Heterogeneous Globalization: Offshoring and Reorganization*

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Abstract

This paper exploits a unique offshoring survey to show that firms continue domestic production of the same goods they offshore to low-wage countries. This shift towards "produced-good imports" coincides with a reallocation of labor from physical production to innovation and technology occupations, and an increase in domestically-produced varieties' unit values. These responses suggest an additional, firm-level benefit of trade liberalization: the opportunity to offshore production of low-quality varieties, thereby freeing up domestic resources for the development, production, and marketing of higher-quality varieties. Firms' reactions also motivate a new offshoring measure – produced-good imports – that is readily observed in most firm-level datasets.

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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] In addition to decreased manufacturing employment, low-wage imports have been associated with lower wages, rising inequality, worsening health, and political polarization.[2] Even as manufacturing employment has declined, however, the share of manufacturing value-added in GDP has been relatively flat. In many of the same industries that experienced rising import penetration, notably computers and electronics, US value-added growth has tracked overall GDP growth or risen even faster (Fort et al., 2018).

In the face of rising low-wage imports, some firms shrink or fail entirely, while others respond by switching industries (Bernard et al., 2006; Bloom et al., 2019) or increasing innovation (Bloom et al., 2016; Hombert and Matray, 2018; Gutiérrez and Philippon, 2017). Existing research documents heterogeneous responses to import competition but centers on firms changing their domestic activities to escape competition. From a domestic producer's perspective, however, the rise of low-wage countries is not only a potential competitive threat in the form of cheaper products, but also a potential opportunity to lower costs by relocating parts of the production process.

This paper studies firms' decisions to offshore production to low-wage countries, and the impact of these decisions on domestic production and employment. We exploit a unique Danish offshoring survey to show that firms increase their imports of the same detailed goods they produce domestically after they offshore. Instead of ceasing domestic production of the newly imported goods, however, offshoring firms continue producing them in the home country. Offshorers reorient their domestic workforce towards technology-related occupations, and increase the prices of – rather than cease to produce – domestic varieties. The evidence suggests that offshoring allows firms to expand their product lines along a quality dimension by exploiting low-cost production opportunities in low-wage countries and shifting domestic workers into innovation and product-development activities.

Policy makers and academics have long understood the tension between the potentially harmful effects on competing domestic producers of low-wage imports and the positive, productivity enhancing effects of imported inputs (e.g., Amiti and Konings, 2007). In this paper, we identify a different dimension of import heterogeneity. From the perspective of a goods-producing firm, imports under the control of other agents (e.g., Walmart importing

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

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

from a Chinese producer) are potentially different from goods made *both* domestically and abroad, and imported by the domestic producer itself (e.g., Cummings importing one line of engines from China). Improvements in technology and reduced costs of trade increase the ability of firms to fragment their production processes both inside and across country borders (Fort, 2017; Bernard and Fort, 2015). The delocalization of production processes means that newly integrated low-wage economies are a potential source for production under the control of domestic firms, either through foreign direct investment or arms-length transactions with foreign firms.

Using a unique firm-level survey that covers the majority of manufacturing output of the Danish economy, we identify firms that offshore their main activity between 2001 and 2006.[3] The data indicate that about nine percent of Danish firms offshored during this period, with Eastern Europe and China as the top two destinations. We link the survey data to detailed import *and* production data to analyze precisely what firms do when they offshore.

As expected, offshoring firms disproportionately increase their imports from the offshore location. In contrast to the common assumption that offshoring necessarily entails imports of inputs, the data indicate that offshorers import the same detailed six-digit HS (HS6) products that they also produce in Denmark. Imports of these "produced goods" grow disproportionately for offshorers, while they are small and relatively flat at non-offshorers. This fact underpins our first contribution: a firm-by-product level measure of offshoring which we define as the share of a 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, and can be constructed for any region or time period. Moreover, it captures an 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.[4]

The most surprising finding is that 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 HS6 goods that they also import accounts for the majority of their domestic output and is more resilient than production of goods that they do not import. The data indicate that offshoring firms continue domestic production of goods, even as they increase imports of

[3]The survey was conducted on a 2005 frame and the firms surveyed account for 80 percent of Danish manufacturing production in that year.

[4]Produced-good imports consist only of 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. For example, Grundfos manufactures pumps that are inputs into other goods, but pumps are final products from Grudfos' perspective.

these goods from the offshoring destination. However, the imported varieties have lower prices than their domestic counterparts, with systematically lower prices from lower-wage countries. In addition, prices of the domestic varieties increase after offshoring begins. This evidence suggests that firms have a set of capabilities in developing, producing, and selling particular products that they exploit by manufacturing different quality versions of the same good in multiple locations.

The fact that imports of produced goods are associated with offshoring highlights a crucial point in research on the role of imports from low-wage countries. Typically, papers examining the consequences of rising low-wage imports use a single industry import penetration measure (Autor et al., 2013, 2014). We show that rising low-wage import penetration consists of two different types of imports: lower-price varieties under the control of offshoring firms and those that represent a more direct, negative demand shock for domestic producers. We conclude the paper by showing that only non-produced-good imports are related to the well-known negative industry employment effects documented in the literature.

Our third contribution is to show that offshoring leads firms to reorganize their domestic activities by increasing their number and share of tech workers. We construct an instrument to capture production cost savings opportunities for Danish firms in Eastern Europe, their main offshoring location. The instrument exploits HS6 product-level variation in changes to Eastern European countries' comparative advantage in those goods that firms produce prior to offshoring. It allows us to identify how intensive and extensive margin changes in firms' produced-good imports affect firm-level outcomes, even controlling for broad sector-level trends. Although offshoring decreases firms' total employment via a reduction in production workers, it does not "hollow out" the firm and transform it into a pure intermediary of imported products. Using the detailed employer-employee data, we show that offshoring leads both to hiring new tech workers and to shifting workers within the firm to tech occupations.

The changing composition of offshoring firms' employment is more easily understood by considering the complete production process for goods. The range of activities involved in the delivery of goods to a final customer entails more than just physical manufacturing activities. Pre-production tasks can include R&D, product design, and engineering as well as the development of production processes.[5] Production itself involves transformation and assembly of inputs and coordination of the various production stages. Post-production activities include marketing, branding, and logistics. This holistic view shows that the manufacturing and assembly of a good abroad is part of a larger production process. For example, the Danish pump manufacturer Grundfos, opened two pump manufacturing plants

[5]These activities are modeled as headquarter services in Antràs and Helpman (2004).

in Hungary in 2000 and 2001, while focusing Danish workers on developing and producing pumps with new digital monitoring systems.[6]

This paper contributes to three distinct literatures. First, we build on a literature documenting the causes and evolution of offshoring. Since the seminal paper by Feenstra and Hanson (1999) and continuing through Hummels et al. (2018), researchers have equated offshoring with imports of intermediate inputs.[7] While we agree that imported inputs are an important form of offshoring, this paper highlights the fact that imports of produced goods are another, often-overlooked type of offshoring. Hummels et al. (2014) measure offshoring as imports of the same four-digit HS industries that importers produce domestically as a way to capture imported inputs. In contrast, we are the first to emphasize that imports of the same goods produced domestically also constitute offshoring. With the aim of distinguishing produced-goods from the imports of inputs, we narrow the scope to the same HS6 products the firm produces at home, and show that these produced-good imports are a significant and growing share of aggregate imports with different effects on industry-level employment.[8] This measure can be applied to multiple countries and time periods to examine this form of offshoring more broadly.

The paper also contributes to a literature that studies the effect of offshoring on domestic employment and productivity. Offshoring is generally modeled as a substitute for domestic activities that raises firm productivity, either by replacing domestic inputs with foreign inputs (Halpern et al., 2015; Blaum et al., 2018), or by serving multiple locations via export platforms that each produce different products (Tintelnot, 2017). Grossman and Rossi-Hansberg (2008) introduce the notion of a "substitution effect" in which domestic employment shrinks as tasks are moved offshore versus a "productivity effect," in which lower input costs lead an industry to expand. These forces are also present in firm-level models of offshoring (Antràs et al., 2017; Boehm et al., 2019), but regardless of which one dominates, firms source each input from the single, lowest-cost location. In contrast to these views, we highlight a distinct type of offshoring in which firms produce the same

[6]This information is based on publicly available information, see `https://www.grundfos.com/about-us/news-and-press/news/grundfos-opens-competence-centre-in-hungary.html`.

[7]Hummels et al. (2018) provide a comprehensive survey on offshoring. Early work focused on imported inputs at the industry level (Hummels et al., 2001; Johnson and Noguera, 2017), while more recent papers exploit firm-level imports by manufacturers. Another strand of literature measures offshoring using multinational firms' affiliate activities (Harrison and McMillan, 2009; Muendler and Becker, 2010; Kovak et al., 2017). Yeats (2001) measures offshoring as imports of products with the words "parts" or "components." Fort (2017) uses survey data on US manufacturing establishments' purchases of contract manufacturing services. Monarch et al. (2017) use Trade Adjustment Assistance petitions to measure offshoring.

[8]In Section 3.4 we document a positive and statistically significant relationship between growth in a firm's produced-good imports and the relocation of its core activity, while there is no relationship between changes in non-produced good imports and relocation. In Appendix Section A, we show that imports of produced-goods and imports of inputs overlap at the HS4 industry level, and provide examples of why that occurs. When feasible to distinguish imported inputs from produced-goods at the HS4 level, only the latter grow for firms that report relocating their core activity in the survey.

detailed products in multiple locations. In this sense, the patterns we document are most similar to the formation of international teams as in Antràs et al. (2006), with knowledge production specializing in the home country. This specialization is reminiscent of Rodríguez-Clare (2010) and Arkolakis et al. (2018), though we find that firms do not cease domestic production when they offshore, and instead increase the prices of their domestic varieties.

The systematic price differences we document across locations suggest that offshoring allows for quality ladders as first modeled in Grossman and Helpman (1991). Prior work has found a relationship between low-wage imports and quality upgrading (Khandelwal, 2010; Amiti and Khandelwal, 2013). Our work is most closely related to Schott (2004) who documents price differences across locations for the same detailed products, and Schott (2008) who shows how unit values evolve within a location. Here we focus on *within-firm* price differences across locations and over time to show that another response to the rise of low-wage countries is to relocate production there and focus domestic production on higher price varieties.

Finally, we contribute to a more nascent body of work that studies the relationship between offshoring and the reorganization of domestic activities. Hummels et al. (2014) use the Danish data to document an increase in the skill premium for high-skill workers due to offshoring as firms decrease employment of low-skill workers. We build on their work by studying offshoring to a low-wage region, and identifying both intensive *and* extensive margin changes, with the latter being particularly important for low-wage offshoring. A key contribution we make relative to their work is to show that firms continue to produce, and increase unit values of, the goods that they offshore. We also show that low-wage offshoring opportunities lead firms to shed production workers but increase both the level and shares of technology workers. Other work finds that tech workers are important predictors of firm growth (Harrigan et al., 2018), and we show that their rise is associated with increased R&D expenditure and unit values. In this sense, our paper is closely related to Bøler et al. (2015) who document complementarities between input sourcing and innovation. While their results are driven by a scale effect, our paper shows that offshoring also entails a reallocation towards technology and innovation-related occupations.

The rest of the paper proceeds as follows. In Section 2 we describe the new offshoring survey and additional data on firm imports, output, and employment. Section 3 documents the differences between offshoring and non-offshoring firms and establishes the link between offshoring and produced-good imports. Section 4 introduces the identification strategy that exploits productivity changes within destination countries to identify the effects of offshoring. Section 5 explores the differences in unit values between domestic and imported varieties at offshoring firms. In Section 6 we consider the implications of non-produced versus produced-good imports on employment. The last section concludes.

2 Data

In this section, we describe the new offshoring survey as well as other firm and worker datasets.

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.[9] The Danish survey achieved a response rate of approximately 98 percent, which translates to 4,161 firms.

The survey asked firms about their decisions to relocate, either in part or entirely, nine different business functions: core activity; distribution and logistics; marketing; sales and after sales services (including help desk and call center); ICT services; administrative and management functions; engineering work and other technical services; R&D; facility management (cleaning, security, food, etc...); 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.[10] We emphasize that this offshoring definition includes only those functions that were previously performed domestically, either by the firm itself or by another domestic firm. The offshoring question specifically does not include other foreign activities that are new to the firm, i.e. a foreign subsidiary in a new line of business, which are covered in a separate part of the survey.

The specific language in the survey asked firms whether they moved a particular activity to one or more of seven distinct regions.[11] 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;[12] 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

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

[10] See online Appendix Table A.1 for statistics on each activity. The survey instructions specify that a firm's core activity corresponds to its primary industry classification.

[11] The actual Danish language is "...udflytning...", which literally translates to "move out." The precise question is presented in Figure A.1 in the online Appendix.

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

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, value-added, material expenditures, capital, 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 1996 to 2008.[13] This time frame and coverage allow us to analyze potential selection into the offshoring survey, as well as any differential trends for offshoring versus non-offshoring firms.

We augment the VAT data with product-level information about the values and quantities of firm production from manufacturing production surveys (ProdCom). These surveys are available beginning in 1995 and cover all manufacturing firms with at least ten employees. They provide information on the value of production by ten-digit product codes, the first eight digits of which map to Combined Nomenclature (CN) product codes. The CN classification system maps to the Harmonized System (HS) at the six-digit level.

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 product and destination/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 facilitates comparisons of Danish firms' production and trade decisions.

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,

[13]Some of the firm-level data continues past 2008 but we have chosen to end the sample to avoid the Great Recession, and because Danish occupation codes change dramatically in 2009.

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 five distinct occupational categories: managers; technology workers (R&D workers and technicians); support activities; sales activities; and line workers. We further decompose line workers into two separate categories: those involved in transport and warehousing ("other blue collar") and production workers.[14]

Finally, we merge in data from R&D surveys that span the period from 2000 to 2010. 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.

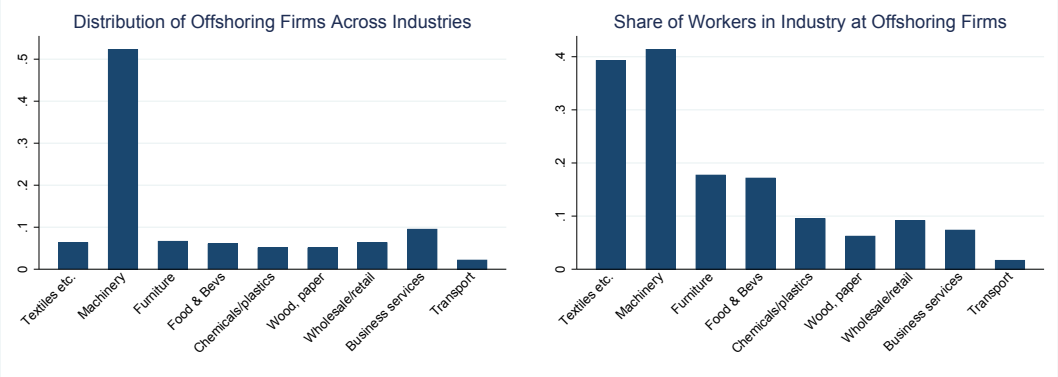
3 Offshoring Firms

The availability of a direct survey measure of offshoring provides a unique opportunity to analyze the differences between offshoring and non-offshoring firms, both before and after they move their core activity abroad. This section provides summary statistics of this survey measure of offshoring, and descriptive evidence on how it relates to changes in firms over time. We focus on two aspects of firm behavior: employment and importing. We go beyond studying the level of employment to examine how offshoring firms change their workforce composition and the set of activities performed in the home country.

Regarding importing, we study the types of goods imported by and (potentially) produced by offshoring firms. While the offshoring survey is specific to 2001 to 2006 in Denmark, we link it to production and trade data to shed new light on the kinds of goods that firms import before and after offshoring. Prior work has associated total imports or imports of intermediate inputs with offshoring. The new survey data indicate that offshoring is predominantly correlated with imports of goods produced by the firm rather than imports of inputs. We exploit this fact to develop a new measure of offshoring that can be employed more generally with data for other countries and time periods.

[14]Section A.5 in the online Appendix explains how we clean the occupation data and map the detailed ISCO codes to these aggregate categories.

Figure 1: Industry shares of offshoring firms and workers



(a) Offshoring Firms Across Sectors (b) Worker Shares Within Sectors

Notes: The left panel shows how offshoring firm are distributed across sectors. More than half of all offshoring firms are in the Machinery sector. The right panel plots 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 sectors are presented to minimize disclosure concerns.

3.1 Offshoring firm characteristics

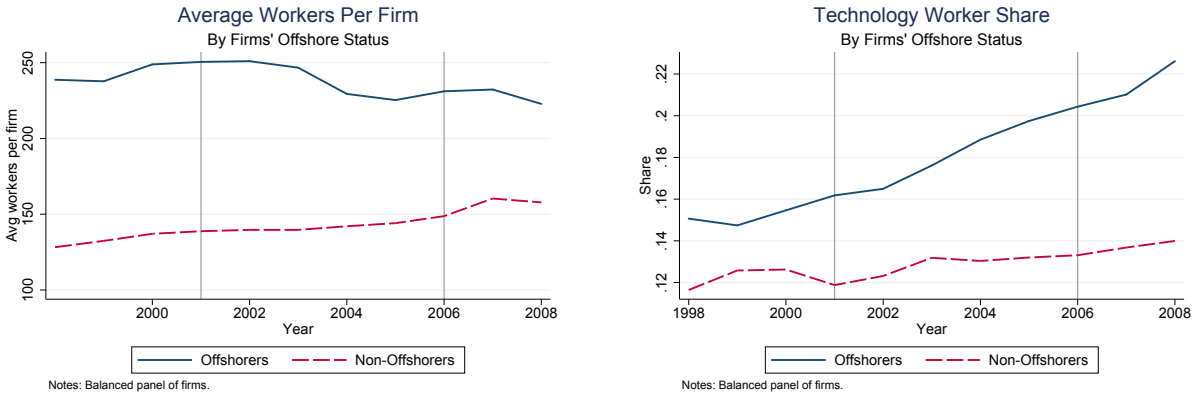
We first provide descriptive statistics on the number, characteristics, and industries of offshoring firms. A total of 380 (9.1 percent) firms relocate some of their core activity to a foreign country between 2001 and 2006. These firms are larger in terms of both employment and sales. In simple "premia" regressions of the log firm employment (or sales) in 2000 on an offshoring dummy and four-digit NACE industry fixed effects, we find that offshoring firms are 57 and 62 log points larger than non-offshorers in terms of employment and sales, respectively.

The majority of offshoring firms are classified in manufacturing sectors. The left panel of Figure 1 shows how offshoring firms are distributed across sectors, using a firm's industry in 2001. Machinery is the largest broad manufacturing sector in Denmark and accounts for more than half of all offshoring firms.[15] 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 depicts the share of workers at firms that offshore within the sector. About 40 percent of workers in the Machinery and Textile and Apparel sectors work at offshoring firms. At the other extreme are the Business Services and Transport sectors, where fewer than five percent of workers are employed by offshoring firms.

[15]In later sections of the paper, we restrict our sample to firms with production, thereby increasing the importance of the Machinery sector in our results.

Figure 2: Employment differences by firms' offshore status



(a) Average Employment

(b) Tech Worker Share

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.

3.2 Employment responses at offshoring firms

As discussed earlier, a number of papers have used firm-level data to document negative employment consequences of offshoring, particularly for low-skill workers. The left panel of Figure 2 depicts the weighted average employment for a balanced panel of both offshoring and non-offshoring firms from 1998 to 2008.[16] As expected offshoring firms are much larger than non-offshorers at all points in time. However, over the sample period, the offshoring firms reduce their average employment while non-offshorers' average size trends upward, confirming results from other studies including those on Danish manufacturing, see Hummels et al. (2014).

The decline in total employment masks important differences in the levels and changes of employment composition at offshoring versus non-offshoring firms. Table 1 presents weighted average employment shares across seven occupation categories over the period 1998 to 2008. To control for industry compositional differences, we divide a firm's employment share in a category by its industry average employment share. A value of 1.0 indicates that the firm-level average is equal to the industry-level average.

There are three notable differences in employment composition between the two firm types. First, offshorers start with relatively higher production worker and tech worker shares of employment. They employ about a quarter more tech workers relative to their

[16] In this subsection, the results are for a balanced panel of Danish firms from 1998 to 2008 that responded to the offshoring survey. We focus on a balanced panel since the frame for the survey is based on firms that survived until 2005, so that it is not feasible to analyze entry and exit. Throughout the paper, we weight by firm employment in reporting averages and in the regression analysis.

Table 1: Employment type

Worker occupation shares by offshore status

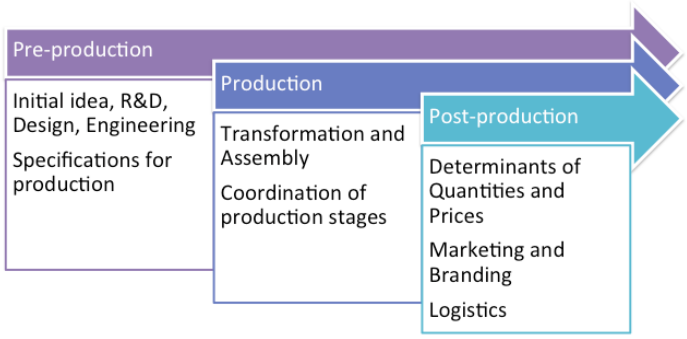
Panel A: Offshoring firms	1998	2001	2006	2008
Production workers	1.10	1.07	0.96	0.88
Other blue collar	0.83	0.89	0.71	0.73
Tech workers	**1.26**	**1.26**	**1.36**	**1.45**
Support workers	0.92	0.95	1.02	1.08
Sales workers	0.92	0.93	0.99	0.98
Managers	0.87	0.87	0.96	1.00
NEC	0.78	0.72	0.78	0.70
Panel B: Non-offshoring firms				
Production workers	0.98	0.99	1.01	1.02
Other blue collar	1.03	1.02	1.05	1.04
Tech workers	**0.95**	**0.95**	**0.94**	**0.93**
Support workers	1.02	1.01	1.00	0.99
Sales workers	1.01	1.01	1.00	1.00
Managers	1.03	1.02	1.01	1.00
NEC	1.04	1.05	1.04	1.05

Notes: Table presents weighted average shares of firm employment by category divided by the weighted industry average of the employment share in that category. 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.

industry average in 1998, while non-offshorers employ less than the average. Offshorers are also more production worker-intensive than average, while non-offshorers are slightly less. Second, the relative shares of these two types of workers evolve in opposite directions over the offshoring period for offshorers versus non-offshorers. While offshorers increase their shares of tech workers and decrease production workers, the relative shares move in the opposite directions at non-offshoring firms. Finally, offshoring firms also increase their shares of sales and support workers. Tech worker occupations are those explicitly aimed at research, engineering, and technical work. Support workers include accountants and lawyers. The employment composition changes at offshoring firms are thus consistent with them re-orienting their domestic activities towards the pre-production and post-production tasks related to manufacturing, as depicted in Figure 3.

We plot the high and increasing share of tech workers at offshoring firms in Panel B of Figure 2. Offshorers have an average of 16 percent of their workforce in tech occupations in

Figure 3: From Idea to Customer



2001 and over 20 percent by 2006. This contrasts with firms that do not offshore, at which there is only a slight increase in the share of tech workers over the same decade.[17]

Since total employment at offshorers is falling, especially in relative terms, the rising tech worker share could be due to a decreasing denominator. Figure 4, depicts the levels of total employment and tech worker employment for the two categories of firms over the period. While total employment declines at offshoring firms, the number of tech workers at those firms rises, contributing to their large tech share increase. For firms that do not offshore, both total employment and tech workers levels increase; the share of tech workers at non-offshorers increases considerably less.

We conclude this section with simple descriptive evidence on firms' research and development (R&D) activities.[18] Figure 5 shows (average) total R&D expenditures and R&D worker shares for offshoring and non-offshoring firms from 1998 to 2008. Figure 5a plots average R&D expenditure in thousands of Danish Kroner by firms' offshore status. Beginning in 2004, there is a clear divergence in R&D spending trajectories, as offshoring firms significantly increase their expenditures, both in level terms and relative to non-offshorers.[19] A similar stark shift is seen in the share of R&D workers at offshoring firms in Figure 5b. These results provide additional evidence that firms' shift in their workforce composition towards technology workers is indeed related to changes in their innovative efforts.

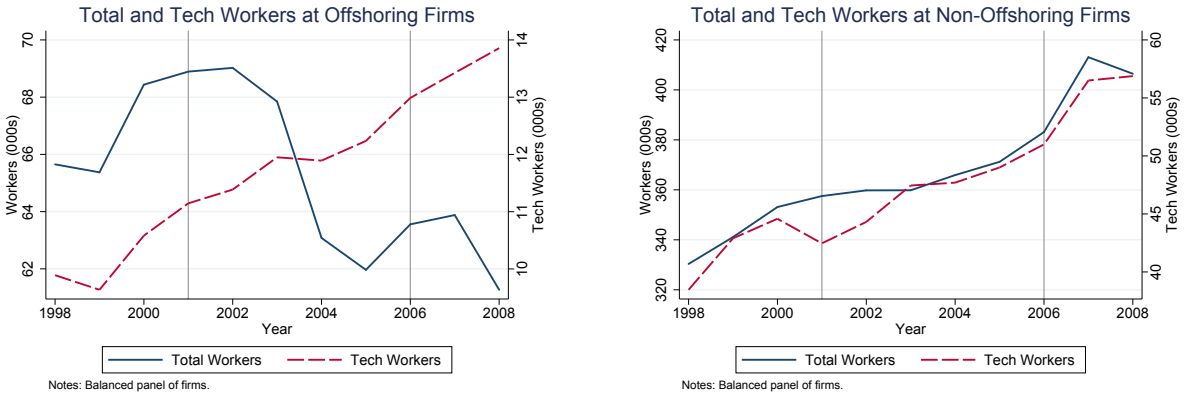
The evidence from the new survey suggests a role for offshoring in changing not just the level of firm employment, but also its occupational composition. Offshoring is associated

[17]The counterpart to Table 1 with non-normalized shares is in online Appendix Table A.4.

[18]The R&D survey covers a rotating panel of approximately 4,300 firms per year. We match about 36 percent of the offshoring firms to the R&D survey.

[19]The share of expenditures shows a comparable divergence starting in 2004, rising from just under 3 to over 4 percent of total expenditures at offshorers.

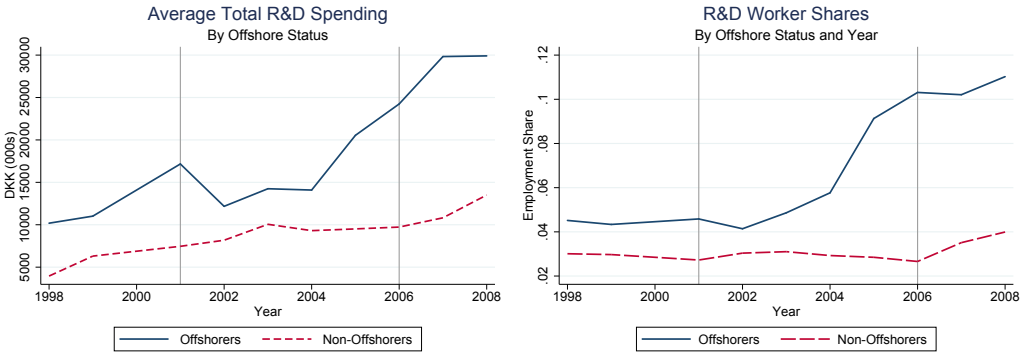
Figure 4: Total tech workers by firm offshore status



(a) Offshorers (b) Non-Offshorers

Notes: The left panel presents the total employment and total tech workers at firms that offshore to new locations between 2001 to 2006. The right panel presents the same measures at firms that do not offshore. Sample is a balanced panel of firms in the offshoring survey that exist from 1998 to 2008.

Figure 5: Total R&D spending and R&D workers



(a) Total R&D spending (b) R&D worker share

Notes: Left panel plots the weighted average of R&D expenditure for firms in the offshoring and R&D surveys. Right panel plots the share of R&D workers over total workers for 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.

with declining total employment, especially of production workers, and rising levels of tech workers. In Section 4 we examine the causal links between offshoring and the changing nature of work within the firm. To do so, we first develop a novel product-level measure of firm offshoring by linking the survey data to the import transactions data and the production data.

Table 2: 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.

3.3 Produced-good imports reflect offshoring

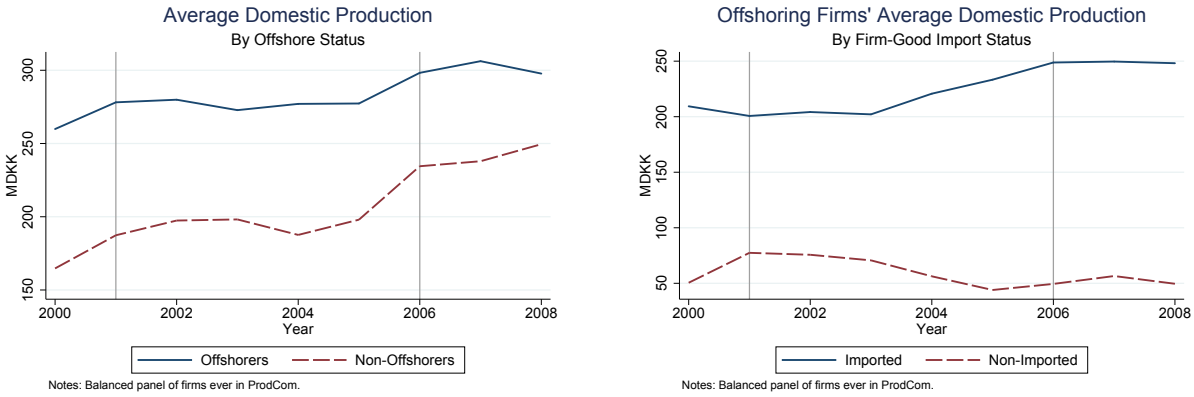
We now examine how offshoring relates to changes in firms' domestic production and import behavior. As discussed in the introduction, offshored activities are often assumed to be substitutes for domestic production and to be captured by imports of *intermediate* inputs. In much of the theoretical work on offshoring, there is a clear prediction that an offshored task will cease to be performed domestically.[20] The employment declines documented above seem to be consistent with the view that offshoring replaces domestic production workers.

We first assess the extent to which firms' offshoring decisions are reflected in their import behavior. Table 2 breaks out offshoring by destination. Between 2001 to 2006, the majority of offshoring firms relocate their core activity to low-wage countries. The main offshoring destination (54 percent) is the 12 New Member States (NMS) that join the European Union (EU) in 2004 or 2007. Approximately one third of these firms also offshore to China. An additional 16 percent offshore to China, but not to the NMS. The primary region in "Other" consists of the 14 countries besides Denmark that had previously joined the EU (see online Appendix Table A.2).

The shares in Table 2 highlight the importance of low-wage countries in firms' extensive margin offshoring decisions from 2001 to 2006. To assess the extent to which these firms'

[20]The net effects of offshoring on total firm size are theoretically ambiguous since they depend on the relative size of the substitution effect (substituting domestic tasks for offshored tasks) versus the scale effect (increase in firm size due to marginal cost reductions from offshoring), as well as on the increase in the competitive environment due to the cost reductions (i.e., the fall in the aggregate price index). Existing work models these opposing forces at the industry level (Grossman and Rossi-Hansberg, 2008) and the firm level (Antràs et al., 2017; Boehm et al., 2019).

Figure 6: Domestic production by offshore status and good type



(a) Total Production by All Firms

(b) Production by Good Type by Offshorers

Notes: The left panel presents the weighted average of firms' total domestic production at firms that offshore to new locations between 2001 to 2006 and those that do not. The right panel presents the weighted average of firms' domestic production split out based on whether the firm imports the same HS6 product (solid line) or does not import the same HS6 product (dashed line). Sample is a balanced panel of firms in the offshoring survey that exist from 1998 to 2008 and that report production in Prod Com in at least year over this period.

offshoring decisions are captured by their imports, we link the survey data to the firm Customs transactions data. We find that the average growth rate of imports from NMS or China over the offshoring period is 74.5 log points higher for offshorers to those regions relative to non-offshorers.[21]

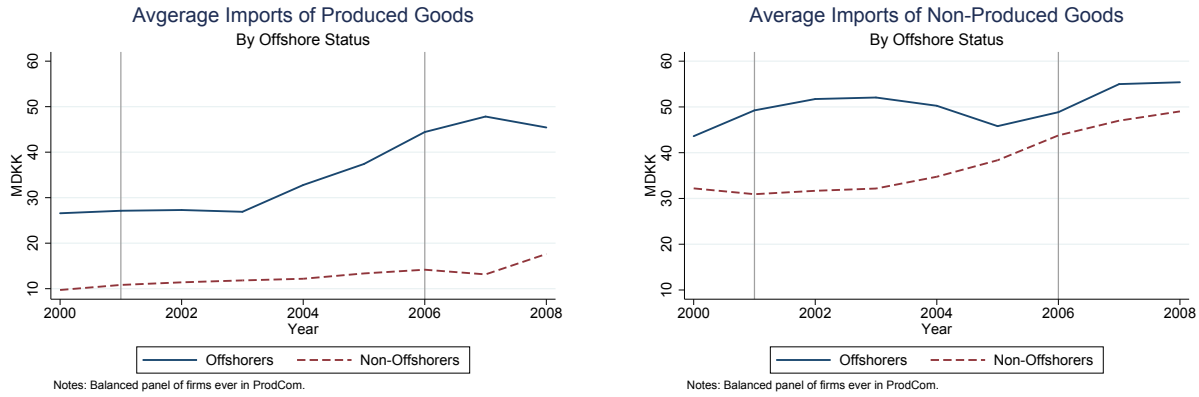
We next investigate the extent to which offshoring firms' new imports replace their production in Denmark. For this analysis, we are limited to manufacturing firms with production data in the ProdCom survey. Figure 6a depicts the weighted average of domestic production by firms' offshoring status. Both offshoring and non-offshoring firms increase their domestic production over the period. This finding is surprising, particularly in light of the falling total employment and falling production worker employment at offshoring firms.

To understand why domestic production rises for offshorers, even as they grow their imports, we split firms' domestic production and imports into three groups of detailed HS6 products: (1) produced-imported: goods that are produced by the firm domestically and also imported in that year; (2) produced-only: goods that are produced domestically but not imported in that year; and (3) imported-only: goods that are imported by the firm but not produced domestically in that year.

In Figure 6b, we split offshorers' domestic production of HS6 products into those that are produced-imported and those that are produced-only. Two facts are apparent. First,

[21] For the sample of offshoring firms, 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 offshores to that region.

Figure 7: Imports by offshore status and good type



(a) Produced goods

(b) Non-Produced Goods

Notes: The left panel presents the weighted average of firms' imports of HS6 products that the importing firm also produced domestically in the same year, at firms that offshore to new locations between 2001 to 2006 (solid line) and those that do not (dashed line). The right panel presents the weighted average of firms' imports of HS6 products that the importing firm did not produce domestically in the same year, at firms that offshore to new locations between 2001 to 2006 (solid line) and those that do not (dashed line). Sample is a balanced panel of firms in the offshoring survey that exist from 1998 to 2008 and that report production in ProdCom in at least year over this period.

the bulk of domestic production for offshoring firms is in detailed product categories that are also imported by the same firm. This is consistent with the offshoring survey capturing relocation of firms' main activities. It also shows that offshoring firms are both importing and producing the same good. Second, the growth in domestic production at offshoring firms is in these same products that they also import. Production of goods that are not imported actually shrinks. In contrast, in online Appendix Figure A.3, we show that non-offshorers' domestic production grows in both types of goods.

We perform a comparable decomposition of firm imports in Figure 7. Figure 7a depicts imports of goods that are also produced by the importing firm, while Figure 7b shows import-only goods, i.e., goods not produced domestically by the importer. Each panel presents the weighted average of these import types by firms' offshore status. While both types of firms increase their imports over the period, offshorers' import growth is concentrated in produced goods; non-produced good imports are essentially constant in levels. In contrast, for non-offshoring firms, the levels and increases of produced-good imports are quite small, but their non-produced good imports increase.[22] In addition, the bulk of the changes in imports for both types of firms occurs during the 2001 to 2006 offshoring period.

[22]Figure 7a also shows that offshoring firms have higher initial levels of produced-good imports relative to non-offshorers. In online Appendix Figure A.4, we show that this is because firms that relocate their core activities to NMS and/or China during the offshoring period have higher shares of produced-good imports from old EU countries. Firms that report relocating their core activity to NMS and/or China from 2001 to 2006 start with low levels of produced-good imports from those regions and increase them over the period.

These findings reveal an important new way to think about offshoring. Rather than being linked solely to imported inputs, offshoring is strongly associated with imports of a firm's "final" or produced goods. There are numerous examples of firms focusing on innovation in the domestic market while offshoring manufacturing activities to low-wage countries, including phones and tablets by Apple, vacuum cleaners and hand dryers by Dyson, and pumps by Grundfos. We develop a new measure of offshoring in the next subsection based on these findings.

3.4 The measure of offshoring

In this section, we exploit the fact that offshoring is associated with imports of produced goods to introduce a new measure of offshoring: the ratio of a firm's imports of "produced-imported" HS6 goods from a region to total firm imports. As noted earlier, we do not dispute that inputs or other types of imports constitute another type offshoring, instead we focus here on a specific measure that aligns with the results from the offshoring survey, and for which we develop a new identification strategy in the next section. Our aim is to make the conceptual point that imports of goods that are considered final from the perspective of a producing firm are another type of offshoring that has been relatively less studied, yet is important in aggregate trade flows.

This measure is similar to the one introduced by Hummels et al. (2014), who measure "broad" offshoring as all imports by a manufacturing firm, and "narrow" offshoring as imports of HS4 industries that the importer produces domestically. In order to distinguish produced-good imports from other imports, we narrow the scope of what is "produced" by using the more detailed HS6 product category.[23] We also divide by the firm's total imports to decrease the possibility that we are simply capturing a growing firm that imports more. Appendix Figure B.1 shows that this measure increases dramatically for both NMS and China offshorers between 2001 and 2006, while it does not change for firms that do not offshore to those regions.

In the next section, we exploit the detailed product-level measure to identify plausibly exogenous variation in firms' produced-good import shares, even while controlling for broad sector trends. Such an analysis is not possible with the aggregate, binary offshoring indicator from the survey. To provide additional justification for the new measure, we estimate the probability that changes in a firm's produced good import share from a region predict its

[23] In Appendix Section A we use the material input survey to assess the extent to which offshoring firms in the survey import inputs versus produced goods. Since the material survey collects information at the HS4 industry level, we cannot distinguish inputs from produced goods as accurately (for example, because an HS4 industry often contains one HS6 product labeled "Parts" along with other products). To the extent that we can separate produced goods from inputs at the HS4 level, we find that firms that relocate their core activity to the NMS and China increase their imports of produced goods relatively more than inputs.

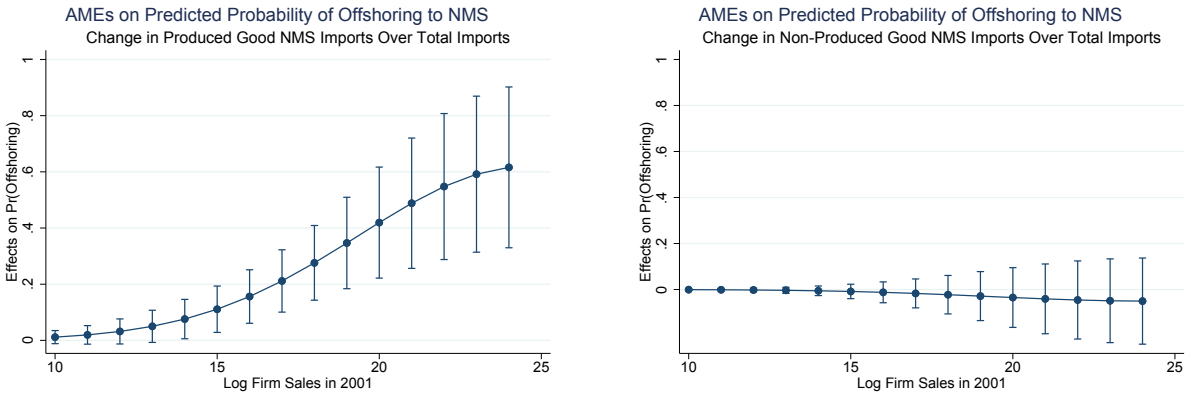
response in the offshoring survey. Specifically, we estimate:

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

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 our instrumental variable strategy focuses on that region. Similar results for China are presented in Appendix Figure B.2.

Figure 8a reports the average marginal effects (AMEs) of changes in import shares on predicted offshoring to the NMS from 2001 to 2006. The AMEs are positive and significant across the entire range of firm sizes but strongest for the largest firms. Figure 8b depicts the AMEs when the independent variable is the change in the import share of non-produced goods from NMS. Increases in import shares of non-produced goods have no relationship with the probability of offshoring.

Figure 8: Offshoring and Produced-Good Imports



(a) Produced good import share

(b) Non-Produced good import share

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

The attributes of the Danish offshoring survey allow us to develop a better understanding of changes at offshoring firms. Our results on production and imports are surprising. Instead of reducing domestic output and importing more intermediates, offshoring firms maintain the value of domestic production but at the same time increase imports of goods they produce domestically. These findings from the offshoring survey underpin a new mea-

sure of offshoring based on the share of produced goods imported by the firm from the offshoring region. This measure has the advantage that it can been constructed from firm-level production and import data for many other countries, including all other EU member states. In addition, for our purposes it allows us to study offshoring decisions and outcomes at the product level for more firms in Denmark over a longer time horizon.

4 Causal Impact of Offshoring

In the previous section we show that offshoring firms disproportionately increase their imports of produced goods. In this section, we develop an IV strategy to establish a causal link between firm-specific offshoring opportunities and subsequent reorganization. Our approach exploits the detailed firm-product variation in our new offshoring measure.

4.1 Identification strategy

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

We measure firm-level offshoring as the change in the share of produced-good imports from a particular region in total imports and estimate its relationship with firm outcomes according to

$$\Delta FirmAttribute_{ft} = \alpha + \beta_{PG}\Delta\frac{PG\ Imports_{ft}^{NMS}}{Imports_{ft}} + Ind_{ft} + \varepsilon_{ft}, \tag{2}$$

using two stacked five-year difference panels for 1998 to 2008. Ind_{ft} are two-digit NACE fixed effects in the initial year of each panel. 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. Firm attributes are firm size, occupation shares, and growth rates. We weight the regressions by firm employment in the initial year of each panel. A potential concern with using product-level shares rather than levels is that a high initial import share may mean the offshoring of the product has already happened. Given the importance of the extensive margin, however, this concern seems less problematic in

our context, and it is more likely to bias our results down.

Offshoring is an endogenous decision of the firm. Ordinary least squares (OLS) estimates of equation (2) may be biased up if a firm chooses to offshore because it aims to reorganize its domestic workforce. Omitted variables may bias the OLS estimates in either direction. For example, firms may offshore in response to competition, such as imports, (e.g., as in Rodriguez-Lopez, 2014). Although we control directly for import competition in robustness checks, other unobservable competition shocks might bias the OLS estimates.

To identify changes in offshoring due to factors exogenous to the firm, we construct a novel, firm-specific instrument based on the desirability of locating production in the New Member States (NMS) of the EU by exploiting changes in NMS comparative advantage. We focus on this region since it constitutes the main offshore location for Danish firms. The NMS underwent significant reforms starting in the mid-1990s as they undertook necessary changes to join the European Union (EU) in 2004 and 2007. These internal changes led to large shifts in the composition of their exports which allow for a strong first stage in predicting changes in produced-good imports. An increase of the export share by NMS states to the rest of the world (ROW), excluding Denmark, signals increasing NMS comparative advantage.

These export share changes are at the product-level, but we require a firm-level instrument to predict changes in offshoring. In particular we aim to distinguish between offshoring activities of different firms in the same broad industry. To capture the extent to which a Danish 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:

$$Shock_f^{NMS} = \sum_{p \in f} ProdShare_{fpt} \times \underbrace{\Delta \frac{Exports_p^{NMS}}{Exports_p^{World}}}_{\substack{\text{NMS comparative} \\ \text{advantage growth}}}, \tag{3}$$

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 export shares and lag the export shares by two years to reduce the possibility of Danish firms' offshoring decisions driving NMS export shares.[24]

We assign the product-level shocks based on the firm's initial period production, as

[24] We use the firm's production in $t-1$ and t to calculate its initial production shares to minimize noise from lumpy production. We are limited to lagging the export shares by two years due to a significant change in the HS classification system in 1996. In online Appendix Figure C.2, we show that NMS exports to Denmark are a tiny fraction of their exports to the ROW, suggesting that Denmark is relatively unimportant in NMS aggregate activity.

opposed to its initial imports as has been done in prior studies. This allows us to capture both intensive *and* extensive margin changes in offshoring, with the latter being particularly important for offshoring to low-wage regions. For instance, in our balanced panel of manufacturing firms, we find that about ten percent of firms begin offshoring to the NMS over the 1998 to 2008 period.

We follow Antràs et al. (2017) and use changes in NMS export shares rather than levels to instrument for offshoring. This reduces the possibility that growth in the instrument is driven by aggregate demand or technology shocks that increase exports of particular products across all countries. The growth in NMS global market share corresponds more closely to increasing comparative advantage for NMS countries in that product.

One concern with this approach is that firms within industries may not differ in their product mix. We find substantial product-share variation across firms within industries. The average NMS offshoring firm produces 5.3 unique products, while the average non-NMS offshorer produces 3.4 products. For all firms, the average of the firm-level median product share is 0.48 for NMS offshorers and 0.57 for non-NMS offshorers.[25]

Our IV strategy identifies firms that began offshoring to the NMS as a result of improved NMS comparative advantage (relative export shares) in products relevant to the firm. The key identifying assumption is that the common within-product component of the relative increase in exports from an offshoring destination (NMS) is due to relative increases in the destination's productivity and/or decreases in their external trade costs. The exclusion restriction requires that the foreign region's increased productivity in the product only affects a firm's domestic activities through its impact on the offshoring decision. By using six-digit product variation, we are able to control for broad two-digit sector fixed effects. We thus control for broad industry-level trends in a manner that is not feasible with more aggregated industry-level measures of offshoring.

One potential violation of the exclusion restriction is that improvements in NMS comparative advantage may also increase import competition from NMS into Denmark, and that increased competition may directly affect firms' innovative activities and workforce composition (e.g., as in Utar, 2014; Bloom et al., 2016). China's rise in world markets may also be correlated with NMS changing market shares. We therefore construct two measures of firm-level import penetration, one for imports from the NMS and one for imports from China. Using firm-product weights from production in the initial year, t, we measure changes in import penetration as

[25] 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).

$$\Delta ImpPen_f^{Source} = \sum_{p \in f} ProdShare_{fp}^t \times \Delta \frac{Imports_{DKp}^{Source}}{Imports_{DKp}^{World} + DomProd_{DKp}}, \quad (4)$$

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 constructing its import penetration measure. We show that controlling for these measures of import competition does not materially affect our first stage estimates, and we present robustness analyses of the second stage estimates with these controls in Section 4.3.

4.2 Results

Results from the first stage estimation for two stacked five-year differences for 1998 to 2008,

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

are presented in Table 3. 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 9.03. To address potential concerns about weak instruments, we also report the reduced-form estimates as well as the Anderson-Rubin Chi-squared statistic in all the two-stage least squares (2SLS) estimates.

Table 4 contains the main results on the effects of offshoring on the organization of the firm. We report results from estimating equation (2) via OLS and 2SLS, as well as the reduced form, for total firm employment and production as well as the employment shares of tech, support, and production workers. The results are largely consistent in sign and significance across the OLS, reduced-form, and IV specifications although the magnitudes of the coefficients vary.

As found in the offshoring survey, the decision to relocate the main activity of the firm to a low-wage region (*i.e.*, the NMS), has a significant negative effect on total firm employment. However, in line with the results from the offshoring survey presented above, there is no significant reduction in domestic production. These results provide a potential

Table 3: First Stage

	(1)	(2)	(3)	(4)
$\Delta ExportSh_f^{NMS}$	0.359***	0.336***	0.362***	0.339***
	(0.118)	(0.116)	(0.119)	(0.118)
$\Delta ImpPen_f^{NMS}$		0.174**		0.181**
		(0.077)		(0.076)
$\Delta ImpPen_f^{China}$			0.066	0.086
			(0.174)	(0.172)
KP-Fstat	9.03	8.36	9.31	8.31
Observations	5,160	5,160	5,160	5,160

Notes: 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

explanation for the divergence between output and employment for the US and elsewhere in industries with large import penetration increases, such as computers and electronics.

The effects of offshoring on the reorganization the firm's domestic activities are even more pronounced. Offshoring leads to increased shares of tech and support workers while reducing the share of production workers. Focusing on the IV estimates, a ten percentage point increase in the share of produced-good imports leads to a 2.2 point increase in the share of tech workers. The average tech worker share increase over this period was only 0.01 points, so this is an economically large effect. That same increase in offshoring leads to a 5.9 point decline in the production worker share, which is almost double the average decline for firms in the sample. The offshoring firms are not merely shrinking at home, they are changing what they do. These offshoring firms are reorganizing themselves to focus on non-production aspects of value-added creation by focusing on pre-production and post-production stages as shown in Figure 3.

In Table 5, we examine growth rates of the three types of workers, rather than shares, to ensure that the growth in non-production worker shares is not driven solely by falling total employment. The growth rates of the types of workers are defined as $\frac{(Occup_{f,t+5}-Occup_{f,t})}{0.5(Occup_{f,t+5}+Occup_{f,t})}$ to allow for extensive margin changes in firm employment across occupations. In both the reduced-form and the IV estimates, the data indicate that offshoring results in relatively higher tech worker growth, while production worker growth has a negative and significant relationship. Both the levels and shares of tech and production workers are changing as a result of offshoring to the NMS.

The rise in the share and level of tech workers in offshoring firms is driven in part by occupation switching within the firm. By tracking worker employment and occupation over time, we calculate the extent to which the same workers switch into a tech occupation

Table 4: Firm Outcomes - Output, Employment and Workforce Composition

A: OLS	log Emp	log Production	Share of Workers in Tech	Support	Production
$\Delta PG\ ImpSh_f^{NMS}$	-0.214***	-0.034	0.020**	0.041***	-0.071***
	(0.071)	(0.090)	(0.008)	(0.009)	(0.015)
R^2	0.04	0.07	0.03	0.04	0.05
B: Reduced Form					
$\Delta ExportSh_f^{NMS}$	-0.730**	-0.046	0.078**	0.088	-0.213**
	(0.371)	(0.976)	(0.033)	(0.059)	(0.089)
C: IV Estimates					
$\Delta PG\ ImpSh_f^{NMS}$	-2.031*	-0.129	0.216**	0.244*	-0.592**
	(1.161)	(2.678)	(0.099)	(0.140)	(0.257)
KP-Fstat	9.303	9.303	9.303	9.303	9.303
AR Chi-sq P-val	0.05	0.96	0.02	0.13	0.02
Observations	5,160	5,160	5,160	5,160	5,160

Notes: Two stacked five year differences for 1998 - 2008. Regressions are weighted by 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.

within the firm. The final column shows that offshoring is positively associated with the share of tech workers that come from other occupations in the same firm. Focusing on the reduced-form estimates, which are the most precise, we find that a ten percentage point increase in offshoring leads to 0.31 point increase in the share of tech switchers. Since the average share at these switchers is only 0.0004, this is an economically large effect, and highlights an important role for the firm in facilitating reallocation. Offshorers both hire new tech workers and shift existing workers into tech occupations.

4.3 Robustness

In Table 6, we include additional controls to check the robustness of the results. As discussed above, one concern is that our findings are being driven by import competition rather than offshoring by the firm. Our IV approach views offshoring as a positive choice by the firm to take advantage of changing comparative advantage in a destination country rather than a negative response to increased competition in the home market. We therefore control for import penetration from NMS and China.

We also address concerns that the results are driven by foreign multinationals who are shifting production across borders into NMS from Denmark and that initial firm size might be driving the outcomes. Additional controls include a dummy for foreign ownership and

Table 5: Firm Outcomes - Growth Rates and Switchers

A: OLS	Growth Rate of Workers in			Δ Share
	Tech	Support	Production	Tech Switchers
$\Delta PG\ ImpSh_f^{NMS}$	0.014	0.039	-0.240***	0.001
	(0.097)	(0.076)	(0.065)	(0.003)
R^2	0.02	0.04	0.06	0.05
B: Reduced Form				
$\Delta ExportSh_f^{NMS}$	0.893**	0.028	-1.034***	0.031**
	(0.400)	(0.476)	(0.385)	(0.015)
C: IV Estimates				
$\Delta PG\ ImpSh_f^{NMS}$	2.484*	0.078	-2.876**	0.087*
	(1.431)	(1.301)	(1.286)	(0.051)
KP-Fstat	9.303	9.303	9.303	9.303
AR Chi-sq P-val	0.02	0.95	0.01	0.04
Observations	5,160	5,160	5,160	5,160

Notes: Two stacked five year differences for 1998 - 2008. Growth rate is $\frac{(Occup_{f,t+5}-Occup_{f,t})}{0.5(Occup_{f,t+5}+Occup_{f,t})}$. Share Tech Switchers is share of tech workers in year t+5 that changed occupation within firm. 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.

the level of employment in the initial year to control for firm size.

The results for the NMS offshoring variables are unchanged in sign, significance and magnitude. Offshoring reduces firm employment with no effect on domestic production. Within the firm, non-production workers including tech and support workers rise, while the number and share of production workers falls.

5 Offshoring and Quality

The prior section documents the causal impact of produced good imports, a new measure of offshoring, on firm employment, production, and the composition of workers across occupations. Although offshoring firms decrease domestic employment, the value of their domestic production does not fall. Moreover, total employment declines are driven by a decrease in production workers, as offshorers actually increase their employment of technology workers, both via new hires and relatively greater switching of workers into tech occupations.

The reorientation towards innovation-related occupations provides a potential explanation for why offshoring firms' domestic production does not fall, even as they increase imports of goods they produce domestically. Although offshorers produce and import the

Table 6: Robustness of the IV Estimates

	log Emp	log Production	Share of Workers in Tech	Share of Workers in Support	Share of Workers in Production
$\Delta PG\ ImpSh_f^{NMS}$	-2.299**	-0.031	0.239**	0.281**	-0.645**
	(1.125)	(2.684)	(0.110)	(0.138)	(0.271)
$\Delta ImpPen_f^{NMS}$	-0.03	0.626	-0.053*	-0.026	0.107
	(0.280)	(0.979)	(0.028)	(0.038)	(0.070)
$\Delta ImpPen_f^{CN}$	-0.436	0.099	0.013	0.086	-0.181
	(0.618)	(0.572)	(0.059)	(0.056)	(0.143)
MNC	-0.001	0.069	-0.004	-0.004	0.001
	(0.050)	(0.057)	(0.003)	(0.004)	(0.007)
$log(emp_f^t)$	-0.02	0.007	0.001	0.003	0.00
	(0.013)	(0.028)	(0.001)	(0.002)	(0.004)
AR Chi-sq P-val	0.01	0.99	0.01	0.07	0.01

	Growth Rate of Workers in Tech	Growth Rate of Workers in Support	Growth Rate of Workers in Production	Δ Share Tech Switchers
$\Delta PG\ ImpSh_f^{NMS}$	2.422*	0.045	-3.321**	0.086*
	(1.448)	(1.218)	(1.345)	(0.050)
$\Delta ImpPen_f^{NMS}$	-0.641	0.008	0.371	-0.012
	(0.506)	(0.351)	(0.289)	(0.017)
$\Delta ImpPen_f^{CN}$	-0.345	-0.34	-0.801	0.009
	(0.616)	(0.500)	(0.724)	(0.018)
MNC	0.023	0.01	0.023	0.00
	(0.045)	(0.042)	(0.062)	(0.001)
$log(emp_f^t)$	-0.031*	-0.002	-0.027	-0.001
	(0.016)	(0.015)	(0.017)	(0.001)
AR Chi-sq P-val	0.03	0.97	0.00	0.03

Notes: Two stacked five year differences for 1998 - 2008. Growth rate is $\frac{(Occup_{f,t+5}-Occup_{f,t})}{0.5(Occup_{f,t+5}+Occup_{f,t})}$. Regressions weighted by initial employment and include industry (NACE2) and year fixed effects. Share Tech Switchers is share of tech workers that change occupation w/in firm. Standard errors clustered by HS2 sector. * p<0.10, ** p<0.05, *** p<0.01.

same goods, they may focus on high quality versions domestically and source low quality versions from lower wage countries. Existing work documents a strong relationship between worker skill and quality (Verhoogen, 2008; Kugler and Verhoogen, 2012) that is consistent with this mechanism.

In this section, we assess the potential for quality differences between domestic and imported products to explain our findings that offshoring induces firms to produce and import the same goods and to change their occupation structure. We examine price differences between domestically produced and imported varieties of the same narrowly defined product. In addition, we show that there are significant changes in the prices of domestic varieties after offshoring to low-wage destinations.

5.1 Unit values for domestic and imported varieties

Offshoring may allow firms to focus their domestic production on high quality and innovative versions of a product, while sourcing less sophisticated, lower quality versions from low-wage locations. To assess the empirical support for this explanation, we compare the unit values of the same CN8 product produced domestically and imported by the same firm in the same year.[26] Since we consider imports of produced goods offshoring, this sample effectively includes all firms that offshore some activity. Specifically, we estimate

$$log(UV_{fpct}) = \alpha_t + \gamma_{fp} + \beta Dom_{fpct} + \varepsilon_{fpct}, \tag{5}$$

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

We limit the analysis to a sample of firm-CN8 products from 2000 to 2008 with both production in Denmark and imports in the same year.[27] In these regressions, we focus on firms in the offshoring survey so that we can assess whether the *differences* in unit values also vary systematically for firms that report relocating their core activity to a foreign region. The firm-product fixed effects remove any firm-specific differences in costs, markups or quality.

Table 7 presents the results from estimating equation (5) via OLS. The coefficient on

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

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

Table 7: Unit value differences for domestically-produced varieties of the same product

Dependent variable - the log unit value of a CN8 product

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

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

domestically-produced varieties is large, positive, and statistically significant. Column 1 suggests that, on average, domestic varieties' unit values are 60 log points higher than their imported counterparts within the same firm and year. This large difference supports the premise that firms offshore lower quality versions of the goods they produce domestically.

A possible concern with the estimate in Column 1 is that the domestic and import unit values come from different data sources, with the latter potentially excluding any markups the offshoring firm may add between the port and sale to a customer in the domestic market.[28] Since there is no clear reason to suspect systematic variation in markups across data sources for firms that report relocating their core activity, we examine the extent to which this differential in domestic versus foreign unit values is larger for those firms. Consistent with the premise that firms relocate their main activity to access cheaper production costs, the interaction between the offshoring dummy from the survey and the domestic unit value shows that the price gap is 27 log points higher for firms that report

[28]The domestic unit value represents a factory-gate price and might also exclude markups.

relocating their core activity abroad (Column 2).

The final column includes country or region-specific indicators for the imported varieties for the top three offshore regions. Prices of imports from China are 42 log points lower than than those for imports from all other locations, and NMS imports are 20 log points lower. In contrast, import unit values from the 14 EU countries are 12 log points higher. These patterns suggest quality differentiation within a detailed product category that differs systematically across countries (e.g., as in Schott, 2004, 2008), with firms offshoring production of especially low-quality versions to China and NMS countries.

5.2 Evolution of domestic unit values after importing

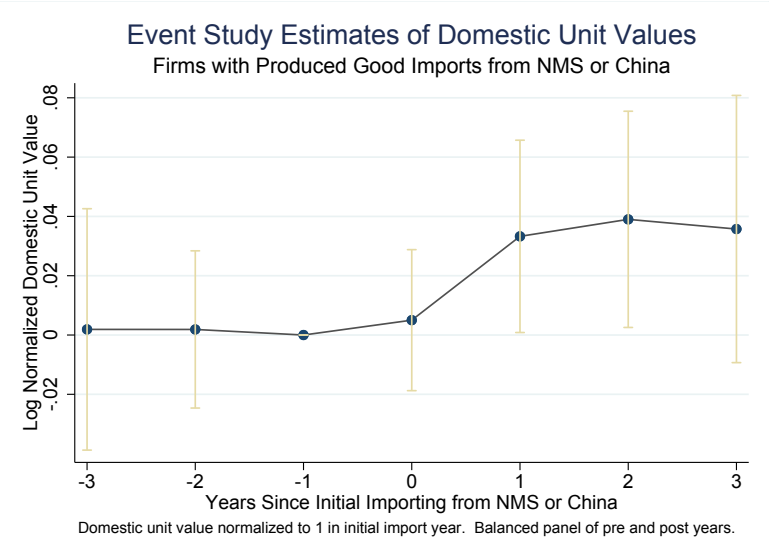
If offshoring involves relocating production of low-quality versions of particular products abroad, we would also expect to see the domestic unit value of those goods rise after firms begin to import them. To assess the extent to which offshoring firms' domestic quality changes in conjunction with its offshoring decision, we estimate how firms' domestic unit values evolve in an event study setting. We focus on firms that produce the same detailed product for at least 7 consecutive years, that also import the product during the period, and for which we observe at least three years of pre-importing and three years of post initial-importing domestic production. To address differences in units across unit values, we normalize unit values to one within each firm-product in the firm's initial import year, and estimate

$$log(UV_{fpt}) = \alpha_t + \sum_k \beta_k \Delta Imp_{fp,t+k} + \varepsilon_{fpt}, \tag{6}$$

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 cluster the standard errors by CN8 product category. Figure 9 presents the event study coefficients, and shows a clear increase in domestic unit values after firms begin offshoring the good. This increase may reflect offshoring firms abandoning domestic production of lower quality versions (e.g., as proposed in Schott, 2008), or quality upgrading of their domestically-produced versions as they reallocate domestic resources towards innovation.

The richness of these data provides novel evidence on the relationship between offshoring and importing. While it has become common to equate a firm's decision to relocate production to a foreign country with a decision to import intermediates, we show that offshorers tend to import the same goods that they produce domestically. Perhaps most surprisingly, firms' imports of goods that they produce are not associated with lower domestic production. The unit values of domestically-produced goods are systematically higher and rise after offshoring, however, suggesting a role for quality differentiation within the same detailed product category. Offshoring firms' behavior is consistent with them leveraging

Figure 9: Imports from offshoring region over total imports



their capabilities in certain products by producing different quality versions across multiple locations.

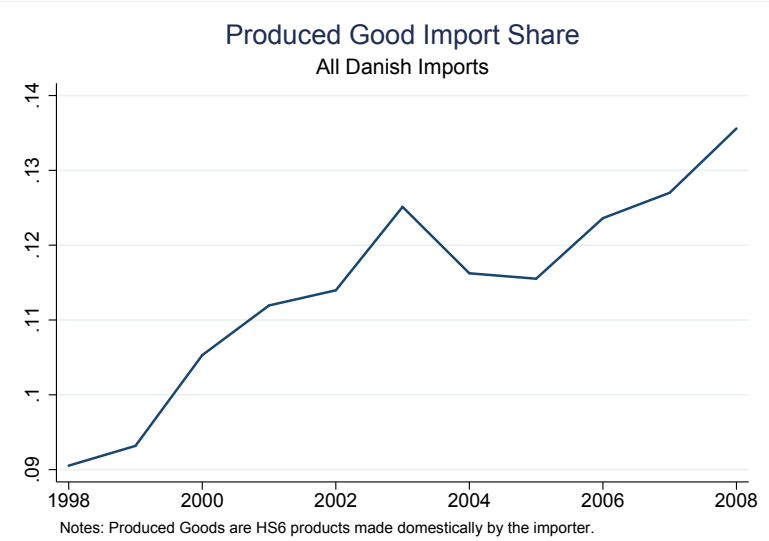
6 The aggregate importance of produced-good imports

Having established that offshoring firms reorganize their domestic employment by shifting towards technology-related occupations and charging higher prices for their domestically-produced goods, we now show how these firm-level decisions affect aggregate trade measures. Figure 10 shows that products that had been, or continue to be, produced by firms in Denmark constitute a rapidly rising segment of Danish imports, rising from just over 9 percent in 1998 to over 13.5 percent in 2008.[29]

Given the growing importance of produced-good imports in the aggregate, we decompose standard industry-level measures of import competition into flows of produced-good versus non-produced good imports. We analyze how these measures differ, and document which types of imports drive the well-established relationships between aggregate import competition and employment. Distinguishing between these two types of flows yields new insights into the mechanisms behind existing results on how and why imports affect domestic activities.

[29]In online Appendix Section B.1 we show that continuing or new products constitute the vast majority of produced-good imports.

Figure 10: Aggregate share of produced-good imports



Notes: Figure presents the share of produced-good imports over total imports. Produced-good imports are imports of HS6 products that the importing firm produces in Denmark in 1997 and/or 1998, and/or in the import year.

6.1 Comparing measures of industry import penetration

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

$$\Delta ImpPen_{iT}^{R} = \Delta \frac{Imports_{iT}^{R}}{Imports_i + DomProd_i}, \tag{7}$$

where R denotes region (China or NMS), i denotes a HS4 industry, and T denotes the good-importer type. Product type T can be all imports, non-produced good imports, or produced-good imports. For simplicity, produced-good imports are imports of HS6 products that the importer also produces domestically in *that* year, while non-produced good imports are all other products. Since our aim in this section is to provide new insights into prior work that has focused on Chinese import competition, we consider ten year changes in these import penetration measures from 1998 to 2008.[30]

Changes in the standard measure of import penetration, based on all imports, are positively correlated with changes in both of the components for China and the NMS. For

[30]This time frame captures China's WTO accession and the main surge in China's imports to developed countries. Measures of import penetration often subtract exports from the denominator to capture total domestic absorption. 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).

China, the change in the standard measure of import penetration has a correlation coefficient of 1.00 for changes in non-produced good import penetration, but only 0.24 for produced-goods. For NMS, the standard measure has a correlation coefficient of 0.89 for non-produced good imports and 0.62 for produced-good imports. In contrast the correlation between changes in the two components are substantially lower. For China (NMS) the correlation of changes in non-produced good and produced-good import penetration is 0.15 (0.19). Standard measures of import penetration capture both types of imports, but each type captures a different aspect of import activity.

It is also interesting to note that changes in the standard measure of Chinese and NMS import penetration are negatively correlated, with a coefficient of -0.23. In contrast, changes in produced-good import penetration from China and NMS are positively correlated, with a coefficient of 0.11. Produced-good imports also grow relatively more for products that are initially more tech-worker intensive and that have more dispersion in their unit values. These patterns, presented in online Appendix Section B.2, are consistent with produced-good imports capturing the formation of international teams in which offshoring firms leverage Danish tech workers' capabilities across multiple low-wage production locations to expand their product lines along a quality dimension.

6.2 Industry import penetration and employment

In this section, we revisit studies on the impact of industry-level import competition on employment. An important contribution of this paper is to show that produced-good imports capture firms' offshoring decisions, and that the effects of offshoring may differ from other imports. We therefore examine the relationship between imports and employment using changes in import penetration of produced versus non-produced goods separately. Specifically, we estimate

$$\Delta log(employment_i) = \alpha + \beta_{MNPG}\Delta ImpPen^R_{iNMP} + \beta_{MPG}\Delta ImpPen^R_{iPG} + \varepsilon_i, \quad (8)$$

where $\Delta log(employment_i)$ is the change in log employment 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 and employment to the HS4 level for 369 industries with positive production in Denmark.

Table 8 presents the results from estimating equation (8) via OLS. Columns 1 and 3 present results for changes in a standard measure of import penetration for China and NMS respectively. While import penetration from China is associated a decrease in employment,

the estimate for NMS is statistically insignificant. Columns 2 and 4 decompose the standard measure into imports of produced and non-produced goods. For both China and NMS, increases in non-produced good imports are associated with a large, and statistically significant decline in manufacturing employment. In contrast, changes in produced-good imports have a positive (though insignificant for China) relationship with industry employment.

Table 8: OLS estimates of industry import penetration and employment

	Chinese Imports		NMS Imports	
	(1)	(2)	(3)	(4)
$\Delta ImpPen_i^R$	-3.145***		-1.669	
	(0.796)		(1.295)	
$\Delta ImpPen_{iNPG}^R$		-3.547***		-4.240***
		(0.817)		(1.636)
$\Delta ImpPen_{iPG}^R$		13.824		4.605*
		(8.387)		(2.786)
Constant	0.152**	0.173***	0.240***	0.234***
	(0.059)	(0.06)	(0.056)	(0.056)
Observations	369	369	369	369
R-Squared	0.041	0.052	0.005	0.022

Notes: Regression is a long difference from 1998 to 2008. Dependent variable is the log difference in industry employment. NPG is imports of goods not produced domestically by importer. PG is imports of HS6 goods produced domestically by the importer in that year. * p<0.10, ** p<0.05, *** p<0.01.

The results in Table 8 show that the well-established negative relationship between increased import competition and employment changes is driven by non-produced good imports, supporting the premise that increased import competition in output markets is a negative demand shock for firms. In contrast, increased industry offshoring of the products made by a firm is not associated with decreasing employment at competing firms. A simple comparison of columns (1) and (3) might have suggested that Chinese imports are inherently different from NMS imports, and that the latter do not entail the same negative employment consequences. A comparison of columns (2) and (4), however, shows similar relationships of non-produced good import penetration with employment.

It may seem surprising that increases in produced-good import penetration in a firm's products do not affect its employment. A reasonable prior is that increased imports of any type of good – produced or non-produced – both represent competition and would therefore have the same negative employment effects on competing domestic firms. In Section 5, we

show that firms that import products they also produce domestically source lower unit value versions from the offshore location. To the extent that offshoring firms import lower price and quality products, those produced-good import flows are less likely to compete with other domestic firms' production. This type of quality differentiation across locations is consistent with the evidence in Section 5 and rationalizes the relationships between the distinct measures of import penetration and employment presented in Table 8. It also highlights the fact that, from the perspective of the firm, not all imports are created equal.

7 Conclusion

This paper exploits new information on Danish firms' offshoring activities to construct a rich dataset on firms' global production choices. We use these data to analyze how firms' decisions to relocate their primary activities to low-wage countries affect not only their aggregate employment and output, but also their employment across activities. We find that over time, offshoring firms change their employment composition significantly so that they ultimately employ a much higher share of technology and research-related workers.

We show that after firms relocate their main activity to a low-wage region, they increase their imports from that region, but that these new imports are primarily in products produced domestically by the firm, rather than in intermediate inputs. This finding underpins our creation of a new measure of firm offshoring by destination based on the change in the share of produced-good imports by the firm. While offshorers increase imports of the same domestically-produced goods, we find that they continue – rather than abandon – domestic production of those goods. However, the imported varieties have lower prices than their domestic counterparts and prices of the domestic varieties increase after offshoring begins. These findings suggest that offshorers have product-specific capabilities and exploit low-wage destinations to pursue a quality differentiation strategy.

The rise of new low-wage production opportunities in developing countries allows offshoring firms to reorganize their domestic activities by increasing the number and share of domestic tech workers at the firm. Although offshorers decrease their total employment by shedding production workers, they do not "hollow out" the firm and transform into pure intermediaries of imported products. In addition to maintaining their output and raising the quality of domestically product varieties, they shift their workforce towards innovation-related occupations.

The results in this paper point to important long-term implications of offshoring. We show that firms that relocate their main activities to a foreign low-wage country maintain their domestic production by shifting to higher price varieties and are more likely to shift their domestic workers into innovative activities. Since innovation is a major determinant of

future performance, this shift has important potential implications for the long-term effects of offshoring on productivity and growth.

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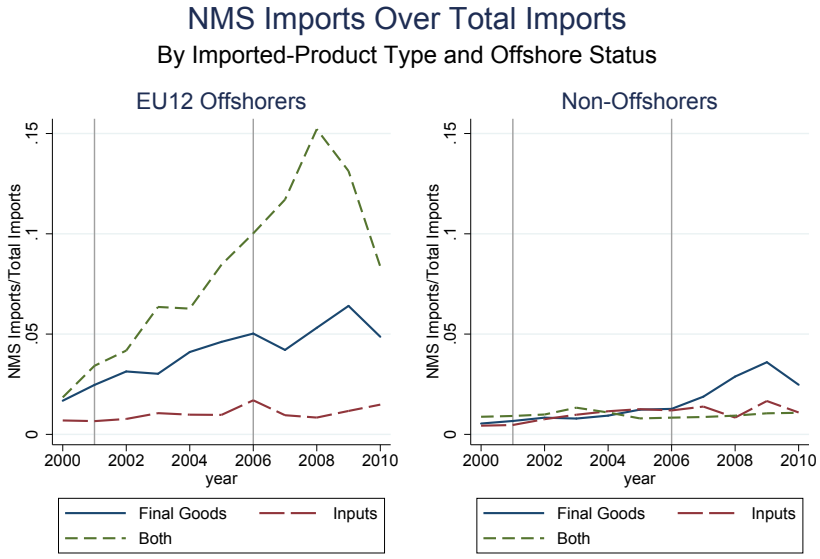
Appendices

A Imports of produced goods versus intermediates

In this section, we use the input purchase data, which are generally available at the HS4 industry level, along with the Prodcom data at the HS4 industry level to assess the extent to which firms that report offshoring in the survey import inputs versus domestically produced goods. To do so, we exploit the input use survey to classify firm imports into three categories: (1) produced-good imports of HS4 industries that the importer produces in Denmark but does not purchase as inputs ("Produced Good"); (2) imports of HS4 industries that the firm purchases as inputs but does not produce in Denmark ("Inputs"); and (3) imports of HS4 industries that the firm *both* produces in Denmark and purchases as inputs ("Both"). Figure A.1 shows that firms that offshore to the NMS increase their share of produced-good imports, as well as their share of imports of industries that they both produce and purchase as inputs ("Both"). In contrast, their share of imported inputs of HS4 industries that they do not produce domestically is low and fairly stable.

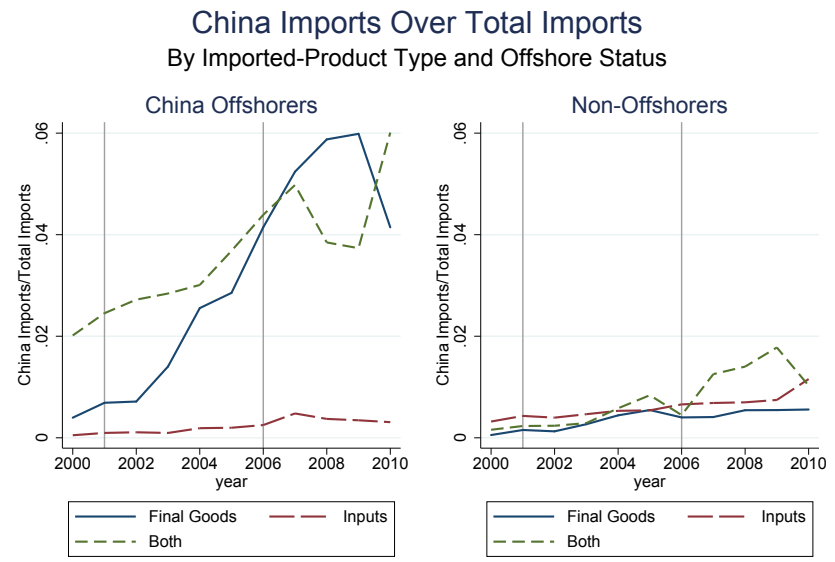
Figure A1: NMS imports of inputs and produced goods



Notes: Figure plots the share of imports from NMS of HS4 industries that are "Produced goods", "Purchased inputs", or HS4 industries classified as "Both" produced goods and purchased inputs over total imports of the firm.

Given the lack of detail for firms' input purchases, we cannot rule out the possibility that they are importing both inputs and produced goods. However, it is also possible that HS6 product-level detail on inputs would lead to much smaller shares of imported

Figure A2: Chinese imports of inputs and produced goods



Notes: Figure plots the share of imports from NMS of HS4 industries that are "Produced goods", "Purchased inputs", or HS4 industries classified as "Both" produced goods and purchased inputs over total imports of the firm.

inputs (whereas the main text shows that firms import the same detailed HS6 products they produce). Table A.1 provides an example of why this might the case. Each of the HS4 industry codes 8414 and 8415 contains an HS6 product code that corresponds to "Parts".

The low share and small changes for imported inputs suggests that the relocation of a firm's core activity to a foreign region is more related to imports of produced goods rather than inputs from that region. Figure A.2 presents similar patterns for firms that offshore to China, though we are better able to distinguish inputs from produced-goods. For firms that relocate their core activity to China, shares of produced-good imports grow significantly more.

Table A1: 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 Produced-good import shares

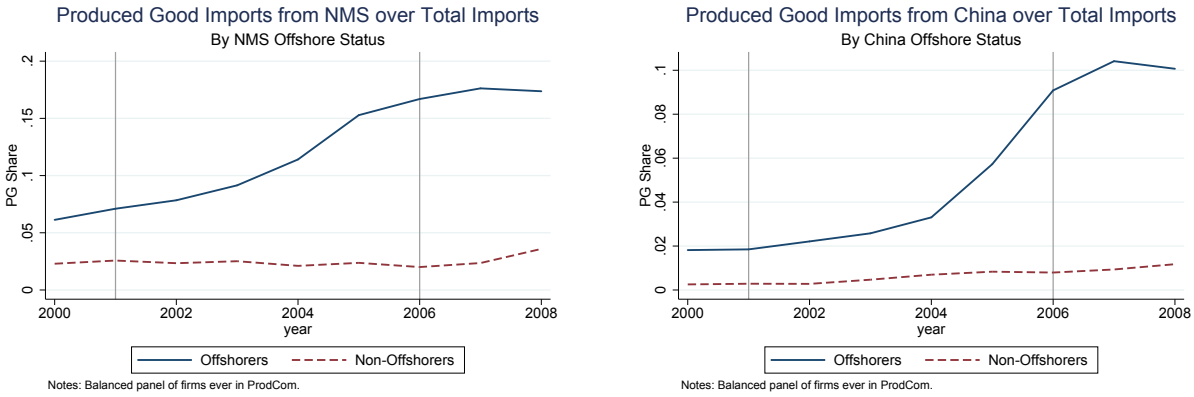
In this section we present figures of the weighted average of produced-good imports from a low-wage region over total imports by firm offshore status from the survey. Figure B.1 shows that the share of produced-good imports from NMS grows dramatically for firms that offshore to NMS (left panel), while the share of produced-good imports from China grows dramatically for firms that offshore to China (right panel).

Here we also present the results from estimating

$$Pr(\Delta Off_f^{China} = 1) = \alpha + \beta_{PG}\Delta\frac{PG\ Imports_f^{China}}{Imports_f} + \beta_s log(sales_f^{2001}) + Ind_f, \qquad (9)$$

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 B.2a 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 B.2b 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 B1: Produced-good imports from region over total imports

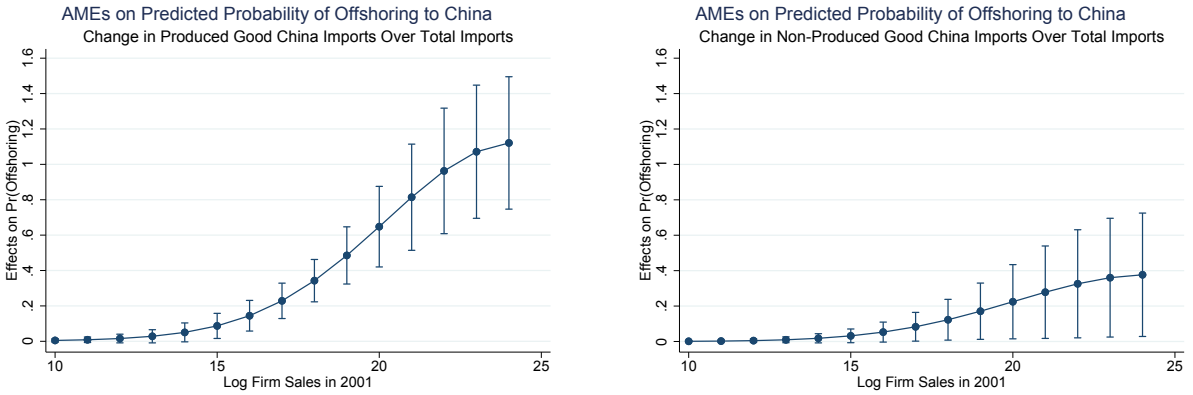


(a) NMS Offshorers

(b) China Offshorers

Notes: Sample is a balanced panel of firms in the offshoring survey that exist from 2000 to 2008 and that report production in ProdCom in at least one year over this period.

Figure B2: 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.

C Offshoring to China and firm outcomes

In this section we show that the relationship between offshoring and firm outcomes documented in the text using firms' produced-good imports from NMS are similar for offshoring to China. Table C.1 presents the results from estimating equation (2) via OLS. Offshoring to China is correlated with a decrease in firm employment, an increase in tech and support worker shares, and an increase the level of tech workers.

We present only the OLS results here because changes in Chinese market share in the ROW (the instrument we use for the NMS IV estimates) does not have a reasonable first-stage over this period. Although we can generate a first-stage for China using ten year changes from 1998 to 2008, for China the instrument is more correlated with non-produced good imports rather than produced-good imports.

Table C1: OLS estimates of offshoring to China

	log Emp	log Production	Share of Workers in Tech	Share of Workers in Support	Share of Workers in Production
$\Delta PG\ ImpSh_f^{China}$	-0.228**	-0.222	0.037***	0.038***	-0.121***
	(0.110)	(0.138)	(0.012)	(0.015)	(0.024)
R2	0.04	0.07	0.03	0.04	0.05
Observations	5,160	5,160	5,160	5,160	5,160

	Growth Rate of Workers in Tech	Growth Rate of Workers in Support	Growth Rate of Workers in Production	Δ Share Tech Switchers
$\Delta PG\ ImpSh_f^{China}$	0.306**	-0.059	-0.269***	0.004
	(0.149)	(0.117)	(0.101)	(0.005)
R2	0.02	0.04	0.06	0.05
Observations	5,160	5,160	5,160	5,160

Notes: Two stacked five year differences for 1998 - 2008. Growth rate is $\frac{(Occup_{f,t+5}-Occup_{f,t})}{0.5(Occup_{f,t+5}+Occup_{f,t})}$. Regressions weighted by initial employment and include industry (NACE2) and year fixed effects. Share Tech Switchers is share of tech workers that change occupation w/in firm. * p<0.10, ** p<0.05, *** p<0.01.

D Industry measures of produced-good imports

D.1 Correlation coefficients across industry measures

In this subsection we present correlation coefficients across various industry measures of changes in import penetration, as defined in equation (7).

D.2 IV estimates of aggregate Chinese import penetration and employment

In this subsection, we instrument for industry-level measures of Chinese import penetration using China's market gains in the rest of the world. Table D.2 presents the results from estimating equation (8) via 2SLS. In Column (2) we instrument for non-produced good import penetration while controlling for produced-good import penetration. In Column (3)

Table D1: Correlation coefficients between changes in import penetration measures

	Chinese Imports			NMS Imports	
	All	PG	NPG	All	PG
Chinese PG	0.24				
	0.00				
Chinese NPG	1.00	0.15			
	0.00	0.00			
NMS All	-0.23	0.02	-0.24		
	0.00	0.77	0.00		
NMS PG	-0.31	0.11	-0.32	0.62	
	0.00	0.03	0.00	0.00	
NMS NPG	-0.11	-0.05	-0.11	0.89	0.19
	0.03	0.37	0.04	0.00	0.00

Notes: Table reports pairwise correlation coefficients across 369 HS4 industry measures of changes in import penetration from 1998 to 2008. All includes all imports in the numerator. PG includes imports of HS6 products that the importer also produces domestically in the import year. NPG is all imports of HS6 products that the importer does not produce in the import year.

we instrument for produced-good import penetration while controlling for non-produced good import penetration.

Across all specifications, non-produced good import penetration has a negative and significant relationship with employment. The instrument has a first-stage F-statistic of 132 for non-produced good imports, but is quite weak at only 4.91 for produced-good imports. It is thus not a valid instrument for produced-good imports from China so the negative and very imprecisely estimated coefficient in Column (3) is uninformative. The fact that the estimated coefficient on non-produced good imports is always negative and significant, and that the produced-good import coefficient is positive and significant even when instrumenting for non-produced goods provides reassuring evidence that the results documented in Section 6.2 are not biased by endogeneity concerns.

Table D2: IV estimates of industry Chinese import penetration and employment

	All	NPG	PG
	(1)	(2)	(3)
$\Delta ImpPen_f^R$	-3.950***		
	(1.488)		
$\Delta ImpPen_{fNPG}^R$		-4.577***	-2.749*
		(1.584)	(1.404)
$\Delta ImpPen_{fPG}^R$		15.407*	-41.00
		(8.628)	(76.736)
Constant	0.125*	0.144**	0.09
	(0.073)	(0.071)	(0.132)
Observations	369	369	369
First-stage F-Statistic	146.359	131.768	4.908

Notes: Regression is a long difference from 1998 to 2008. Dependent variable is the log difference in industry employment. NPG is imports of goods not produced domestically by importer. PG is imports of HS6 goods produced domestically by the importer in that year. Column (1) uses Chinese market share gains in the ROW to instrument for Chinese import penetration in Denmark in all goods. Columns (2) and (3) instrument for NPG and PG import penetration, respectively. * p<0.10, ** p<0.05, *** p<0.01.

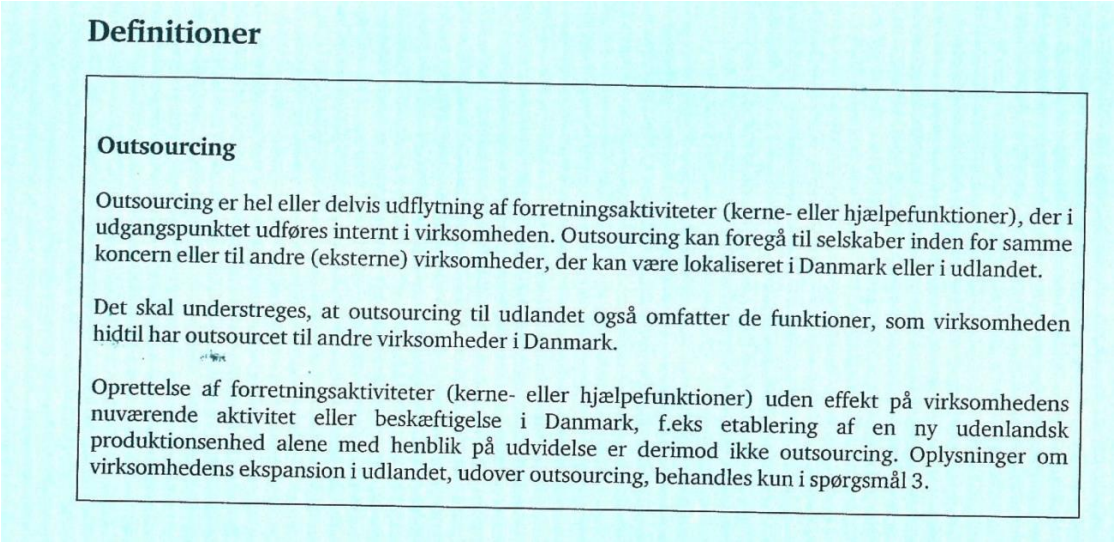
For Online Publication Only: Online Data Appendix for Heterogeneous Globalization: Offshoring and Reorganization, *by:* Bernard, Fort, Smeets, and Warzynski

This online Appendix for Bernard, Fort, Smeets, and Warzynski (2020) provides additional details on the data construction and the empirical patterns documented in the paper.

A Original survey

A.1 Offshoring survey question

Figure A1: 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.

Figure A.1 presents the original survey question in Danish. The work "udflytning" translates to "move out".

A.2 Offshoring data details

Table A.1 presents the number of firms that relocate non-primary activities to other countries, broken out by whether they relocate their core activity or not. The 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 A1: Offshoring of other activities, by core activity status

Primary 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: 380 firms (9.1%) offshore their core activity.

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

Table A2: 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	0.091

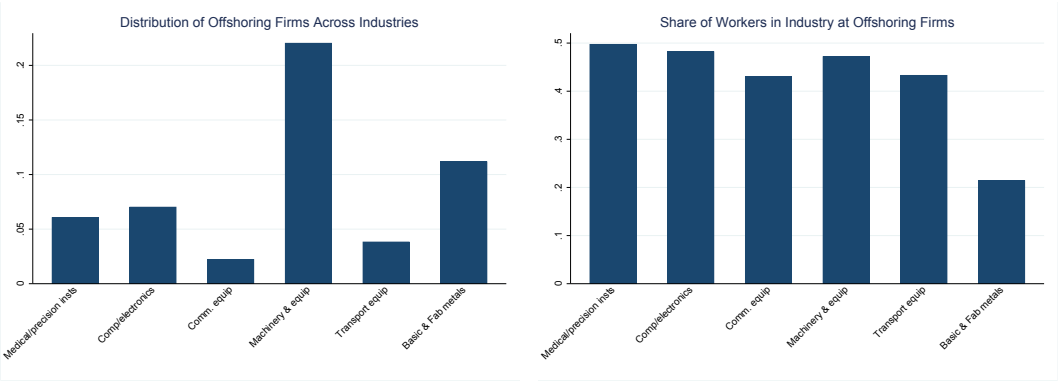
Notes: Table presents the foreign locations to which firms relocated their core activity between 2001 to 2006. Firms may relocate their core activity to more than one foreign locations, as shown in table A.3.

Table A3: Number of locations to which firms offshore core activity

	Total Firm	
No. of regions	Count	Percent
1	229	60.26
2	97	25.53
3	36	9.47
4+	18	4.74

Notes: Table presents the number of foreign locations to which firms relocated their core activity between 2001 to 2006.

Figure A2: Industry shares of offshoring firms and workers



(a) Offshoring Firms Across Sectors (b) Worker Shares Within Sectors

Notes: The left panel shows how offshoring firm are distributed across sectors. More than half of all offshoring firms are in the Machinery sector. The right panel plots 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 sectors are presented to minimize disclosure concerns.

A.3 Industry distribution of offshoring firms and workers

Here we present details on how offshoring firms are distributed across industries within the machinery manufacturing sector, and on worker shares at offshoring firms within industries in this sector.

A.4 Worker shares

Here we present the employment-weighted level shares of workers by broad occupation type at offshoring versus non-offshoring firms. This is the counterpart to Table 1.

Table A4: Weighted average of employment shares by firm offshore status

Worker occupation shares by offshore status

Panel A: Offshoring firms	1998	2001	2006	2008
Managers	0.04	0.04	0.04	0.05
Production workers	0.54	0.54	0.44	0.39
Other blue collar	0.07	0.07	0.05	0.05
Tech workers	0.15	0.16	0.20	0.23
Support workers	0.14	0.13	0.16	0.18
Sales workers	0.05	0.05	0.07	0.08
NEC	0.02	0.01	0.02	0.02
Panel B: Non-offshoring firms				
Managers	0.04	0.04	0.04	0.04
Production workers	0.30	0.31	0.26	0.24
Other blue collar	0.09	0.09	0.10	0.09
Tech workers	0.12	0.12	0.13	0.14
Support workers	0.29	0.28	0.26	0.26
Sales workers	0.12	0.13	0.16	0.19
NEC	0.04	0.03	0.04	0.04

Notes: Weighted average shares are relative to a firm's industry average.

A.5 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.[31] 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`.

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

A.6 Summary statistics for regression variables

Table A5: Summary statistics for regression variables, Table 4

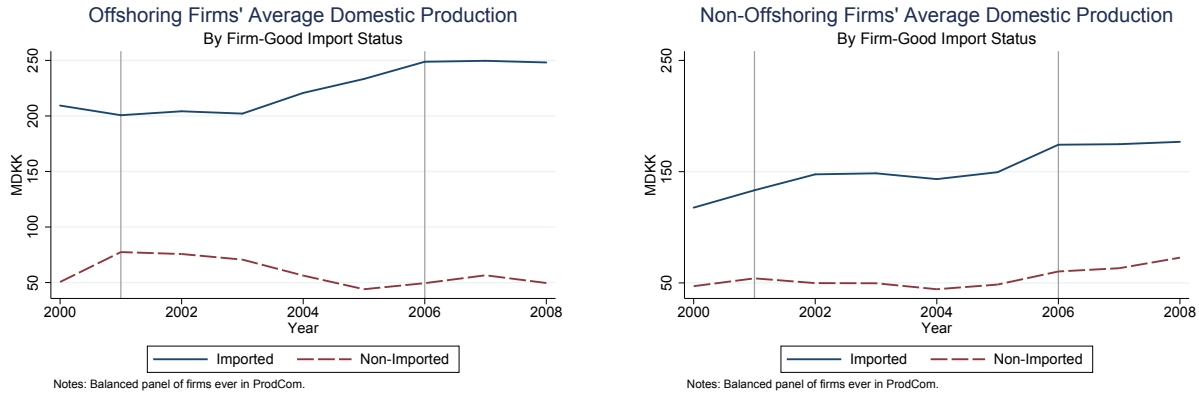
	$\Delta \frac{PG\ Imports_{ft}^{NMS}}{Imports_{ft}}$	$Shock_f^{NMS}$	Change in firm log emp	log prod	share tech	share support	share prod
Mean	0.0067	0.011	-0.058	0.18	0.0068	0.0048	-0.033
Std. Dev	0.12	0.025	0.48	0.68	0.065	0.091	0.13

Table A6: Summary statistics for regression variables, , Table 5

	DHS tech	DHS support	DHS prod	Δ Switchers
Mean	0.025	-0.048	-0.11	0.00042
Std. Dev	0.92	0.75	0.52	0.029

A.7 Domestic production by good type

Figure A3: Domestic production by offshore status and good type



(a) Offshorers (b) Non-Offshorers

Notes: Figures present the weighted average of firms' domestic production split out based on whether the firm imports the same HS6 product (solid line) or does not import the same HS6 product (dashed line). Sample is a balanced panel of firms in the offshoring survey that exist from 1998 to 2008 and that report production in Prod Com in at least year over this period.

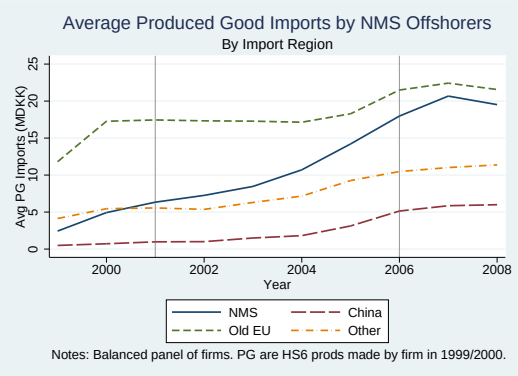
A.8 Imports of produced goods by region

Figure 7 shows that offshoring firms grow their produced-good imports relatively more than non-offshorers between 2001 to 2006. One notable feature in Figure 7 is that offshorers have

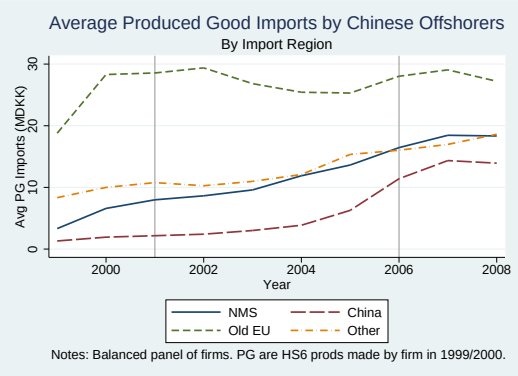
an initially higher value of produced-good imports. In this Appendix section, we show that this is because firms that offshore to NMS and China tend to have higher initial shares of produced-good imports from the other 14 original EU countries.

We decompose firm imports by region of the imports, for firms that offshore to NMS and China. The top, left panel of Figure A.4 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 produced-good imports from the old EU countries. The top right panel of Figure A.4 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 between 2001 to 2006.

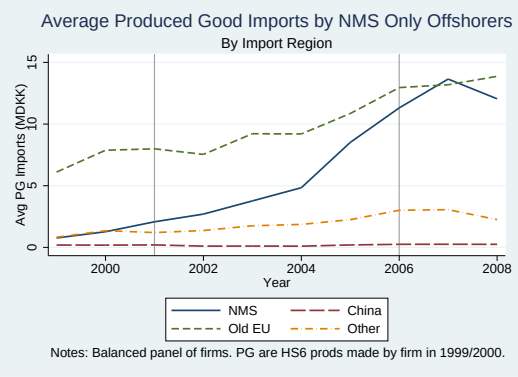
Figure A4: Average produced good imports by region and offshore status



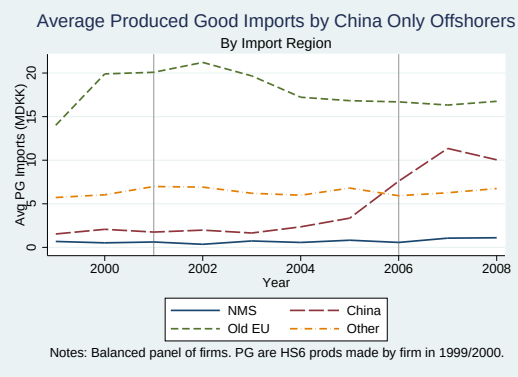
(a) NMS Offshorers



(b) China Offshorers



(c) NMS Only offshorers



(d) China Only Offshorers

Notes: Figure presents weighted average of firms' produced-good imports by region, for firms that offshore to NMS and/or China. Sample is a balanced panel of firms in the offshoring survey that exist from 1998 to 2008.

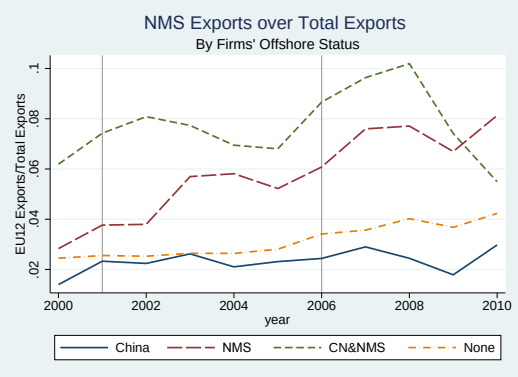
To understand how firms' offshoring decisions may be interrelated across space, the bottom panel of Figure A.4 presents similar figures for firms that offshore to NMS but not China and for firms that offshore to China, but not the NMS countries. Here, the patterns are more stark. While both sets of firms 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 see considerable 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.

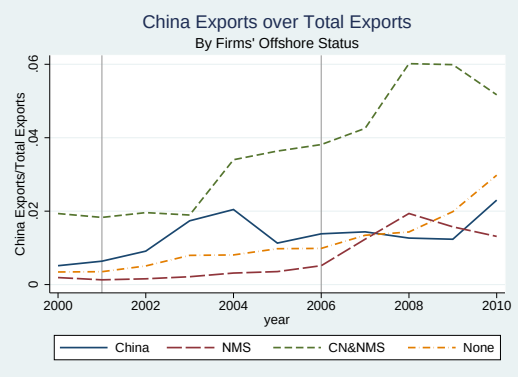
A.9 Offshoring and exporting

Here we show that offshoring firms shift their exports somewhat towards offshore regions, but that these changes and levels are considerably smaller than the comparable changes observed for firm imports. Offshoring thus seems to entail imports from the offshore location back to Denmark, without considerable exporting of inputs from Denmark to the offshore location. Figure A.5 depicts these patterns.

Figure A5: Exports to offshoring region over total exports



(a) NMS



(b) China

B Aggregate produced good import penetration measures

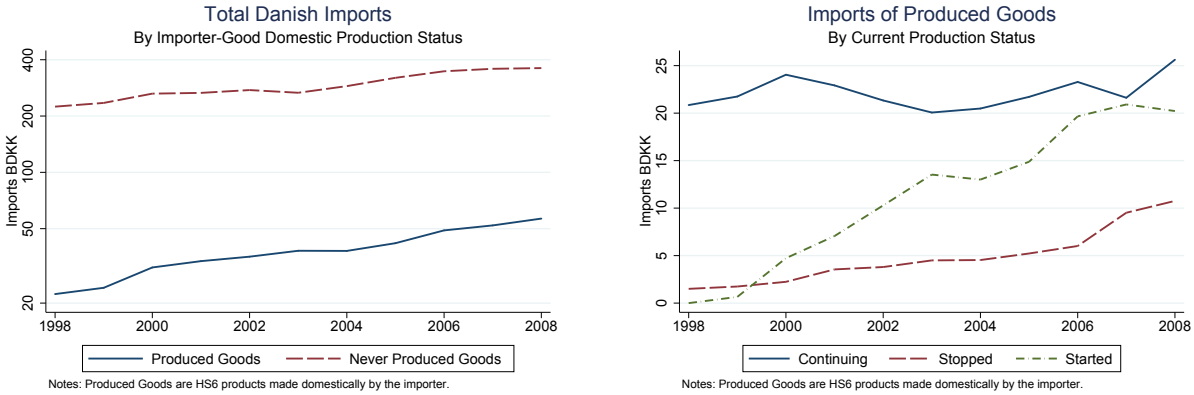
B.1 Produced-good imports by type

Figure 10 shows that produced-good imports grow from about nine percent of total Danish imports in 1998 to almost 14 percent in 2008. In that figure, we define produced-good imports as imports of HS6 products that the importer produced either in the first two years of the sample, and/or in the year of import. The left panel in Figure B.1 plots the level growth of produced and non-produced good imports in Denmark from 1998 to 2008.

In the right panel of Figure B.1, we decompose those produced-good imports based on their current year production status. The figure shows that the majority of the value of produced-good imports is of HS6 products that firms produce initially and continue to produce throughout the period, though the value of these imports is fairly constant over time. The majority of the growth in produced-good imports over the period, by contrast, is driven by imports of newly produced goods. While a common misconception of offshoring is that firms replace domestic production with imports, Figure B.1 shows that these produced-good imports constitute the smallest share of total produced-good imports over this period.

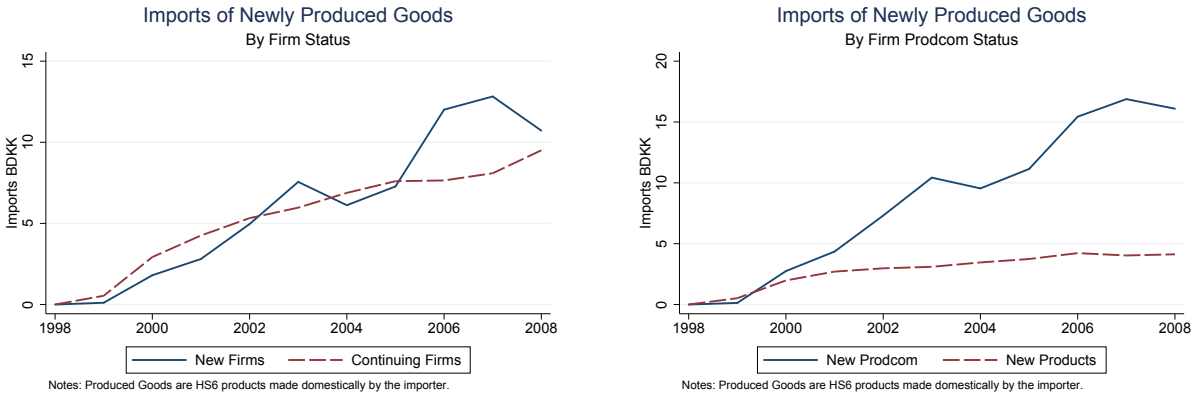
The aggregate patterns depicted in Figure B.1 corroborate the firm-level evidence in Section 4 that offshoring firms do not disproportionately reduce domestic production. They also show that produced-good imports grow as offshoring firms begin domestic production of new HS6 products. In Figure B.2, we show that these imports of newly-produced goods are predominantly driven by firms that enter ProdCom, either because they begin to produce for the first time or grow their employees to over 10. Produced-good imports are thus a considerable and growing share of total Danish imports. Consistent with the micro-level evidence presented in Section 4, they are largest for products that the firm continues or starts to produce domestically, rather than for products that the firm offshores and ceases to produce domestically.

Figure B1: Danish Imports by Good Type



Notes: Left panel presents total Danish imports by imported product type. Produced-good imports are imports of HS6 products that the importing firm produces in Denmark in 1997 and/or in 1998 and/or in the import year. The right panel decomposes produced-good imports into imports of products that the firm: (1) produced in 1997 and/or 1998 and is "Continuing" to produce in that year; (2) produced in 1997 and/or 1998 but has "Stopped producing" in that year; or (3) did not produce in 1997 or 1998 but "Started" to produce subsequently.

Figure B2: Imports of Newly Produced Goods



Notes: Figure presents total imports of HS6 products that the firm did not produce in 1997 or 1998 but "Started" to produce it subsequently. The left panel breaks apart the imports of these newly produced goods into imports by "New Firms" that are born after 1998 versus "Continuing Firms" that existed prior to 1999. The right panel breaks apart the imports of these newly produced goods into: (1) imports by "New ProdCom" that are firms that begin to report positive production in ProdCom after 1998; versus (2) "New Products" that are imports by firms in ProdCom prior to 1999 that report production of new HS6 products after 1998.

B.2 Basic characteristics of produced good imports

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

$$\Delta ImpPen_{pT}^{R} = \Delta \frac{Imports_{pT}^{R}}{Imports_{p} + DomProd_{p}}, \tag{10}$$

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 imports are imports of HS6 products that the importer also produces domestically in that year, while non-produced good imports are all other products. 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.[32]

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 B.2. Standard import penetration measures therefore capture both types of import flows, even though produced and non-produced good flows are uncorrelated.

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

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 B.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 tech worker intensity and price dispersion. We measure the importance of technology workers in the production of a particular product as the share of tech 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 B.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 tech 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 tech 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 tech 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 tech workers are relatively more important.

Table B1: 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 (10). All, NPG, and PG correspond to the numerator with all imports, non-produced good imports, and produced good imports in the numerator, respectively.

Table B2: 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 B3: 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 tech workers used to produce a product. Price dispersion is the 90-10 ratio of the product's domestic unit values.

C Danish Production data does not include repackaging

A potential concern with measuring produced-good imports is that firms may import a product, repackage it in Denmark, and then report that same product as domestic production. Figure C.1 presents the documentation from the Denmark's survey on production.

We use the measure of "Own goods" for domestic production, which is available at the HS6 product level. Products that are simply repackaged in Denmark are not included in this measure, and instead are classified as "Commercial (resale) turnover." While we do find that resales also grow disproportionately for offshoring firms, these sales are not available at the HS6 product level, and we exclude them from our measure of production.

Figure C1: 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.

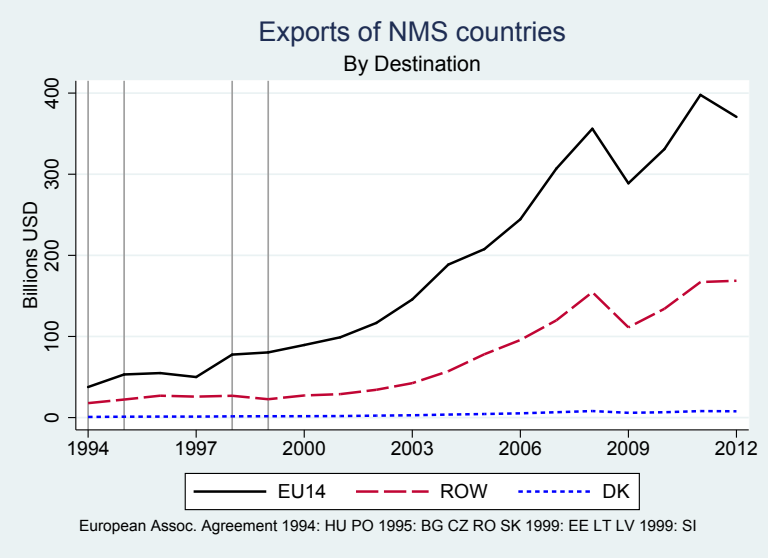
Sales: Sales are in current prices, excluding VAT. All sales are included, domestic and export markets.

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

C.1 Aggregate NMS exports

Here we present exports by NMS countries over time and by region. Figure C.2 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 C2: Aggregate exports by NMS countries



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