Heterogeneous Globalization: Offshoring and Reorganization*

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Abstract

This paper exploits a unique survey to show that firms import the same goods they manufacture at home when they offshore production to low-wage countries. Instead of ceasing domestic production, however, offshorers raise prices of their domestic varieties and increase both the shares *and* levels of their employment in innovation-related occupations. These responses highlight an underexplored benefit of trade liberalization: the opportunity to offshore production of low-end varieties and focus domestic activities on the development, production, and marketing of high-quality or technologically advanced versions. They also call for new models of offshoring that incorporate this form of vertical differentiation in production across countries.

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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] Despite these employment declines, the share of manufacturing real value-added in GDP has held relatively steady, with significant growth and innovation in some of the same industries with soaring imports. For example, from 2000 to 2007, computer electronics manufacturing accounted for the majority of US manufacturing real value-added growth and dominated patenting, while the sector's imports from China skyrocketed (Fort et al., 2018; Kelly et al., 2021).

Trade liberalization with low-wage countries is linked to firm exit and contraction (Hombert and Matray, 2018), as well as industry switching (Bernard et al., 2006). The effect of low-wage imports on innovation is less clear: there is evidence of reduced patenting in the United States (Autor et al., 2020), but also of increased innovation by European firms (Bloom et al., 2016). These responses are all interpreted as firms' efforts to escape competition, with most firms shrinking even as leaders increase investment and innovation (Covarrubias et al., 2019). From a domestic producer's perspective, however, the rise of low-wage countries is not only a competitive threat in the form of cheaper products, but also a potential opportunity to lower costs by relocating parts of its production process. While many papers relate trade cost reductions in a firm's inputs to increased productivity and size (Amiti and Konings, 2007; Antràs et al., 2017), import penetration in a firm's outputs is both modeled and interpreted as greater competition.

In this paper, we show that trade liberalization in a firm's output industries also provides new offshoring opportunities. Exploiting a unique Danish offshoring survey, we find that firms increase their imports of the same detailed goods they produce domestically af-

[1] Autor et al. (2013) and Pierce and Schott (2016) provide evidence for the United States. Negative employment effects of Chinese imports are also documented in 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.

ter they offshore. Instead of ceasing domestic production of the newly imported goods, however, offshoring firms continue producing high-price varieties at home and increase their employment in innovation-related occupations. Offshoring thus allows firms in developed economies to exploit and increase their expertise in knowledge activities by leveraging them across countries to produce vertically differentiated varieties of the same goods.

Using a new firm-level survey that covers the majority of employment and output of the Danish economy, we identify firms that offshore their main activity between 2001 and 2006.[2] About nine percent of Danish firms offshored during this period, with the New Member States (NMS) of the European Union 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 what firms do when they offshore.

As expected, offshoring firms disproportionately increase their imports from the offshore location. In contrast to many studies that equate offshoring with imported intermediate inputs, however, offshorers increase imports of goods they also produce domestically: 91 percent of their import growth is in the same detailed eight-digit Combined Nomenclature (CN8) products that the firm produces in Denmark. By contrast, non-offshorers' import growth of such 'produced goods' is flat. This fact underpins our first contribution: a firm-by-country measure of offshoring, which we define as the firm's produced-good imports from a region over its total imports. This measure is available for all manufacturing firms, has both intensive and extensive-margin variation, can be constructed for any region or time period, and controls for overall growth of the firm. Moreover, it captures an increasingly important component of aggregate imports: the share of produced-good imports in total Danish imports rose from just over 9 percent in 1998 to over 13.5 percent in 2008.[3]

[2]The survey was conducted on a 2005 frame and the firms surveyed account for 53 percent of Danish private-sector output and 83 percent of manufacturing production in that year.

[3]Produced-good imports comprise imported HS6 products that the importer also produces domestically. These goods represent "final" goods from the firm's perspective, but we refer to them as produced goods to avoid confusion with consumer products.

The most surprising finding is that the value of domestic production at these same offshoring firms does not fall, even as their produced-good imports increase. The literature typically assumes that when particular tasks or activities are offshored, they cease to be performed domestically. Our second contribution is to show that offshorers' domestic production of goods that they also import accounts for the majority of their domestic output value and is more resilient than production of goods they do not import. We investigate these patterns using detailed CN8 data on prices and quantity. After the firm begins to import a particular good from the NMS or China, the unit value of its domestic variety rises, while its domestic production quantity falls. These changes are consistent with firms relocating low-end varieties offshore and focusing domestic production on higher quality or more technologically advanced versions.

Our third contribution is to provide descriptive and causal evidence that offshoring leads firms to reorganize their domestic employment towards innovation-related occupations. 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 their planned EU accession in 2004 and 2007. We measure changes in NMS comparative advantage using detailed product-level variation in the region's market share gains in the rest of the world, which we map to firms using their initial-period production by product. Most notably, we distinguish these offshoring effects from import competition by simultaneously controlling for other firms' import penetration into Denmark.

The estimates demonstrate that offshoring decreases firms' total employment as they shed production workers, but also entails reallocation into technology-related occupations. Offshorers increase their shares of workers in technology (e.g., R&D and engineering) and support (e.g., customer service) occupations. Reorganization is most pronounced for technology workers, who increase not only in shares but also in levels. Such reallocation 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.[4] We also find that firms with greater offshoring opportunities increase the share of their workers that switch into technology occupations, suggesting a key role of the firm in mediating occupational changes.

Our results indicate that offshoring is a key driver of firms' reorganization towards innovation activities in their domestic market, and that imports that arise from offshoring are distinct from import competition. We provide further support for this view by revisiting the relationship between low-wage imports and industry employment over a ten-year period. To do so, we partition import penetration into two components: produced-good versus non-produced good imports. Consistent with past work, overall import penetration is negatively correlated with industry output and employment; however, the two components exhibit opposite patterns. Non-produced good import penetration is negatively and significantly correlated with changes in industry employment and output, capturing the increase in competitive pressure from low-wage imports. By contrast, produced-good import penetration, reflecting offshoring, is correlated with employment and production growth. These heterogeneous responses to low-wage imports show that import competition and offshoring are distinct phenomena with opposite implications for aggregate employment and growth.

This paper makes several contributions to the literature. First, we add to a large literature on the employment effects of offshoring. In seminal work, Feenstra and Hanson (1999) show that offshoring can account for a portion of the rise in the US skill premium, despite the fact that the rise primarily occurred within industries.[5] Subsequent theory shows that

[4]This example is from publicly available information: `https://www.grundfos.com/about-us/news-and-press/news/grundfos-opens-competence-centre-in-hungary.html`. Examples of such vertical differentiation 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. 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.

[5]Prior work dismissed trade as an explanation since the Heckscher-Olin rationale implies reallocation

offshoring can raise knowledge-worker employment in high-skill countries via the formation of international production teams (Antràs et al., 2006), with significant implications of this reallocation for aggregate growth (Rodríguez-Clare, 2010). Although empirical work relates offshoring to declining employment of low-skill production workers (Biscourp and Kramarz, 2007), modest increases in polarization (Harrigan et al., 2021), and relative wage increases for high-skill workers (Hummels et al., 2014), evidence on increased demand for certain tasks is scarce.[6] Our contribution is to show that offshoring leads to reallocation *and* growth in knowledge-related occupations, including via occupation switching within the firm.[7]

Our paper also has implications for studies on the effects of low-wage import competition in developed economies. Existing papers relate trade liberalization with low-wage countries to industry switching (Bernard et al., 2006), quality upgrading (Khandelwal, 2010), and rising income polarization (Keller and Utar, 2023). There is conflicting evidence about whether China's WTO accession raised innovation and investment (Bloom et al., 2016; Covarrubias et al., 2019) or decreased them (Autor et al., 2020). These results are all interpreted as firm responses to low-wage import competition. Although several papers find different responses from increased import competition in a firm's outputs versus inputs (Mion and Zhu, 2013; Aghion et al., forthcoming; Ding et al., 2020), we are the first to show that increased imports in a firm's outputs also contain offshoring trade, and that such trade has the opposite effect from import competition on industry growth. Some of the effects of low-wage imports documented in past work may thus be due to offshoring, rather than an 'escape competition' channel, which in turn requires different models to rationalize the evidence.

We also connect with studies on multi-product firms and vertical differentiation across

of employment across industries, whereas trade grew rapidly in the same industries with rising inequality (Berman et al., 1994).

[6]There is also evidence that offshoring is complementary to innovation via a scale effect (Bøler et al., 2015) and that it leads firms to shift from product to process innovation (Branstetter et al., 2021).

[7]Hummels et al. (2014) document increases in high-skill wages in response to offshoring to high-wage countries, but do not analyze level changes in employment by skill or occupation.

space. Past work finds that firms respond to trade liberalization by focusing on core products (Mayer et al., 2014; Bernard et al., 2011). We highlight a new margin of adjustment: offshorers specialize in their core competency goods by manufacturing them in multiple countries. Prior work shows that low-wage countries produce low-price varieties of the same goods made in high-income countries (Schott, 2004), and that these prices rise over time as countries globalize (Schott, 2008). Kugler and Verhoogen (2012) link higher quality outputs to plants' use of higher quality inputs. We relate these facts to offshoring by showing that the same firm locates production of its low-price varieties in low-wage countries, while maintaining production of high-price varieties in its domestic market.

Finally, we add to work about how firms organize production across countries. Canonical models of horizontal FDI predict that a firm's sales in one country cannibalize from its sales in other countries (Helpman et al., 2004; Irarrazabal et al., 2013; Tintelnot, 2017; Ramondo and Rodríguez-Clare, 2013; Arkolakis et al., 2018). More recent firm-level evidence, however, finds that a firm's sales across countries are independent (Garetto et al., 2019) or even complementary (Antràs et al., forthcoming), with US multinationals importing goods in the same industries in which they produce domestically. The detailed data we exploit here rule out input-sourcing or multi-product explanations for such patterns, and instead suggest that firms exploit labor-cost differences across countries to produce vertically differentiated varieties of the same goods, calling for new models of offshoring that incorporate this form of vertical differentiation across space.

The rest of the paper proceeds as follows. In Section 2 we describe the new offshoring survey as well as data on imports, output, and employment. Section 3 exploits the survey to analyze how offshoring relates to firm-level imports and domestic production patterns, and introduces a new measure of offshoring. In Section 4 we 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.

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. These surveyed firms capture 57 percent of Danish private-sector employment, 53 percent of sales, and 56 percent of imports in 2005. Coverage of manufacturing industries is even higher, with the sample of surveyed firms representing 78, 83, and 86 percent of employment, sales, and imports by manufacturing firms, respectively. See Appendix Table A.1 for details.

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; 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,

[8] Certain industries, such as government services were deemed less relevant for measuring offshoring.
[9] See Appendix Table A.2 for statistics on each activity.

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 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]

[10]The actual Danish language is "...udflytning...", which literally translates to "move out." The precise question is presented in Appendix Figure A.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.

[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.

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. These ProdCom firms represent 84 percent of Danish manufacturing employment, 87 percent of sales, and 92 percent of imports, respectively, in 2005. ProdCom provides information on manufacturing firms' total sales, and crucially for our analysis, distinguishes 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 B.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 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 the three stages of production required to manufacture goods: pre-production tasks such as R&D and product design, physical production, and post-production stages such as marketing and distribution. Technology workers fit most closely in pre-production stages, production workers perform physical transformation tasks, and 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 G in the Appendix explains how we clean the occupation data and map the detailed ISCO codes to these aggregate categories.

3 Offshoring Firms

The new 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 offshore, where they go, and how offshoring relates to changes in firm imports and domestic production.

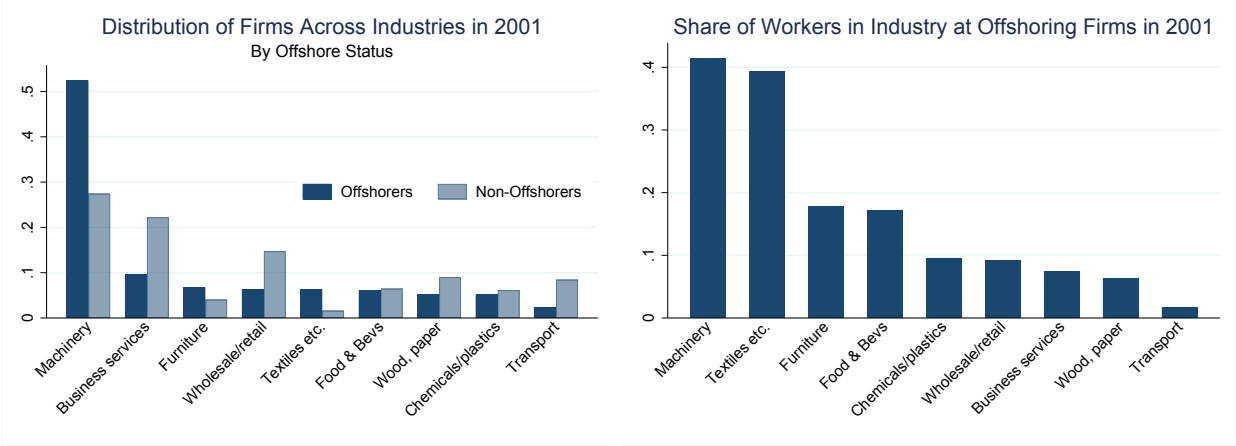
3.1 Offshoring firm activities across sectors and locations

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 1 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 1 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.

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 joined

Figure 1: 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.

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.

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 include Other Asia, Other Europe, India, and US+Canada. See Appendix Table A.3).[14]

3.2 Offshoring and Importing

Table 1 highlights the importance of low-wage countries in firms' offshoring activity from 2001 to 2006. We 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 of firms that are ever in ProdCom.[15] This sample covers approximately 66 percent of employment, 70 percent of sales, and 72 of imports by ProdCom firms over the 2000 to 2008 period.

We first show that offshoring to a destination relates to firm-level imports from the same location. We estimate that the average growth rate of imports from NMS or China from 2001 to 2006 is 2.1 times greater for firms that offshore to those regions relative to firms that do not.[16] The data thus support the widespread use of firm imports as a proxy for offshoring decisions, as recommended by Hummels et al. (2018).

We next identify the types of products that offshorers import by exploiting the uniquely detailed merged import and production data. Specifically, we identify all imports of HS6

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

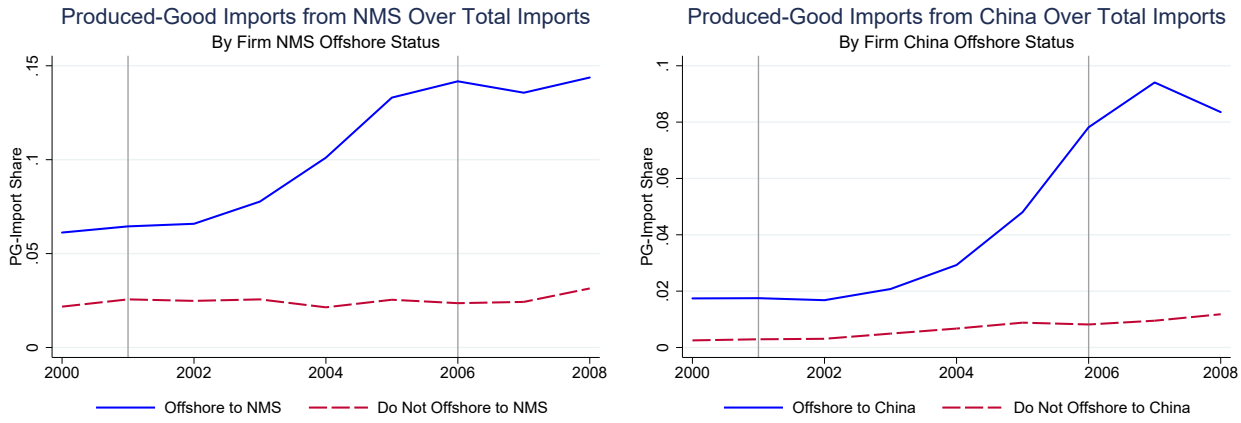
[15]We focus on a balanced panel since the frame for the offshoring survey is based on firms that survived until 2005, so that it is not feasible to analyze entry and exit. We do allow firms to exit ProdCom, however, so that we can assess whether offshoring firms cease their domestic manufacturing activities.

[16]We regress the growth rate of 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 reports offshoring to that region. Appendix Figure B.3 displays import growth by offshore status.

products in year t that the firm also produces that year, which we refer to as 'produced-good imports.'[17] To ensure that we capture actual domestic manufacturing, we restrict our measure to ProdCom's "Own Sales" variable. This category only contains goods manufactured by the firm in Denmark – resales are collected separately under "Commercial Resales" and traded goods are explicitly excluded.

Figure 2 depicts a sharp rise in offshoring firms' imports of 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.

Figure 2: 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. 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.

We confirm the robustness of rising produced-good imports for offshoring firms using disaggregated CN8 data. 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

[17]Recall that Statistics Denmark collects both transaction types at the CN8 level, so we can make direct comparisons of production and imports for detailed products concording across systems. We use the CN6/HS6 level as our baseline to allow comparisons with work on other countries.

year. Across HS4, HS6, and CN8 aggregation levels, offshoring firms disproportionately grow their imports of the same goods they manufacture at home (see Appendix Figure B.4). These findings contrast with past work focused on firms' use of imported intermediate inputs, and instead aligns more closely with models of horizontal FDI in which firms manufacture the same goods in multiple markets.

Finally, we show that the patterns depicted in Figure 2 provide a new measure of offshoring for a firm to a region: 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.

We demonstrate the validity of this measure by estimating 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,

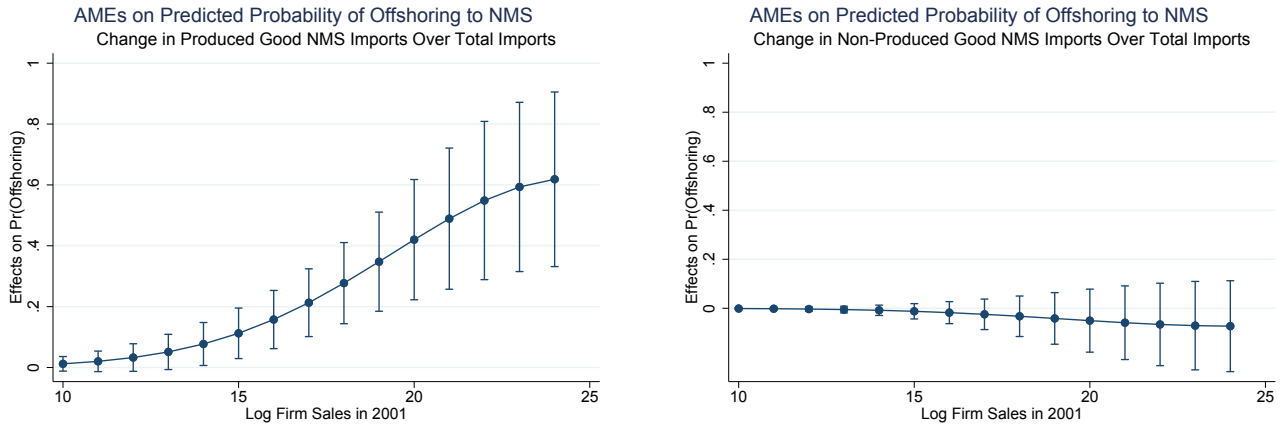
$$Pr(\Delta Off_f^{NMS} = 1|X_f) = \alpha + \beta_{PG}\Delta\frac{PG\ Imports_f^{NMS}}{Imports_f} + \beta_s log(sales_f^{2001}) + Ind_f, \qquad (1)$$

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 results for China are similar.[18]

Figure 3a depicts 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. Figure 3b shows that changes in a firm's non-produced-good import shares from a region are unrelated to the

[18]See Appendix Figure E.1.

Figure 3: Probability of Offshoring and Produced-Good Import Share



(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.

probability that it reports offshoring to that region.[19]

3.3 Offshoring and Domestic Production

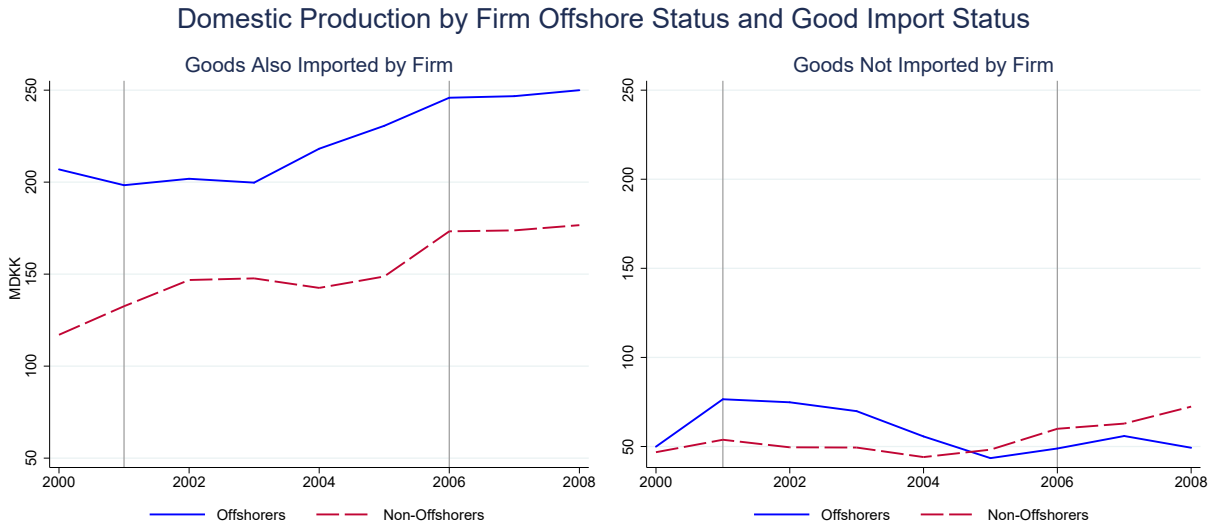
A contentious and policy-relevant question about offshoring is the extent to which it substitutes for domestic manufacturing. Indeed, many models of offshoring feature a substitution effect, in which foreign sourcing replaces domestic production (Grossman and Rossi-Hansberg, 2008; Antràs et al., 2017; Boehm et al., 2020). Models of horizontal FDI similarly tend to assume that foreign production locations cannibalize sales from each other (Ramondo and Rodríguez-Clare, 2013; Tintelnot, 2017; Arkolakis et al., 2018).

Our most surprising finding is that the value of offshoring firms' domestic production of the same goods they also import is substantially larger and more resilient than production of their non-imported products. Using the linked production and import data, we separate

[19]See Appendix Table E.1 for the estimated coefficients.

a firm's sales into HS6 goods that the firm also imports in that year versus goods that it only produces in Denmark. Figure 4 reveals that Danish firms' production is substantially higher for goods that the firm also imports. Most notably, offshorers' production of these simultaneously imported goods rises over the period (left panel), while their production of non-imported goods falls (right panel). By contrast, non-offshorers' production of both imported and non-imported goods grows similarly over the period.

Figure 4: Value of Domestic Production by Firm Offshore Status and Good Type



Notes: Figure presents the value of domestic production by offshorers and non-offshorers. Left panel comprises production of HS6 goods that the firm also imports that year. Right panel comprises production of HS6 goods that the firm does not import in that year. 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.

Importance of Produced-Good Imports We provide additional details on the goods that firms import and produce in Appendix Table B.2. To do so, we classify goods into six mutually exhaustive and exclusive categories based on their production status prior to offshoring (1999 or 2000), their production status in year t, and their import status in year t. We report the value of imports and production for each good type in 2001, 2006, and 2008 for offshoring and non-offshoring firms. The results confirm the key message from Figure 2: offshoring firms disproportionately grow their imports of produced-goods over the period.

These produced-good imports are equal to 9 percent of their total domestic production in 2001 and grow to 13 percent of production by 2008. For non-offshorers', produced-goods imports hover at about 5 percent of their total production throughout. Appendix Table B.2 also shows that offshoring firms' domestic production of goods that the firm also imports is larger and grows over the period, whereas their production of goods they do not import actually falls.[20]

Imports of Inputs versus Produced Goods A number of offshoring studies focus on imported intermediate 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 its outputs (Mion and Zhu, 2013; Boehm et al., 2020).[21] These methods clearly capture different elements (b and c are exact opposites), yet identifying input trade is crucial for assessing theoretical predictions on the effects of imported inputs. In Appendix Table B.3, we use a novel input purchase survey to show that most of offshorers' growth in imports of produced goods indeed occurs within the same HS4 industry as their inputs. The vast majority of these imports, however, are also of the same CN8 products the firm manufactures domestically, which the product descriptions suggest are *not* inputs.[22] Non-offshorers considerably increase their imports of goods in the same HS4 industry as their outputs, but that are *not* inputs. Using imports of HS4 products within the firm's HS4 output industries thus does not seem to capture primarily imports of intermediate inputs.

The findings here point to a relatively understudied form of production fragmentation.

[20] Appendix Figure B.5 shows that firms that offshore to NMS and China both have considerable produced-good imports from the original EU countries prior to 2001, suggesting prior offshoring to those countries.

[21] Feenstra and Hanson (1999) first defined a 'narrow' measure of offshoring as an industry's imports of goods in its same two-digit sector.

[22] Many HS4 industries include a separate HS6 product category entitled 'Parts', which is distinct from the industry output products. For example, Table B.1 shows that HS4 8414 (air vacuums, fans, recycling hoods) contains 841410 (vacuum pumps), 841420 (hand or foot-operated pumps), etc. and 841490 (Parts).

Offshoring firms produce the same detailed products in low-wage countries and their domestic market, and sell both varieties at home. Traditional models of offshoring in which firms relocate production of low-skill inputs or tasks to low-wage countries (Grossman and Rossi-Hansberg, 2008; Feenstra and Hanson, 1999), separate manufacturing versus headquarter tasks across countries (Antràs and Helpman, 2004), or source each input from the lowest-cost location (Antràs et al., 2017) do not rationalize these patterns. We next explore the potential for vertical differentiation in production locations to explain this behavior.

3.4 Vertical differentiation motive for offshoring

We conclude this section by digging into the detailed firm-by-product level data to understand why firms produce seemingly identical products in multiple countries to serve the same market (their domestic market in this case). One possibility is the 'Armington assumption' invoked in recent papers (Garetto et al., 2019; Antràs et al., forthcoming), which rests on the premise that a good is inherently differentiated based on its production country. Another possibility is that a particular CN8 category contains vertically differentiated varieties, and that low-wage countries have a comparative advantage in producing lower-price versions.

We first assess the extent to which offshoring firms produce vertically differentiated varieties across countries by exploiting detailed (CN8) product-level unit values available for both domestic and imported goods. We compare the unit values of the same CN8 product produced domestically and imported by the same firm in the same year by estimating:

$$log(UV_{fpct}) = \alpha_t + \gamma_{fp} + \beta Dom_{fpct} + \varepsilon_{fpct}, \tag{2}$$

where $log(UV_{fpct})$ is the log of the unit value of the product by source country c and Dom_{fpct} is an indicator equal to one for the domestic variety. We control for year fixed effects (α_t) and firm-by-product (CN8) (γ_{fp}) fixed effects, which remove any firm-specific differences in

costs, markups, or quality. Standard errors are clustered by CN8 product.

Table 2: Domestic versus Import Unit Values Within Firm-Product-Year

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.

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.[23] In these regressions, we focus on firms in the offshoring survey so that we can assess whether *differences* in unit values also vary systematically for firms that report relocating their core activity to a foreign region.

Table 2 presents the results from estimating equation (2) via OLS. The coefficient on

[23]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.

domestically produced varieties is large, positive, and statistically significant. Column 1 shows that, on average, domestic varieties' unit values are 81 percent higher ($e^{0.596}-1 = 0.81$) than their imported counterparts within the same firm and year. This large difference favors the explanation that firms offshore lower quality or less technologically advanced 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 2 reports the estimate for the interaction term. Consistent with the premise that firms offshore to access lower production costs, the interaction with the offshoring survey dummy indicates that the domestic-foreign price gap is 31 percent higher for firms that report relocating their core activity abroad.

The final column of Table 2 includes country or region-specific indicators for the imported varieties for the top three offshore regions. Prices of imports from China are 53 percent ($e^{0.423} - 1 = 0.53$) lower than than those for imports from all locations other than NMS, China and EU15, and NMS imports are 22 percent lower. By contrast, import unit values from the original EU countries are 13 percent 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 or less technologically advanced versions to China and NMS countries.

In a second analysis, we focus exclusively on firms' *domestic* unit values for a particular CN8 product pre- and post-importing of that product. If offshoring enables firms to focus on higher quality or more technologically advanced varieties at home, the unit value of domestically produced goods should rise after firms begin to import them. Using an event-study setting, we focus on firms that produce the same CN8 product for at least 7 consecutive years, that also 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 them to one within each firm-product in the firm's initial import year, and estimate

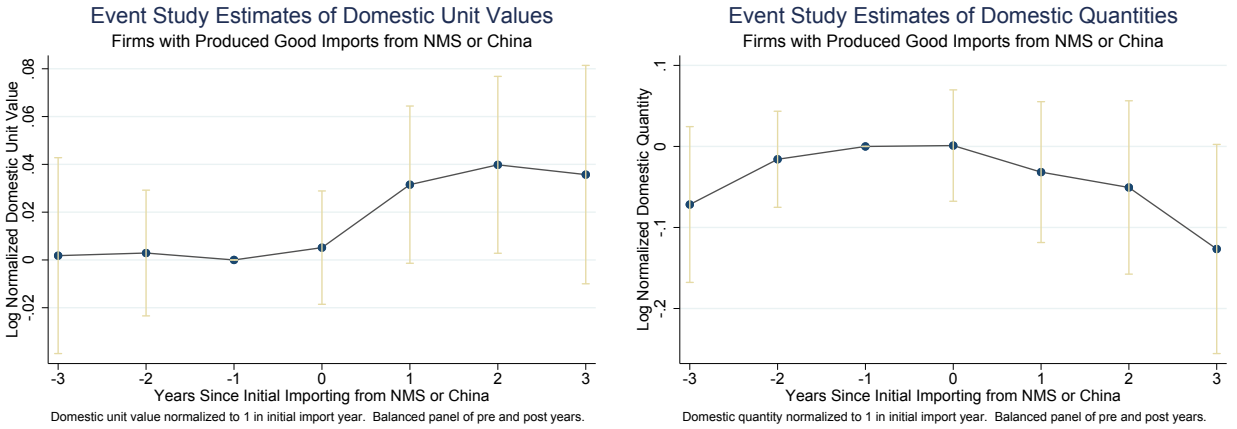
$$log(UV_{fpt}) = \alpha_t + \sum_k \beta_k \Delta Imp_{fp,t+k} + \varepsilon_{fpt}, \tag{3}$$

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. We also assess whether this increase reflects offshorers' ceasing domestic production of lower quality versions (e.g., as proposed in Schott, 2008) by estimating a variant of equation (3) 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 depicts a clear increase in the firm's domestic unit values after it begins importing the same good (see Appendix Table C.1 for the coefficients). The right panel of Figure 5 plots 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

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.

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, are consistent with firms offshoring production of lower-quality varieties to low-wage countries, and are at odds with firm-level demand shocks or market power exploitation driving the rise in domestic prices. The divergence in domestic versus imported quantities of a particular good also provides 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.[24]

We find that Danish firms exploit low-income countries to produce vertically differentiated

[24] Appendix Table B.4 also shows that offshorers' domestic production of goods it imports in the same year is more than 5.5 times greater than its imports, which is an implausibly high markup for 'relabeling'.

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 leads firms to reorganize their domestic workforce into innovation-related activities.

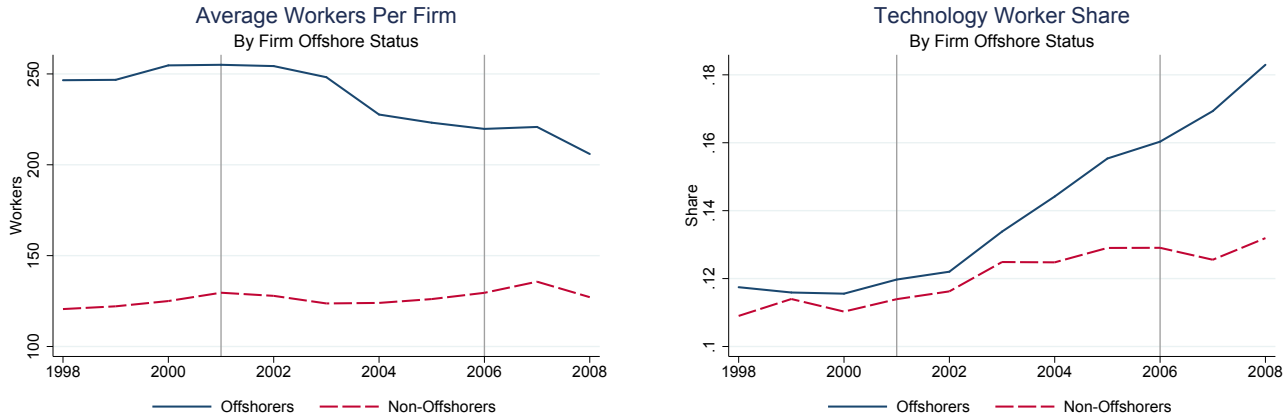
4 The Impact of Offshoring on Domestic Activities

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 use 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 using firm-level data documents negative employment consequences of offshoring, particularly for low-skill workers (Biscourp and Kramarz, 2007). The left panel of Figure 6 depicts the weighted average of firm employment by offshore status from the survey.[25] 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 slightly upward.

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 technology 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 technology occupations, versus only about 13 percent for non-offshoring firms.

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

To examine the full scope of firms' occupational changes, Table 3 presents weighted average 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.

Table 3: 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.

Table 3 confirms the sharp and distinct reorientation towards technology occupations at offshoring firms. Despite starting with similar shares of technology workers in 1998, the average share of technology workers rises dramatically for offshorers over the period, while it falls for non-offshorers. By 2008, offshoring firms have 21 percent higher shares of technology 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 theirs. The employment composition changes at offshoring firms are thus consistent with them reorienting their domestic activities towards pre- and post-production tasks related to manufacturing, such as product design and marketing.

The rising share of technology workers at offshoring firms is not simply due to their falling employment. In Appendix Figure E.3, we show that the average number of technology workers grows at offshoring firms over the period.[26] Offshorers' reorientation towards technology activities is thus a combination of rising employment in innovation-related occupations and a reduction in production workers. We next describe an identification strategy using our new firm-level measure of offshoring to estimate the causal relationship between offshoring and the changing nature of work within the firm.

4.2 Identification strategy

The survey data show falling employment and rising output at offshoring firms, but do not establish the causality of those outcomes. We therefore use an instrumental variable strategy to identify the impact of offshoring on firms' domestic production, employment,

[26]In Appendix Figure D.1, we also show that offshoring firms disproportionately increase their share of R&D workers and total R&D spending over the period, using a sample of R&D data available for 38 percent of the offshoring sample.

and workforce composition. We use our new measure of offshoring – growth in produced-good imports from a region over total imports – which is available for two, stacked five-year balanced panels of manufacturing firms in ProdCom, covering 54 percent of manufacturing firms' employment in 1998 and 68 percent of their employment in 2003.[27]

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 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.[28]

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 in its export share signals increasing NMS comparative

[27]The sample in Hummels et al. (2014) covers 50 to 70 percent of manufacturing employment in Denmark, depending on the year (p. 1603). Keller and Utar (2023) focus only on textiles and apparel, which is a minority of Danish manufacturing.

[28]A concern with using shares of produced-good imports rather than levels is that 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.

advantage. 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. 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:

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

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.[29] In the language of recent shift-share analyses, we treat the changes in NMS market shares as exogenous to Danish firms' domestic organizational decisions.

Danish firms are sufficiently multi-product for our instrument to be firm, rather than industry-specific. 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

[29] 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. Appendix Figure H.1 shows that NMS exports to Denmark are a tiny fraction of their exports to the ROW, so Denmark should not affect NMS aggregate activity.

median product share is 0.48 for NMS offshorers and 0.57 for non-NMS offshorers.[30] 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 Appendix Tables E.4 and E.6, 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 several ways. First, we follow Antràs et al. (2017) and use changes in NMS export shares to the ROW rather than level growth in exports to reduce the possibility that the instrument is driven by correlated demand or technology shocks across countries. Second, we assign the foreign shocks based on a firm's domestic production, whereas Hummels et al. (2014) use firms' past imports and exports by product and country. Our approach therefore captures both intensive *and* extensive margin changes in offshoring opportunities. We find that the latter is 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 in equation (5), our first-stage regression is

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

[30] 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).

The key identifying assumption is that NMS market share gains in a firm's products ($Shock_f^{NMS}$) are due to increased NMS productivity and/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 7 and Appendix Table E.5. Our analysis therefore shows the effect of new offshoring opportunities, netting out any potential role for import competition.

4.3 Results

Results from the first-stage estimation for two stacked five-year differences for 1998 to 2008 are presented in Table 4. 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 specification (Column 1) is of reasonable magnitude, at 9.0. To address potential concerns about weak instruments, we 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.[31]

Table 5 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 technology, support, and production workers. The qualitative message is similar across specifications, although the magnitudes of the coefficients vary.

The OLS estimates are consistent with the descriptive evidence from the offshoring survey. A ten percentage point increase in the firm's share of produced-good imports from the NMS is associated with a 1.9 percent reduction in its employment, while the value of its domestic production is unchanged. Consistent with offshoring firms increasing innovation as they

[31]The concern with a weak instrument is an over-inflated and imprecisely estimated second stage coefficient. By focusing on the reduced-form estimates in which we regress the outcome variables directly on the instrument, we avoid this issue.

Table 4: 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

reorient domestic production into higher-price, more technologically advanced varieties, the decline in total employment is accompanied by a shift away from production workers and into technology and support-worker occupations.

Panels B and C of Table 5 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 significant impact of new low-wage offshoring opportunities on firms' domestic employment composition. Focusing on the reduced-form estimates, a ten percentage point increase in NMS market shares in the ROW in a firm's products leads to a 0.008 percentage point increase in its share of technology

Table 5: 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					
$\Delta ExportSh_f^{NMS}$	-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.

workers, which is 1.1 times the size of the average firm's change in the technology worker share over this period. That same increase in offshoring leads to a 2.1 percentage point decline in the production worker share, equal to 65 percent of the average firm decline in the production worker share.

In Table 6, 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

Table 6: 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				
$\Delta PG\ ImpSh_f^{NMS}$	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 technology workers that switched into technology 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.

$\frac{(Occup_{f,t+5}-Occup_{f,t})}{0.5(Occup_{f,t+5}+Occup_{f,t})}$ 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 technology-worker occupations, but decrease growth in production workers. Both the levels and shares of technology and production workers change in response to NMS offshoring. The reduced-form estimates indicate that a ten percentage point increase in NMS market shares in a firm's products leads to 0.09

percentage point increase in its growth rate of technology workers. This effect is economically large when compared to the average growth of technology workers of 0.03.

The rise in the share and level of technology 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 technology occupation within the firm. The final column of Table 6 shows that new offshoring opportunities raise the share of technology 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 technology 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 technology workers and shift existing workers into technology occupations.[32]

4.4 Robustness

In this section, we demonstrate 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, but 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 identify an "exploit opportunities" rather than an "escape competition" motive, we control directly for import penetration from NMS and China. We also include a dummy for foreign ownership to mitigate concerns that the estimates are contaminated by foreign MNEs shifting production from other countries

[32]In additional analyses, we find that most of these 'switchers' move from production to technology occupations.

to the NMS. Finally, we include the log of firm employment in the initial year to control for potential confounding effects of firm size.

Table 7 presents robustness of the reduced-form estimates. The IV estimates are similarly robust (see Appendix Table E.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 technology workers in firm employment, while they decrease production workers. The estimated coefficient on NMS import competition is negative (though insignificant) for both technology 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, that respond in both shares and levels. Some of these workers change occupation within the firm, and the increase in technology workers is evident even controlling for direct measures of import penetration from the NMS and China.

Table 7: 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 technology workers that switched into technology 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.

5 Industry import penetration and employment

We complete our analysis on offshoring by revisiting studies on the impact of industry-level import competition on employment. The firm-level results indicate that produced-good imports capture firms' offshoring decisions, which are distinct from a foreign import competition channel. One possibility, however is that all imports necessarily represent increased competition 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 them, 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 produced-good imports, whereas imports of concrete pumps by firms that do not manufacture those pumps in Denmark are non-produced good imports. By construction, the produced and non-produced 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.[33]

The three measures of changes in import penetration are correlated within a country. Comparing the penetration measures across sources, however, shows that non-produced good import penetration from China is negatively correlated with non-produced good imports from NMS. By contrast produced-good imports from both regions are positively correlated. These relationships suggest that Chinese and NMS exports to Denmark generally differed across sectors, though Danish firms' offshoring decisions to both countries are correlated. Appendix Section F reports all these correlations, and shows that produced-good imports grow relatively more for products that are initially more technology-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 3.4.

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

$$\Delta log(outcome_i) = \alpha + \beta_{NPG}\Delta ImpPen^R_{iNPG} + \beta_{PG}\Delta ImpPen^R_{iPG} + \varepsilon_i, \tag{9}$$

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 8 presents the results from estimating equation (9) via OLS. The top panel presents

[33]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).

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 38 percent ($e^{0.3188} - 1 = .375$) reduction in employment (column 1). Decomposing this aggregate effect into produced versus non-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 8. 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 50 and 69 percent percent reductions in industry employment and production, respectively. By contrast, the same increase in produced-good import penetration relates to a 56 percent increase in employment and over a 100 percent 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

Table 8: 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.

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., 2020). 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 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

We provide evidence that offshoring leads to increased specialization in knowledge activities in developing economies, which firms leverage by manufacturing around the world. Offshoring leads firms to reduce production workers, as they reorganize towards pre-production stages by increasing their shares *and* levels of employment in technology occupations. This reallocation 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.

Our findings also suggest that offshorers have product-specific capabilities they exploit by producing vertically differentiated varieties of the same goods at home and in low-wage countries. The aggregate importance of continued domestic production by firms that manufacture abroad is supported by recent evidence from the United States (Fort, 2023); moreover the detailed data we exploit here rule out multi-product firms or input sourcing as explanations, and instead suggest that colocating manufacturing and innovation is important for certain high-end varieties. More broadly, offshoring may engender vertical product expansion, calling for new models that incorporate its potential to facilitate growth along this dimension (e.g., as in Grossman and Helpman, 1991; Klette and Kortum, 2004).

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Online Appendix for "Heterogeneous Globalization: Offshoring and Reorganization" *by:* Bernard, Fort, Smeets, and Warzynski

This online Appendix for Bernard, Fort, Smeets, and Warzynski (2024) provides additional details on the data construction and the empirical patterns documented in the paper.

A Details on the offshoring survey

Table A.1 presents the share of aggregate firms, employment, sales, and imports in the offshoring survey by broad industry.

Table A.1: Offshoring Survey Coverage by Industry

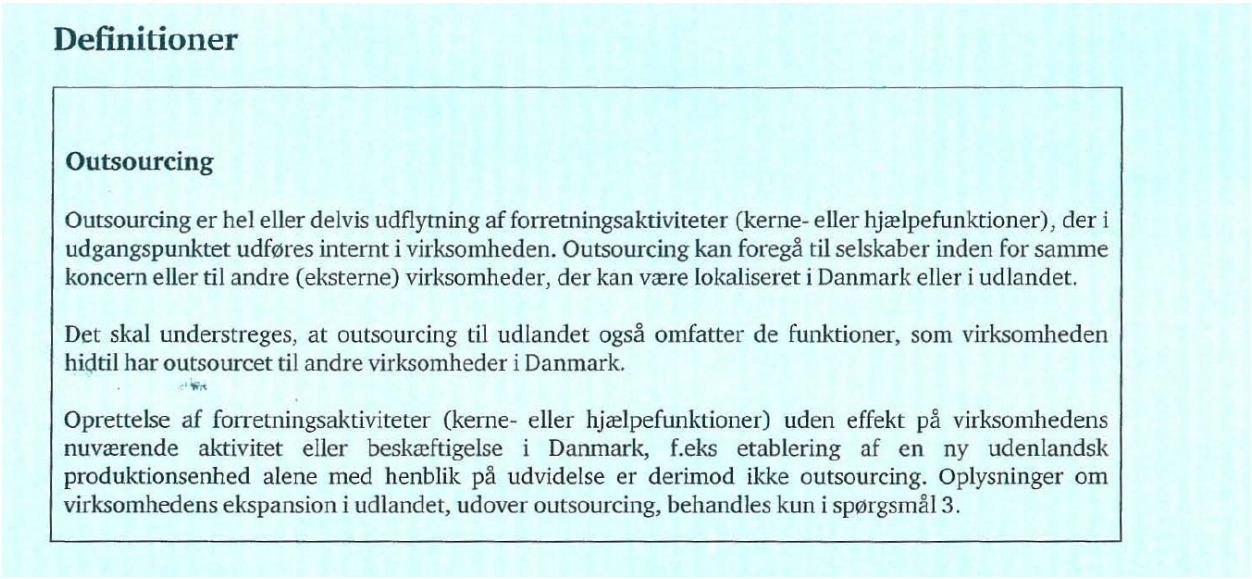
	Sample Share of Aggregate Activity			
Non-Manufacturing Industries	Firms	Employment	Sales	Imports
Agriculture	0.00	0.00	0.00	0.00
Fishing	0.00	0.00	0.00	0.00
Raw Material Extraction	0.07	0.62	0.09	0.66
Utilities	0.03	0.87	0.55	0.80
Construction	0.02	0.29	0.37	0.45
Sales/Wholesale	0.02	0.44	0.43	0.45
Hotel/Transport	0.02	0.50	0.65	0.61
FIRE	0.02	0.69	0.19	0.14
Business services	0.04	0.59	0.54	0.66
Manufacturing Industries				
Food & Beverage	0.14	0.85	0.90	0.87
Textiles, etc.	0.09	0.60	0.62	0.69
Wood & Paper	0.13	0.70	0.72	0.87
Chemicals & Plastics	0.23	0.87	0.90	0.85
Stone & Glass	0.22	0.87	0.87	0.90
Machinery	0.16	0.75	0.79	0.87
Furniture	0.13	0.73	0.79	0.86
Total Economy (excluding public sector)	0.04	0.57	0.53	0.56
Manufacturing Only	0.15	0.78	0.83	0.86

Notes: There are 4,161 firms in the survey.

Figure A.1 presents the original survey question in Danish. The work "udflytning" translates to "move out". The full survey is available here `https://www.dst.dk/da/Statistik/`

Publikationer/VisPub?cid=13110 from Statistics Denmark, or archived here http://faculty.tuck.dartmouth.edu/images/uploads/faculty/teresa-fort/Danske_virksomheders_outsourcing_2007.pdf.

Figure A.1: Question on offshoring in Danish



Definitioner

Outsourcing

Outsourcing er hel eller delvis udflytning af forretningsaktiviteter (kerne- eller hjælpefunktioner), der i udgangspunktet udføres internt i virksomheden. Outsourcing kan foregå til selskaber inden for samme koncern eller til andre (eksterne) virksomheder, der kan være lokaliseret i Danmark eller i udlandet.

Det skal understreges, at outsourcing til udlandet også omfatter de funktioner, som virksomheden hidtil har outsourcet til andre virksomheder i Danmark.

Oprettelse af forretningsaktiviteter (kerne- eller hjælpefunktioner) uden effekt på virksomhedens nuværende aktivitet eller beskæftigelse i Danmark, f.eks etablering af en ny udenlandsk produktionsenhed alene med henblik på udvidelse er derimod ikke outsourcing. Oplysninger om virksomhedens ekspansion i udlandet, udover outsourcing, behandles kun i spørgsmål 3.

Table A.2 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.2: 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.3 presents all the offshoring locations to which Danish firms relocate their core activities.

Table A.3: 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, analyze imports of produced goods versus inputs, and provide reassuring evidence that domestic production is not simply repackaged imports.

B.1 Production of 'Own Goods'

Figure B.1 presents the documentation from the Denmark's survey on production. Although the description of "Own goods" may include products manufactured by a subcontractor, the definition explicitly states that "Traded goods are not included."[34] In addition, goods that the firm buys and resells without processing are explicitly reported as "Commercial (resale) turnover," and that description notes that goods that the firm repackages have not been processed. Repackaged goods are thus categorized as Resales, not as Own Goods.

Here we depict total ProdCom sales by these main categories. Production represents firms' "sales of own goods", which is the focus in the paper, both since these sales represent actual production in Denmark by the firm, and since they are broken out by detailed CN8 product code. We also plot resales here to show that sales of goods that the firm purchases and then repackages or relabels are explicitly measured in a different category.

[34]We further confirm that offshoring firms' imports do not contain significant values of subcontracted production using a flag in the import data.

Figure B.1: ProdCom definitions

2.4 Statistical concepts and definitions

Other turnover: Other turnover is for turnover not related to activities in manufacturing or mining and quarrying. This can be from construction, research and development or renting.

Own goods: The statistics measures sales of own goods, that is goods extracted, produced, processed or assembled by the reporting enterprise. Own goods are also products manufactured by a subcontractor, if the reporting enterprises owns the inputs for the subcontracted manufacturing. Traded goods are not included.

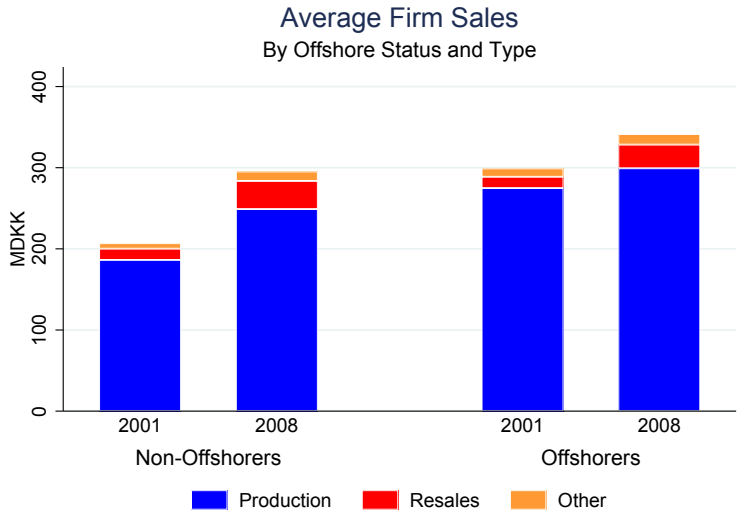
Commercial (resale) turnover: Commercial (resale) turnover is turnover from sales of goods that are bought and sold with any processing. Repackaging does not constitute processing.

Contract work for other enterprises: Contract work for other enterprises is work done for another enterprise, which owns the input for the manufacturing work.

Sales: Sales are in current prices, excluding VAT. All sales are included, domestic and export markets.

Notes: Definition from Statistics Denmark "Documentation of statistics for Manufacturers' Sales of Goods 2017 Quarter 1."

Figure B.2: Composition of Firm Sales by Offshore Status

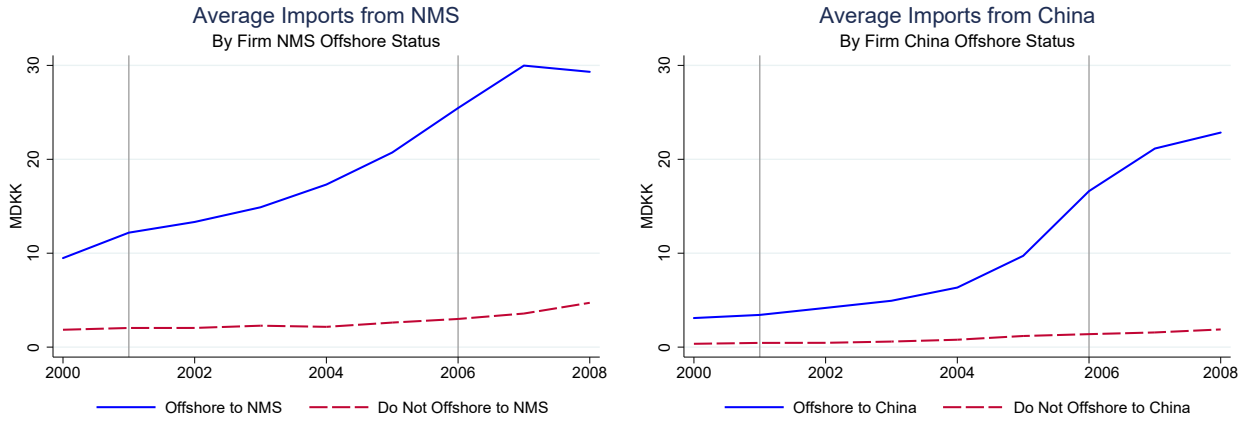


Notes: Figure presents the weighted-average of total firm sales reported in ProdCom, split apart by type of sales. Production is "sales of own goods," (i.e., goods that are produced by the firm). Resales are sales of goods that are bought and sold without any processing, where repackaging does not constitute processing. Other includes contract work, installation, and packaging and repair. 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.

B.2 Imports from Offshoring Regions

The left panel of Figure B.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

Figure B.3: Average Firm Imports from Offshore Region



Notes: Figure presents weighted-average of firm imports from the New Member States (left panel) and from China (right panel). Offshoring firms relocated their core activity to NMS (left panel) or China (right panel) between 2001 to 2006. 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.

growth in their average NMS imports over the period, while non-NMS offshorers' imports are relatively flat. The right panel of Figure B.3 displays similar patterns for China.

B.3 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.

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.4 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).[35] Figure B.4 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).

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

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

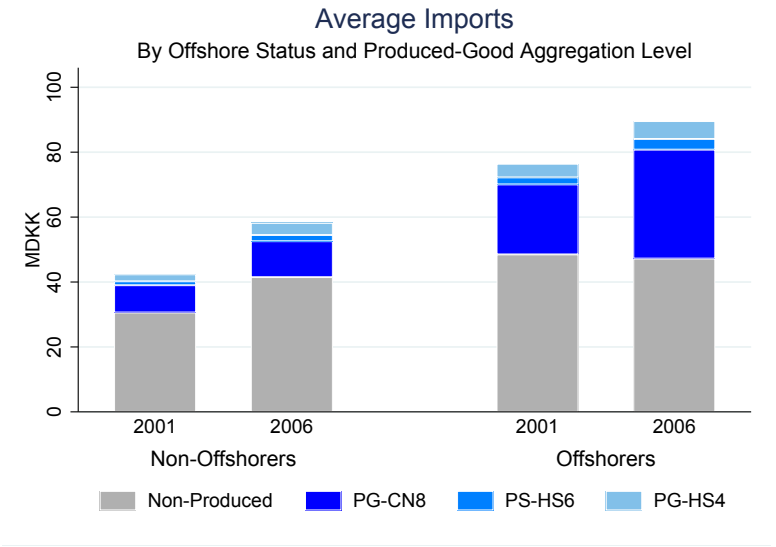
Notes: Table presents product descriptions for HS4 8414 and 8415 industries, along with all HS6 products under these HS4 industries.

B.4 Details on production and imports

To provide additional information on both these dimensions, we classify a firm's imports and production in each year into six mutually exclusive and exhaustive categories. As above, we identify all HS6 goods produced domestically by the firm *prior* to the offshoring period (in 1999 and or 2000). For each firm-year, we also identify all HS6 products the firm produces in that year, and all HS6 products that it imports in that year. On the production side, goods can be in the initial production set, newly produced by the firm after 2000, or never produced. If a good was in the initial production set, it can have positive production in a subsequent year or have been dropped, i.e., no production after 2000. On the import side, an HS6 good is either imported by the firm in that year or not. This yields six potential categories of products in any year: four with positive production and four with positive imports.

Table B.2 reports weighted averages of firms' production and imports at the beginning and end of the offshoring period for the six categories of firm-products. The first 3 rows in each panel correspond to HS6 goods the firm imports and ever produces, and provide further evidence on the importance of these produced-and-imported goods for offshoring firms. On the production side, offshorers' domestic production of produced-and-imported goods rises in levels, with HS6 products in both the prior and current set (row 1) dominating in importance. Offshorers' production of non-imported goods decrease substantially over the period (rows 5 and 6). By contrast, non-offshorers grow their production of imported and non-imported HS6 goods. On the import side, offshorers' imports of produced-and-imported goods grow

Figure B.4: 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.

dramatically, with imports of goods that the firm produced prior to 2001 and continues to produce also dominating its imports and import growth (row 1). While all categories of their produced-good imports rise, offshorers' imports of goods they never produce decrease over the period. By contrast, non-offshorers' imports and import growth are concentrated in products that they never produce domestically, accounting for two-thirds of their imports and over half of their import growth (row 4).

B.5 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 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.[36] 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.3 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.

The results in Panel A of Table B.3 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.

The results in Panel B of Table B.3 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.

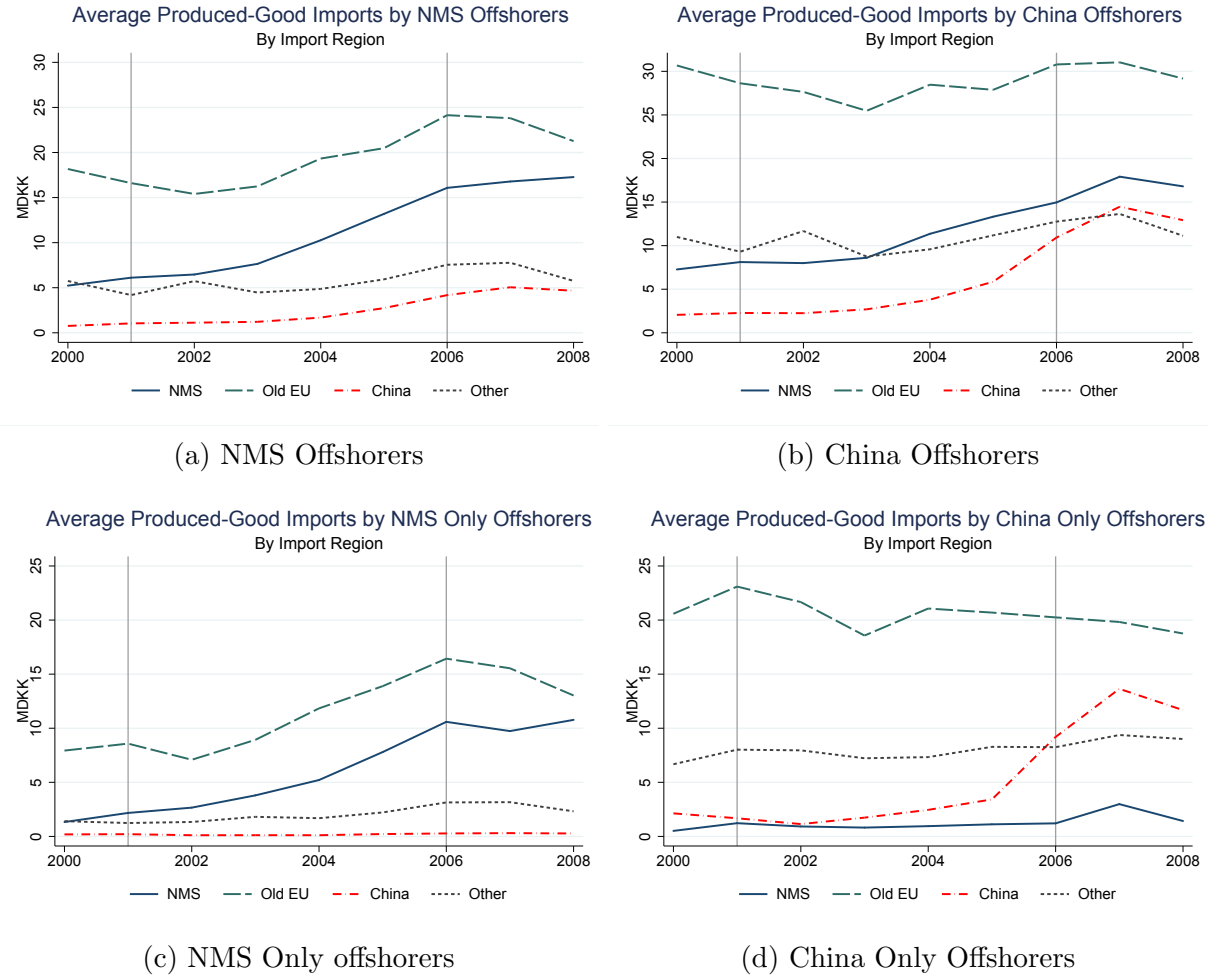
B.6 Produced-goods imports by region

In this section, we show that offshoring firms have relatively high levels of produced-good imports prior to offshoring largely due to their imports of produced-goods from the original EU member countries.

We decompose firm imports by region of the imports, for firms that offshore to NMS and China. The top, left panel of Figure B.5 shows that firms that offshore to the NMS between 2001 to 2006 grow their produced-good imports from that region the most over the period. It is also evident that NMS offshorers start with relatively high levels of average

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

Figure B.5: Average produced good imports by region and offshore status



(a) NMS Offshorers

(b) China Offshorers

(c) NMS Only offshorers

(d) China Only Offshorers

Notes: Top panel presents weighted average of firms' imports by region of goods that they also produce domestically in the same year, for firms that offshore to NMS (left panel) and or China (right panel). Bottom panel presents weighted average of firms' imports by region of goods that they also produce domestically in the same year, for firms that offshore to NMS and not China (left panel) or China but not NMS (bottom panel). Sample is a balanced panel of firms in the offshoring survey that exist from 2000 to 2008 and are ever in ProdCom.

produced-good imports from the old EU countries. The top right panel of Figure B.5 shows similar patterns for firms that offshore to China, with even higher levels of produced good imports from the old EU in 2001, and slight declines in those imports in the initial years of the offshoring period.

To understand how firms' offshoring decisions may be interrelated across space, the bottom panel of Figure B.5 presents similar figures for firms that offshore to NMS but not China and for firms that offshore to China, but not the NMS countries. Here, the patterns are more stark. While both sets of firms have high levels of produced-good imports from the old EU in 2001, the NMS offshorers grow those imports as they also increase their produced good imports from the NMS countries. In contrast, firms that offshore to China but not the NMS

exhibit declines in their average produced good imports from the old EU. These figures not only show how closely produced-good imports match with an explicit relocation of production as identified by firms, but also highlight the potential for produced-good imports to show how global value chains are structured across space.

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

	HS6 Good Status			Average Production			Average Imports		
	Production (1999-2000)	Production (t)	Imports (t)	2001	2006	2008	2001	2006	2008
Panel A: Offshoring firms									
1.	Produced	Produced	Imported	195	220	215	26	39	39
2.	Not Produced	Produced	Imported	4	26	35	1	5	6
3.	Produced	Not Produced	Imported				3	7	12
4.	Not Produced	Not Produced	Imported				45	41	43
5.	Produced	Produced	Not Imported	75	42	45			
6.	Not Produced	Produced	Not Imported	1	6	4			
Total				275	294	299	75	92	100
Panel B: Non-offshoring firms									
1.	Produced	Produced	Imported	130	155	152	10	12	14
2.	Not Produced	Produced	Imported	3	18	25	0	3	4
3.	Produced	Not Produced	Imported				1	2	5
4.	Not Produced	Not Produced	Imported				31	42	44
5.	Produced	Produced	Not Imported	51	48	59			
6.	Not Produced	Produced	Not Imported	2	12	13			
Total				186	233	249	42	59	67

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. "Production (1999-2000)" indicates whether goods were produced by the firm in 1999 and or 2000 (prior to offshoring); "Production (t)" indicates whether goods are produced by the firm in year t; "Imports (t)" indicates whether goods are imported by the firm in year t. Rows labeled 1 and 2 therefore capture goods that are both produced and imported by the firm in the same year. 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.

Table B.3: Share of firm imports decomposed by domestic production and input purchase status

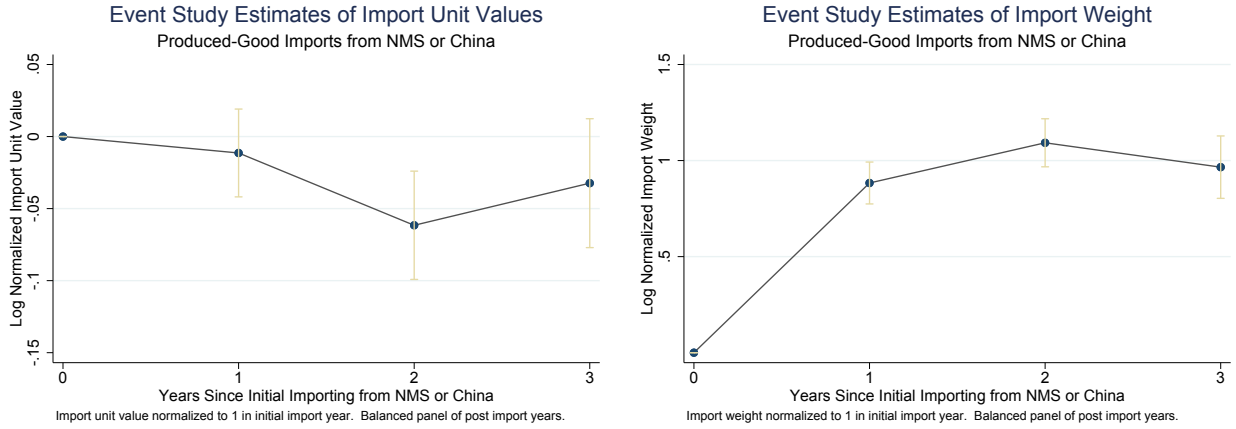
	Offshorers		Non-Offshorers	
	2001	2008	2001	2008
Panel A: CN8 Imports within HS4 Input Industries				
Not Produced	0.33	0.28	0.37	0.37
Produced at CN8	0.23	0.36	0.13	0.12
Produced at HS4 but not CN8	0.06	0.08	0.04	0.06
Total Potential Inputs	0.62	0.72	0.54	0.55
Panel C: CN8 Imports outside HS4 Input 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.

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.

C.1 Event Study Coefficients

Table C.1: Event Study Regressions

	Produced goods			
Years since initial importing from NMS or China	log domestic unit value	log domestic quantity	log imported unit value	log imported weight
t-3	0.002	-0.072		
	(0.021)	(0.049)		
t-2	0.003	-0.016		
	(0.013)	(0.030)		
t	0.005	0.001		
	(0.012)	(0.035)		
t+1	0.032*	-0.032	-0.011	0.883***
	(0.017)	(0.044)	(0.016)	(0.056)
t+2	0.040**	-0.051	-0.062***	1.093***
	(0.019)	(0.055)	(0.019)	(0.064)
t+3	0.036	-0.127*	-0.032	0.966***
	(0.023)	(0.066)	(0.023)	(0.083)
R^2	0.02	0.01	0.02	0.08
Observations	3,638	3,638	4,612	4,612

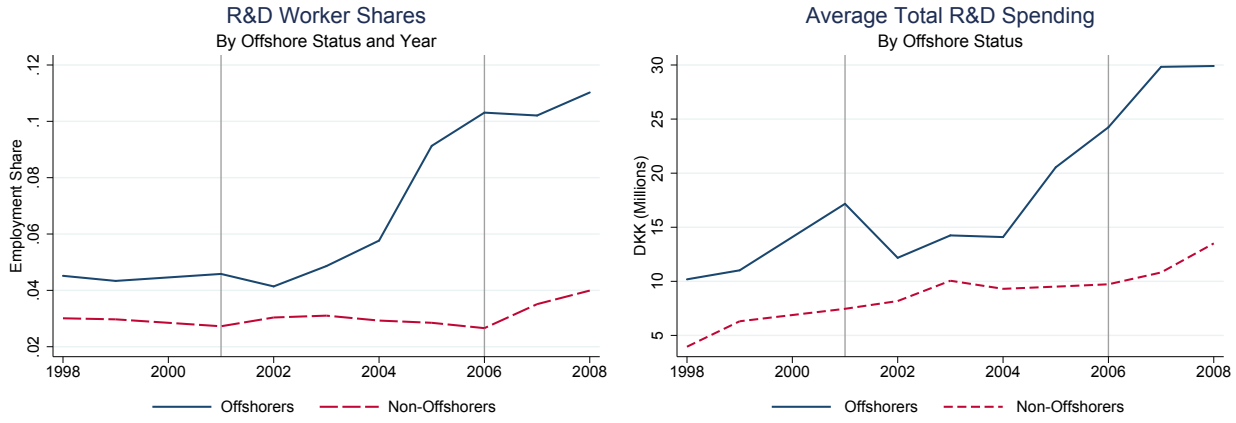
Notes: The log unit values and quantity or weight are normalized to one in the initial import year. Coefficients normalized to zero in the initial import year $(t-1)$. The domestic specifications include year fixed effects, while the import specifications include year and country fixed effects. Domestic unit value sample limited to firms that produce a CN8 good at least two years without importing, begin to import the CN8 good from NMS or China in year t, and continue to produce the CN8 good domestically for at least 3 more years. Import unit value 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 product. * p<0.10, ** p<0.05, *** p<0.01.

D 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. Although 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 show that offshoring firms' reorganization towards technology occupations is also accompanied by relative growth in their R&D employment and spending.

The left panel of Figure D.1 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 technology 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.

Figure D.1: 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.

E Regression Section

Here we present robustness and additional details for the results in the Section 4.

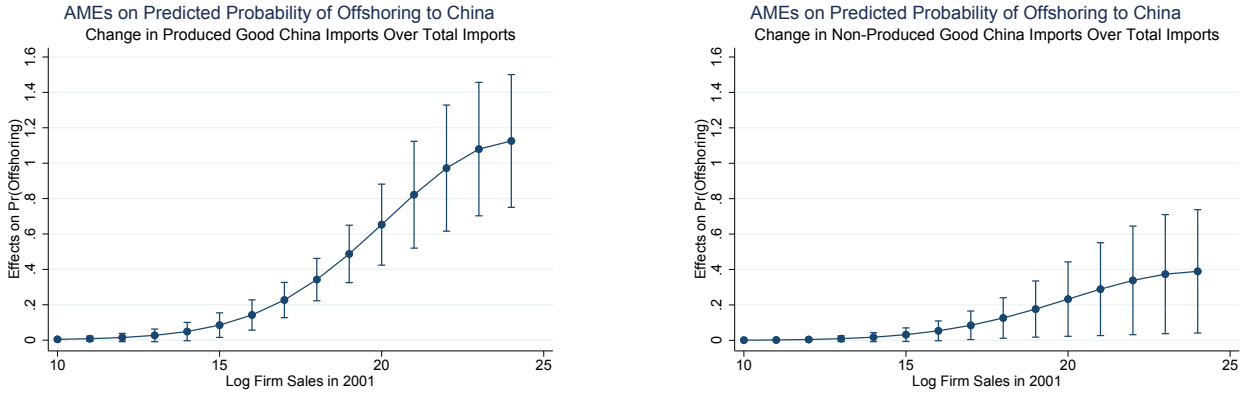
E.1 Produced-good imports and offshoring to China

Here we also present the results from estimating

$$Pr(\Delta Off_f^{China} = 1) = \alpha + \beta_{PG}\Delta\frac{PG\ Imports_f^{China}}{Imports_f} + \beta_s log(sales_f^{2001}) + Ind_f, \qquad (10)$$

where $\Delta\frac{PG\ Imports_f^{China}}{Imports_f}$ is the change in the firm's produced-good import share from 2001 to 2006, Ind_f are two-digit NACE fixed effects, and $log(sales_f^{2001})$ is the firm's sales in 2001. Figure E.1a reports the average marginal effects (AME) of changes in import shares on predicted offshoring to China during 2001-2006. The AME is positive and significant across the entire range of firm sizes but is strongest for the largest firms. Figure E.1b shows AME effects when the RHS variable is the change in the import share of non-produced goods from China. Non-produced good imports from China have a much smaller and less precisely estimated relationship with the probability of offshoring.

Figure E.1: China 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 as a function of firm sales in 2001 of changes from 2001 to 2006 in a firm's produced-good imports from China over total imports on the probability that the firm reports relocating its core activity to China from 2001 to 2006. The right panel presents the average marginal effects of changes from 2001 to 2006 in a firm's non-produced good imports from China over total imports on the probability that the firm reports relocating its core activity to China from 2001 to 2006. Sample is a balanced panel of firms in the offshoring survey that exist from 2001 to 2006 and that report production in ProdCom.

E.2 Regression coefficients for probability of offshoring in survey

Here we present the coefficient estimates for estimating equation (1) via Logistic regression. The marginal effects that correspond to these estimates are presented in Figure 3, evaluated at different measures of firm size.

Table E.1: Import shares by imported good input and production status, and firm offshore status

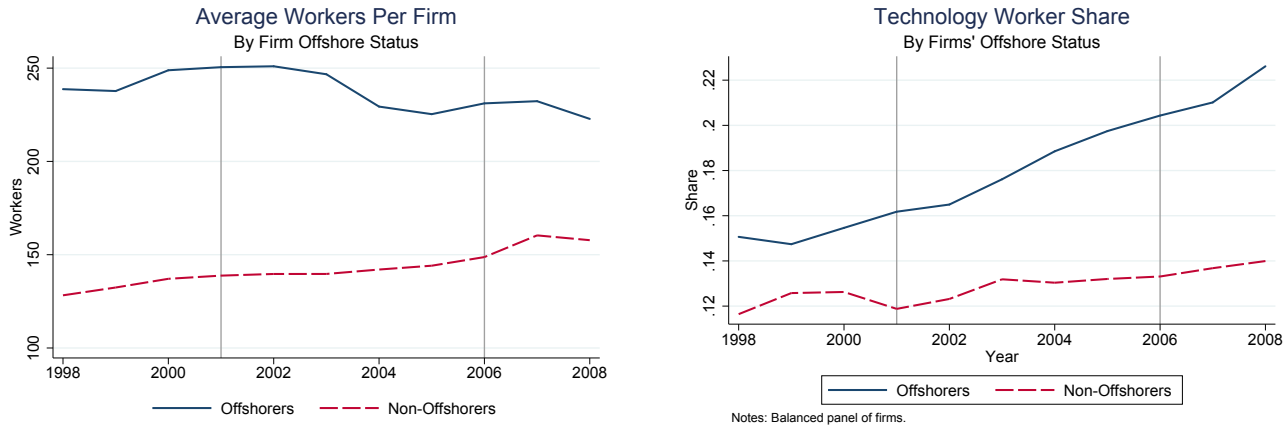
Dependent variable is an indicator if firm offshores to:				
	NMS		China	
$\Delta PG\ ImpSh_f^{Region}$	1.713***		3.117***	
	(0.413)		(0.535)	
$\Delta NPG\ ImpSh_f^{Region}$		-0.199		1.069**
		(0.258)		(0.492)
$log(sales_f^{2001})$	0.208***	0.218***	0.278***	0.265***
	(0.043)	(0.043)	(0.052)	(0.051)
Observations	1174	1174	1057	1057

Notes: Table presents results from estimating equation (1) via Logistic regression. Dependent variable is an indicator equal to 1 if the firm reports relocating its core activity to a particular region from 2001 to 2006. $\Delta PG\ ImpSh_f^{Region}$ is the change in the firm's produced-good imports from the region over that period. $\Delta NPG\ ImpSh_f^{Region}$ is the change in the firm's non-produced-good imports from the region over that period.

E.3 Employment patterns for regression sample

Here we replicate Figure 6 for the entire sample of firms in the offshoring survey, regardless of their ProdCom status. The total employment declines and disproportionate increase in technology workers for offshoring firms are both persistent in the full sample.

Figure E.2: 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 technology workers by firm offshore status. Sample is a balanced panel of firms in the offshoring survey that exist from 1998 to 2008.

Figure E.3: Average Technology Workers by firms' offshore status for offshoring and ProdCom samples

Notes: Figure presents the weighted average of employment in technology occupations at firms that offshore to new foreign locations between 2001 to 2006 and those that do not. The left panel sample is a balanced panel of firms in the offshoring survey that exist from 1998 to 2008. The right panel is the subset of firms in the left panel that are ever in ProdCom over the period.

E.4 Summary statistics for regression variables

Here we provide summary statistics for the variables used in the regression analysis on workers and offshoring.

Table E.2: Summary statistics for regression variables, Table 5

	$\Delta \frac{PG\ Imports_{ft}^{NMS}}{Imports_{ft}}$	$Shock_f^{NMS}$	Change in firm				
			log emp	log prod	share tech	share support	share prod
Mean	0.0066	0.011	-0.058	0.18	0.0068	0.0048	-0.033
Std. Dev	0.12	0.025	0.48	0.68	0.065	0.091	0.13

Table E.3: Summary statistics for regression variables, , Table 6

	DHS tech	DHS support	DHS prod	Δ Switchers
Mean	0.026	-0.049	-0.11	0.00042
Std. Dev	0.92	0.75	0.52	0.029

E.5 Robustness of the IV and Reduced-Form Estimates

Table E.4: Main Results with BHJ Standard Errors

	Δ log Emp	Δ log Production	Δ Share of Workers in Tech	Support	Production
Reduced Form					
$\Delta ExportSh_f^{NMS}$	-0.731*	-0.047	0.078*	0.088	-0.213**
	(0.404)	(0.881)	(0.046)	(0.055)	(0.085)
IV Estimates					
$\Delta PG\ ImpSh_f^{NMS}$	-2.024	-0.130	0.215*	0.243*	-0.589**
	(1.382)	(2.434)	(0.125)	(0.126)	(0.248)
KP-Fstat	5.722	5.722	5.722	5.722	5.722
AR Chi-sq P-val	0.07	0.96	0.10	0.11	0.02
Firms-by-year	5,159	5,159	5,159	5,159	5,159
Products-by-year	3,521	3,521	3,521	3,521	3,521

	Growth Rate of Workers in Tech	Support	Production	Δ Share Tech Switchers
Reduced Form				
$\Delta ExportSh_f^{NMS}$	0.889*	0.032	-1.033***	0.031**
	(0.482)	(0.489)	(0.386)	(0.015)
IV Estimates				
$\Delta PG\ ImpSh_f^{NMS}$	2.464	0.088	-2.863*	0.086
	(1.567)	(1.339)	(1.488)	(0.055)
KP-Fstat	5.722	5.722	5.722	5.722
AR Chi-sq P-val	0.08	0.95	0.01	0.04
Firms-by-year	5,159	5,159	5,159	5,159
Products-by-year	3,521	3,521	3,521	3,521

Notes: This tables reproduces the main results of Tables 6 and 7 following Borusyak et al. (2022) to compute standard errors, transforming the data from firm-year to product-year observations (HS6 level) to take into account the fact that shocks are at the product-year level. Standard errors are clustered by HS2 sector.

Table E.5: Robustness of the IV Estimates

	Δ log Emp	Δ log Production	Δ Share of Workers in Tech	Support	Production
$\Delta PG\ ImpSh_f^{NMS}$	-2.324**	-0.068	0.243**	0.283**	-0.655**
	(1.148)	(2.734)	(0.111)	(0.141)	(0.276)
$\Delta ImpPen_{i,NMS}$	0.010	0.634	-0.058*	-0.026	0.112
	(0.283)	(0.978)	(0.030)	(0.039)	(0.072)
$\Delta ImpPen_{i,CN}$	-0.561	0.113	0.020	0.092*	-0.204
	(0.549)	(0.547)	(0.052)	(0.052)	(0.126)
MNC	-0.003	0.069	-0.004	-0.004	0.000
	(0.050)	(0.059)	(0.003)	(0.004)	(0.008)
$log(emp_f^t)$	-0.020	0.007	0.001	0.003	0.001
	(0.013)	(0.029)	(0.001)	(0.002)	(0.004)
KP-Fstat	9.053	9.053	9.053	9.053	9.053
AR Chi-sq P-val	0.01	0.98	0.01	0.08	0.01
Observations	5,159	5,159	5,159	5,159	5,159

	Growth Rate of Workers in Tech	Support	Production	Δ Share Tech Switchers
$\Delta PG\ ImpSh_f^{NMS}$	2.455*	0.036	-3.374**	0.087*
	(1.474)	(1.232)	(1.368)	(0.051)
$\Delta ImpPen_{i,NMS}$	-0.661	0.041	0.423	-0.012
	(0.518)	(0.351)	(0.297)	(0.017)
$\Delta ImpPen_{i,CN}$	-0.264	-0.369	-0.955	0.013
	(0.566)	(0.488)	(0.609)	(0.017)
MNC	0.026	0.010	0.019	0.000
	(0.046)	(0.042)	(0.064)	(0.001)
$log(emp_f^t)$	-0.032*	-0.002	-0.025	-0.001
	(0.017)	(0.016)	(0.018)	(0.001)
KP-Fstat	9.053	9.053	9.053	9.053
AR Chi-sq P-val	0.03	0.98	0.00	0.03
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 technology workers that switched into technology 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. $\Delta ImpPen_f^{NMS}$ 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.

Table E.6: Robustness of the Reduced-Form Estimates with BHJ Standard Errors

	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***
	(0.396)	(0.907)	(0.048)	(0.056)	(0.087)
Firm-level controls:					
$\Delta ImpPen_{i,NMS}$	✓	✓	✓	✓	✓
$\Delta ImpPen_{i,CN}$	✓	✓	✓	✓	✓
MNC, $log(emp_f^t)$	✓	✓	✓	✓	✓
$log(emp_f^t)$	✓	✓	✓	✓	✓
Count of firms-by-year	5,159	5,159	5,159	5,159	5,159
Count of products-by-year	3,521	3,521	3,521	3,521	3,521

	Growth Rate of Workers in Tech	Support	Production	Δ Share Tech Switchers
$\Delta ExportSh_f^{NMS}$	0.877*	0.013	-1.205***	0.031**
	(0.486)	(0.490)	(0.372)	(0.015)
Firm-level controls:				
$\Delta ImpPen_{i,NMS}$	✓	✓	✓	✓
$\Delta ImpPen_{i,CN}$	✓	✓	✓	✓
MNC, $log(emp_f^t)$	✓	✓	✓	✓
$log(emp_f^t)$	✓	✓	✓	✓
Count of firms-by-year	5,159	5,159	5,159	5,159
Count of products-by-year	3,521	3,521	3,521	3,521

Notes: This table reproduces the results in Table 7 using the method to calculate standard errors in Borusyak et al. (2022).

F Characteristics of produced-good imports at the industry level

We first define a measure of import penetration similar to what is typically done in the literature, but where the numerator can vary by good-importer type. Specifically, we measure the change in import penetration as

$$\Delta ImpPen^{R}_{pT} = \Delta \frac{Imports^{R}_{pT}}{Imports_{p} + DomProd_{p}}, \tag{11}$$

where R denotes region (China or NMS), p denotes HS6 product, and T denotes the good-importer type. Product type T can be all imports, non-produced good imports, and produced-good imports. Produced-good (PG) imports are imports of HS6 products that the importer also produces domestically in that year, while non-produced good (NPG) imports are imports of products that the importing firm did not produce. Since our aim in this section is to provide new insights into prior work that has focused on Chinese import competition, we consider 10 year changes in these import penetration measures from 1998 to 2008.[37]

To assess differences across types of import penetration, we first calculate their correlation coefficients within a region. For both China and NMS, the change in import penetration based on all imports is highly correlated with the change in non-produced good import penetration, with correlation coefficients of about 0.99. The change in produced-good import penetration is also correlated with standard measures, but with lower correlation coefficients of 0.09 and 0.28 for China and NMS, respectively. In contrast, changes in produced and non-produced good import penetration measures are uncorrelated, as reported in Table F.2. Standard import penetration measures therefore capture both types of import flows, even though produced and non-produced good flows are uncorrelated.

We also assess the extent to which these distinct measures of import penetration from China are correlated with import penetration measures from NMS, reported in Table F.1. There is a negative and significant relationship between increased import penetration from China versus NMS for all imports (-.09) and for non-produced goods (-.08). Those products in which China gained market share in Denmark are thus different from the ones in which NMS countries grew. In contrast, we document a positive and significant correlation between changes in produced-good import penetration from NMS versus China (0.06). Produced-good import flows therefore seem to be more similar across source countries, consistent with the premise that produced good imports reflect Danish firms' leveraging certain capabilities in particular products across different countries.

To gain insight into the characteristics of produced versus non-produced good imports, we assess how changes in import penetration measures relate to product-level measures of technology worker intensity and price dispersion. We measure the importance of technology

[37] This timeframe captures China's WTO accession and the main surge in China's imports to developed countries.

workers in the production of a particular product as the share of technology workers used in firms that make that product in 1998. We construct a measure of an HS6 product's price dispersion based on the ratio of the 90th percentile of the product's domestic unit value relative to the 10th percentile of the unit value. This measure is thus a proxy for the potential to differentiate quality within a particular product, as studied by Khandelwal (2010).

Table F.3 presents the correlation coefficients between these product characteristics and changes in import penetration. The top panel shows that although import penetration from NMS increases relatively more in technology worker-intensive goods and in goods with more scope for quality differentiation, these relationships are present only for produced-good imports. In contrast, Chinese import penetration increases most in low technology worker-intensive goods, but this pattern is accounted for only by non-produced good imports. Across both China and NMS, it is thus the case that changes in produced good import penetration are higher relative to non-produced good imports for technology worker-intensive goods. These patterns are consistent with the premise that produced good imports occur in goods with more scope for quality differentiation and in which technology workers are relatively more important.

Table F.1: Correlations of import penetration measures within source

	$\Delta ImpPen_{pT}^{NMS}$		$\Delta ImpPen_{pT}^{China}$	
	All	NPG	All	NPG
NPG	0.9664***		0.9974***	
PG	0.2782***	0.022	0.0882***	0.0167

Notes: Table reports correlation coefficients between changes in import penetration measures from 1998 to 2008. Import penetration is defined according to equation (11). All, NPG, and PG correspond to the numerator with all imports, non-produced good imports, and produced good imports in the numerator, respectively.

Table F.2: Correlations of import penetration measures across sources

	All	NPG	PG
NMS vs China	-0.091***	-0.0781***	0.0601***

Notes: Changes in import penetration measures of All imports, non-produced good imports (NPG), and produced good imports (PG) from 1998 to 2008.

Table F.3: Correlations of import penetration measures and product characteristics

NMS	All	NPG	PG
Tech Share$_p$	0.0709*	0.0068	0.1161**
Price Dispersion$_p$	0.1083**	-0.0042	0.1905***
China			
Tech Share$_p$	-0.2004***	-0.1975***	-0.0458
Price Dispersion$_p$	-0.0267	-0.0261	-0.0108

Notes: Table reports correlation coefficients between HS6 product characteristics and changes in import penetration measures of All imports, non-produced good imports (NPG), and produced good imports (PG) from 1998 to 2008. Tech share is the share of technology workers used to produce a product. Price dispersion is the 90-10 ratio of the product's domestic unit values.

G Cleaning occupation codes

The occupation code data require significant cleaning prior to use. First, we follow documentation in Statistics Denmark to distinguish between occupation codes that are most reliable versus those that are likely imputed.[38] In effect, observations for which the pstill variable has 1, 2, 4, or 10 are high quality. Second, we fill in missing occupation codes by assigning a worker to the same occupation if that worker remains in the same firm and is missing occupation information in a particular year.

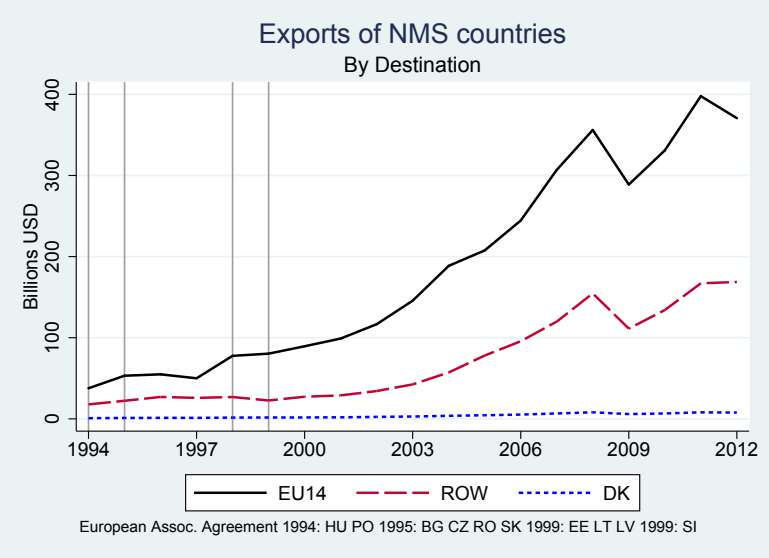
The occupation types are listed in a separate file available here: `http://faculty.tuck.dartmouth.edu/images/uploads/faculty/teresa-fort/occupation_list.pdf`.

[38] See `http://www.dst.dk/da/Statistik/dokumentation/Times/personindkomst/discotyp.aspx` for details.

H Aggregate NMS exports

Here we present exports by NMS countries over time and by region. Figure H.1 shows that Denmark is a relatively small player for NMS countries. Given its small size, we do not expect Danish offshoring decisions to influence NMS ROW export shares.

Figure H.1: Aggregate exports by NMS countries



Notes: Figure presents aggregate exports by destination of the New Member States.