1). Decomposing this aggregate effect into import penetration of non-produced versus produced-good imports reveals interesting heterogeneity. The negative relationship in column 1 is driven entirely by non-produced good imports, while increased import penetration in produced-goods has a positive (though statistically insignificant) relationship with employment changes. Columns 3 and 4 present the same estimates but for log changes in the value of industry production. Consistent with offshoring entailing reallocation towards more productive firms, increased produced-good import penetration is associated with greater industry production. As for employment, growth in non-produced good import penetration is associated with decreased production, in line with the interpretation that these imports correspond to a negative demand shock for domestic firms.

We present a comparable analysis for changes in import penetration from the NMS in Panel B of Table 9. For NMS, changes in the standard measure of import penetration has a negative though insignificant relationship with changes in industry employment and production (columns 1 and 3). Decomposing the standard measure into imports of produced versus non-produced goods reveals that the insignificant estimate for the standard measure can be explained by heterogeneity in the relationships between the two different types of flows. A ten percentage point increase in non-produced good import penetration is associated with 40 and 52 log point reductions in industry employment and production, respectively. By contrast, the same increase in produced-good import penetration relates to a 44 log point increase in employment and 80 log point increase in production.

Firms' heterogeneous responses to produced versus non-produced good imports align with predictions from offshoring models, but demonstrate that offshoring need not entail imports of intermediate inputs. They also raise the possibility that conflicting evidence on the effects of import competition in past studies may be due to heterogeneity in the types of flows they capture, and thus in the underlying motives for imports. For example, some work finds that increased import penetration from China raised domestic innovation in Europe (Bloom et al., 2015), while other work argues that it decreased domestic innovation in the United States (Autor et al., 2020a). In both cases, the authors interpret their results as evidence on the effects of increased competition on innovation. The results in this paper point to an alternative explanation. The aggregate measures

Table 9: Changes in industry import penetration and industry size, 1998 - 2008

Panel A: China	Δ Log Employment		Δ Log Production	
$\Delta ImpPen_{iALL}^{China}$	-3.188***		-4.206***	
	(0.787)		(0.702)	
$\Delta ImpPen_{iNPG}^{China}$		-3.570***		-4.602***
		(0.807)		(0.718)
$\Delta ImpPen_{iPG}^{China}$		13.758		13.347*
		(8.495)		(7.560)
Observations	369	369	369	369
R-Squared	0.043	0.053	0.089	0.103
Panel B: NMS	Δ Log Employment		Δ Log Production	
$\Delta ImpPen_{iALL}^{NMS}$	-1.581		-1.415	
	(1.285)		(1.174)	
$\Delta ImpPen_{iNPG}^{NMS}$		-4.027**		-5.228***
		(1.621)		(1.458)
$\Delta ImpPen_{iPG}^{NMS}$		4.427		7.951***
		(2.766)		(2.489)
Observations	369	369	369	369
R-Squared	0.004	0.02	0.004	0.051

Notes: Table presents OLS estimates of long differences from 1998 to 2008 in variables indicated in columns. $\Delta ImpPen$ is the change in total industry import penetration, which is decomposed into changes in non-produced good (NPGs) and produced-good (PGs) imports. Produced-good imports are imports of HS6 products that the importing firm also produces domestically in the import year.

of import penetration used in those studies may mask important heterogeneity in the types of import flows from China. While increased competition generally leads firms to shrink, offshoring entails reorganization towards innovation-related occupations and thus may also increase innovative output over longer periods. The evidence we present here calls for future work to tease apart these two channels to provide identified evidence on both types of flows.

6 Conclusion

The rise of low-wage production locations such as China and Eastern Europe has disrupted manufacturing industries in advanced economies. The literature has consistently documented negative effects of increased low-wage imports on manufacturing employment, wages, and worker health. The evidence on firms is more mixed. Some work links low-wage import penetration to decreased firm sales, survival, and innovation, but other results point to rising innovation and productivity. In most cases, low-wage imports are viewed through the lens of increased foreign competition, and

domestic firms must either shrink or change to escape it. This paper offers a new perspective: low-wage countries also provide an opportunity for domestic firms to reorganize their activities as they exploit new low-cost production locations through offshoring.

Using a unique survey on offshoring, this paper documents how firms change their production, imports, and domestic employment in response to newly integrated low-wage countries. In contrast to the canonical view that offshoring necessarily entails imports of intermediate inputs, the data indicate that offshorers' import growth is concentrated in the same detailed goods they produce at home. This evidence calls for a broader perspective on measuring global value chains and production fragmentation, gives rise to a new measure of offshoring, and provides the basis for an identification strategy that measures changes in firm-specific offshoring opportunities. Both the survey and IV results show that offshoring leads firms to reduce production workers, as they reorganize towards pre-production stages by increasing both the share and level of employment in technology occupations. This reorganization is suggestive of cross-border production functions as in Antràs et al. (2006), and seems likely to involve a higher degree of technology transfer than import competition from foreign firms. An open question for future work is the extent to which this transfer occurs, and how offshoring will change as countries' comparative advantage continue to evolve (endogenously) along with these activities.

The survey also provides new evidence on how offshoring relates to domestic production. Rather than transitioning to pure wholesalers, most offshoring firms continue to produce the same goods they import. Unit values of domestically produced varieties are substantially higher than import values, and they rise after importing begins, even as their quantity falls. These findings suggest that offshorers have product-specific capabilities and exploit low-wage destinations for the production of vertically differentiated varieties of the same goods they manufacture at home. These findings call for introducing a quality or technology dimension into models of offshoring.

Existing work emphasizes the importance of vertical product expansion in growth, but with the most technologically advanced version superseding prior ones (Grossman and Helpman, 1991; Klette and Kortum, 2004). Our results point to multiple product qualities being produced and sold at the same time, as in Shaked and Sutton (1982), though we document *within-* rather than across-firm quality ladders. Since this type of within-firm vertical differentiation is a key factor in firm innovation and growth (Goettler and Gordon, 2011; Braguinsky et al., 2020), our findings point to a new channel – vertical product expansion – through which offshoring may affect aggregate outcomes. Proposals to restrict offshoring may have unintended negative effects on future growth and innovation if they prevent domestic firms' from specializing in their comparative advantage activities in response to increased integration of low-wage economies.

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Appendices

A Details on the offshoring survey

Table A.1 presents the number of firms that relocate non-primary activities to other countries, broken out by whether they relocate their core activity or not. The survey defines the core activity as the primary industry of the firm. The bottom row displays the total number of firms that relocate each activity. Offshoring of ICT services is the most prevalent of these other activities, though the number of firms engaged in this offshoring is still well below the 380 firms that relocate their core activity.

Table A.1: Offshoring of other activities, by core activity status

Core Activity	Distribution & Logistics	Marketing & Sales	ICT services	Admin & Managmnt	Engineering & Tech services	R&D	Other
No	71	76	145	84	77	61	40
Yes	81	50	46	39	70	59	6
Total	152	126	191	123	147	120	46

Notes: There are 4,161 firms in the survey. 380 firms (9.1%) offshore their core activity.

Table A.2 presents all the offshoring locations to which Danish firms relocate their core activities.

Table A.2: Offshoring of core activity by region

Region	Firm count	Share
NMS	205	0.54
China	126	0.33
EU-15	109	0.29
Other Asian countries and Oceania	60	0.16
Other European countries	46	0.12
India	30	0.08
US and Canada	25	0.07
Total offshoring firms	380	1.00

Notes: Table presents the foreign locations to which firms relocated their core activity between 2001 to 2006. Firms may relocate their core activity to more than one foreign location. There are 4,161 firms in the survey.

B Firm production and import patterns

In this section, we assess the robustness of the produced-good import definition at the CN8 level and analyze imports of produced goods versus inputs.

B.1 Product aggregation robustness

Here we provide examples showing that within an HS4 category, parts are often separated as a distinct HS6 product (see Table B.1). In this sense, HS4 imports of the same goods a firm produces might capture the parts associated with the production of those more detailed products.

Table B.1: Four and six-digit HS product descriptions for 8414 and 8415

Code	Description
8414	Air or vacuum pumps, air or other gas compressors and fans; ventilating or recycling hoods incorporating a fan, whether or not fitted with filters.
841410	Vacuum pumps
841420	Hand or foot-operated air pumps
841430	Compressors of a kind used in refrigerating equipment
841440	Air compressors mounted on a wheeled chassis for towing
841451	Table, floor, wall, window, ceiling or roof fans, with a self-contained electric motor of an output not exceeding 125 W
841459	Other
841460	Hoods having a maximum horizontal side not exceeding 120 cm
841480	Other
841490	Parts
8415	Air conditioning machines, comprising a motor-driven fan and elements for changing the temperature and humidity, including those machines in which the humidity cannot be separately regulated.
841510	Window or wall types, self- contained or split-system
841520	Of a kind used for persons, in motor vehicles
841581	Incorporating a refrigerating unit and a valve for reversal of the cooling/heat cycle (reversible heat pumps)
841582	Other, incorporating a refrigerating unit
841583	Not incorporating a refrigerating unit
841590	Parts

Notes: Table presents product descriptions for HS4 8414 and 8415 industries, along with all HS6 products under these HS4 industries.

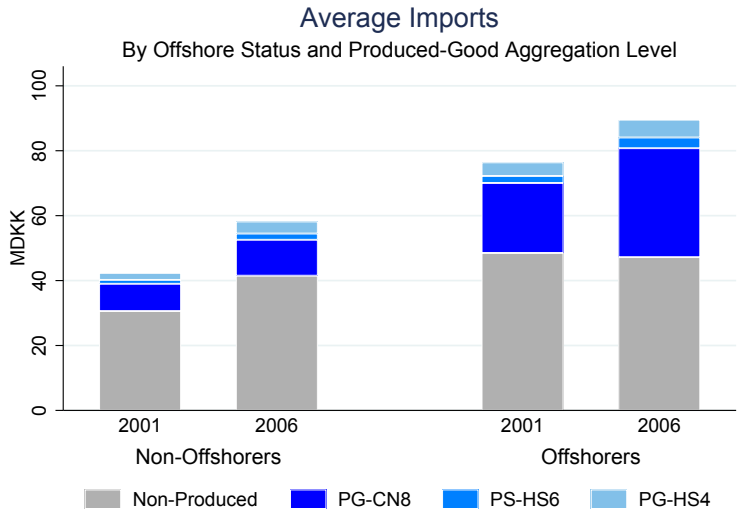
To assess the role of product aggregation on our classification of imports as produced goods, we use HS4, HS6, and CN8 product categories to assign imports to a 'potential' produced-good status. Figure B.1 decomposes firm imports into goods that the firm did not produce in the same year and goods that it both produced domestically and imported in that year. The latter category is created at three levels of aggregation: produced-imported that are the same at the CN8 level (PG-CN8), those that are the same only at the HS6 level (PG-HS6), and those that are the same only at the HS4 level (PG-HS4).[29] Figure B.1 shows that the vast majority (91 percent) of offshorers' import *growth* from 2001 to 2006 is driven by CN8 products that the firm both produces and imports in the same year; and that most HS4 produced-good imports are produced and imported at the CN8 level (79 percent in 2006).

B.2 Imports of produced goods versus inputs

The majority of offshoring studies focus on imported inputs, but use conflicting methods to identify imports. Theoretical predictions on how offshoring affects domestic outcomes are driven by the impact of foreign inputs on firms' domestic costs and sales. For example, car manufacturers that

[29]The offshoring measure proposed by Hummels et al. (2018) would include all three groups. Our proposed measure includes the CN8 and HS6 groups.

Figure B.1: Imports by goods' domestic production status and aggregation level, and firm offshore status



Notes: Figure presents the weighted-average of firm imports for goods that the firm did not produce in the same year and goods that it both produced domestically and imported. Produced and imported status is defined at three levels of aggregation: produced-imported that are the same at the CN8 level (PG-CN8), those are the same only at the HS6 level (PG-HS6), and those that are the same only at the HS4 level (PG-HS4). Sample is a balanced panel of firms in the offshoring survey that exist from 2000 to 2008 and report production in ProdCom in at least one of these years.

import engines benefit from marginal-cost reductions in their car manufacturing. By contrast, car manufacturers that import cars would seem to compete with their own domestic production, and offshoring models focused on imported inputs provide no rationale for these imports.

The lack of a rationale for firms to import the same goods they produce domestically motivates the first two approaches of interpreting all imports by the firm as inputs, or only those inputs in the same industry as the firm's outputs as inputs. The latter recognizes that firms might import for other reasons, and posits that the large diagonal elements in input-output tables mean that most of an industry's inputs will be in the same industry as its outputs.[30] By contrast, papers that classify imports of goods that the firm does *not* produce as inputs aim to capture car manufacturers' imports of tires, engines, and parts, while excluding finished cars themselves. Since most production, input, and trade data are on a different classification system and relatively aggregated, assessing these conflicting assumptions has not been possible.

Our data are uniquely suited to assess whether imports in the firm's industry likely reflect inputs. To do so, we exploit a novel survey that provides firms' input purchases at the HS4 industry level for manufacturers with at least 50 employees. We use the survey to flag all imports of CN8 products that belong to those input industries as potential inputs. Table B.2 presents the results from decomposing firm imports into potential inputs (top panel) or non-inputs (bottom panel). We similarly flag all imports of CN8 products within the HS4 industries in which the firm produces as potential produced-good imports.

[30]The structure of the HS supports this approach – see Figure B.1.

The results in Panel A of Table B.2 indicate that approximately one half to three quarters of firms' imports are potentially inputs. This share is larger and grows considerably more for offshoring firms, from 0.62 to 0.72 (versus just 0.54 to 0.55 for non-offshoring firms). Although the majority of these potential inputs are outside the firm's output industries in 2001 (0.33/0.62), offshoring firms increase imports of products in their output industries to 0.61 (0.44/.072) of potential input imports by 2008. While this growth seems consistent with the assumption that imports of goods within a firm's output industries capture input sourcing, examination of the disaggregated production data suggests otherwise. Offshoring firms' growth in the share of imports that are inputs is overwhelmingly driven by imports of the same CN8 products that the firm produces domestically. These produced-good imports rise 13 percentage points, from 0.23 to 0.36 of offshorers' total imports by 2008.

Table B.2: Share of firm imports decomposed by domestic production and input purchase status

	Offshorers		Non-Offshorers	
	2001	2008	2001	2008
Panel A: CN8 Imports within HS4 Input Industries				
Not Produced	0.33	0.28	0.37	0.37
Produced at CN8	0.23	0.36	0.13	0.12
Produced at HS4 but not CN8	0.06	0.08	0.04	0.06
Total Potential Inputs	0.62	0.72	0.54	0.55
Panel C: CN8 Imports outside HS4 Input Industries				
Not Produced	0.22	0.15	0.31	0.24
Produced at HS4	0.16	0.13	0.15	0.21
Total Non-Inputs	0.38	0.28	0.46	0.45

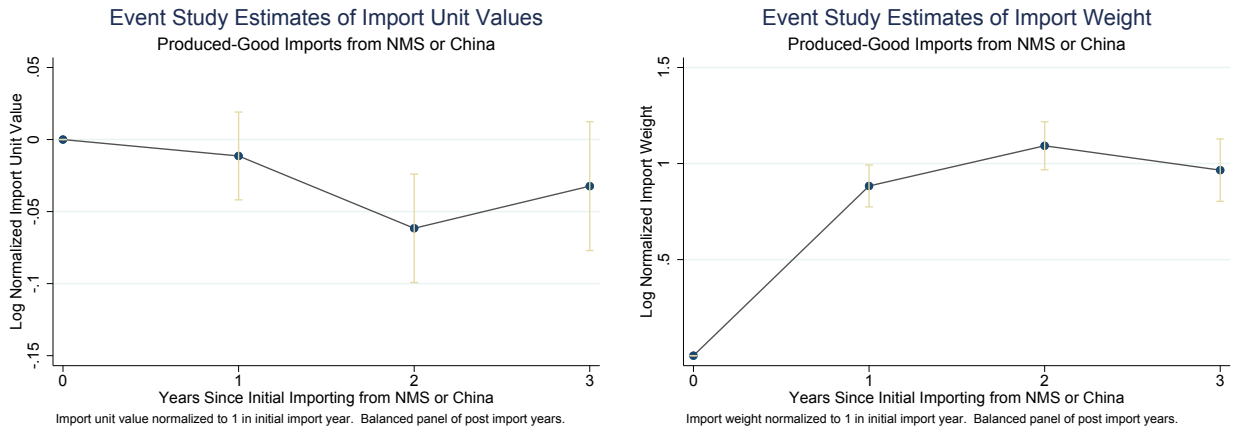
Notes: Table presents the share of firms' total imports decomposed into those CN8 products that are outside (Panel A) or within (Panel B) HS4 industries from which firms purchase inputs. Within each panel, these imports are further decomposed into CN8 products that the firm does not produce versus products that are within HS4 industries in which the firm produces. Panel C decomposes the CN8 products that are within HS4 industries in which the firm purchases inputs and produces into the CN8 products it does versus does not produce. Sample is limited to a balanced panel of firms in the offshoring survey and in the input survey from 2001 to 2008, that are in ProdCom in at least one of these years. The input survey is sent to manufacturing firms with at least 50 employees. There are 138 offshoring firms and 504 non-offshorers in this sample. Shares in each column sum to 1.0 except due to rounding.

The results in Panel B of Table B.2 provide additional information for studies aimed at capturing imports of inputs. We find that between a quarter (0.28) to almost one half (0.46) of firms' imports are *not* inputs into their domestic manufacturing activities. About half of these non-input imports are within the firm's output industries, suggesting that limiting imports to production industries is not effective at targeting inputs. In addition, doing so misses up to one third of firms imported inputs.

C Unit value analysis

One potential question about the rising domestic unit values for the CN8 products that firms begin to import from NMS or China is whether they reflect market power on the part of the Danish importer. For example, if Danish manufacturers also set up production in NMS to lower their costs, they might then raise prices and restrict quantity from NMS to Denmark. Although this seems unlikely given Danish firms' small role in Europe and especially China, we assess this possibility, by examining the evolution of imported unit values for firms that produced a CN8 domestically and then begin to import the good. Figure C.1 shows the import unit values of these goods that the firm both produces and imports fall over time, after the firm begins to import them. This result contrasts sharply with the rising domestic unit values depicted in Section 3.2, and shows another clear divergence between the same CN8 goods that the firm produces domestically versus imports consistent with the premise that firms offshore production of lower-quality varieties to low-wage countries.

Figure C.1: Evolution of produced-good imports' unit values



Notes: Figure plots coefficient estimates from regressing the log of the import unit value (left panel) or log weight (right panel), normalized to one in the first import year, for a given firm-CN8 combination that the firm produces domestically and begins to import from NMS or China on year fixed effects and indicators for the first and subsequent three years after a firm begins importing that CN8 from NMS or China. Coefficient normalized to zero in the first year of imports and sample limited to firms that produce a good in $t-2$ and or $t-1$, start to import the good in year 0, and continue importing the good for at least 3 years. Standard errors clustered by CN8.