

Heterogeneous Globalization: Offshoring and Reorganization*

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Abstract

This paper exploits a direct measure of offshoring to study how the movement of production abroad affects the composition of firms' domestic employment and production, as well as their innovative activities. After offshoring begins, firms increase their imports of domestically produced goods, and retain – rather than abandon – domestic production of those goods. We define a new measure of offshoring based on this relationship that enables us both to distinguish it from import competition and to identify new production cost saving opportunities in foreign countries. In response to such new offshoring opportunities, firms reallocate labor from production work to technology and innovation-related occupations. This reallocation of workers is accompanied by increases in offshoring firms' product development and R&D spending. The results suggest a link between offshoring and domestic innovation.

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1 Introduction

A growing number of studies conclude that low-wage imports, and Chinese imports in particular, are reducing manufacturing employment in advanced economies.¹ A potential puzzle for these papers, however, is that even as manufacturing employment has declined, real value added has continued to rise at about the same rate as GDP. Moreover, this output growth has occurred in some of the same sectors in which import penetration has been rising.

One potential explanation for the role of trade in the divergence between manufacturing employment and output is that imports reflect not only the import competition channel emphasized in existing work, but also production fragmentation decisions made by firms that continue their domestic operations. The growth in Chinese imports to the US was driven not only by imports of wholesale-retail firms, but also by US manufacturers' foreign sourcing decisions (Antràs et al., 2017). While the manufacturing employment loss in response to Chinese imports has received considerable attention, growing evidence suggests that these losses did not necessarily entail firm exit as manufacturers expanded their operations into other activities (Bernard et al., 2017; Fort et al., 2018).

This paper studies how the movement of production abroad affects the composition of firms' domestic employment and production, as well as their innovative activities. To do so, we exploit a clear measure of offshoring based on novel survey data in which Danish firms were asked whether they relocated their core activity to foreign regions between 2001 and 2006. This relocation could occur within or outside the boundary of the firm and only covers activities that were previously performed in Denmark. This is one of the first explicit measures of offshoring that captures the firm decision to move existing domestic activities to a foreign location.

The data show that nine percent of the surveyed Danish firms relocated their core ac-

¹Autor et al. (2013, 2014) and Pierce and Schott (2016) provide evidence for the US. Negative effects of Chinese imports are not limited to the US, see Mion and Zhu (2013) for Belgium, Ashournia et al. (2014) for Denmark, Malgouyres (2017) for France, Balsvik et al. (2015) for Norway, and Thewissen and van Vliet (2017) for the OECD.

tivity to a foreign region between 2001 and 2006. Among these offshorers, countries that joined the European Union in 2004 and 2007, collectively referred to as New Member States (NMS), were the most popular destinations.² 54 percent of Danish offshoring firms offshored to the NMS. One third of the offshoring firms relocated their core activity to China, making it the second most popular destination. We combine these data with information on firm employment, sales, production, input usage, R&D expenditure, imports, exports, and matched employer-employee records to create a rich new dataset for studying the ramifications of globalization.

We first analyze the relationship between offshoring and importing. Consistent with assumptions in prior work, firms that offshore to a particular region increase their imports from that region in both levels and shares. There are important differences, however, in the types of goods that offshorers import. Offshoring firms significantly increase their imports of detailed products (HS6) that they also produce domestically. This increase by offshorers is relative both to their own prior import behavior and to that of non-offshorers, who increase imports of non-produced goods instead. Furthermore, rather than hollowing out their domestic production, offshorers continue to produce the same goods that they import. In fact, we find that offshorers' domestic production of goods that are both produced and imported is more resilient than their production of goods that they do not import.

While it may seem surprising that firms both produce and import the same detailed products, we do find a clear distinction between imported and domestically-produced versions. In particular, prices, as proxied by unit values, are 50 to 60 percent higher for the domestically-produced version compared to the imported version for the same firm-year and detailed CN8 product. The price difference suggests that offshoring firms produce higher quality versions of their goods at home and offshore the production of lower quality versions to NMS countries and China. At the same time offshorers are changing the composition of their workforce by increasing their share of highly educated workers and technology-related

²The 12 NMS countries are Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, and Slovenia, and Slovakia.

workers; non-offshorers have no such composition changes. While imports of produced products are rising, offshorers are also disproportionately introducing more new products relative to non-offshorers.

This evidence is suggestive of an important role for offshoring in a firm's allocation of resources towards R&D and innovation, but there are other potential explanations for the relationship. One possibility is that increased competition may lead firms to increase innovation and to offshore. Bloom et al. (2015) find evidence that increased import competition from China led European firms to increase patenting and productivity, and existing theory shows how increased import competition can provide new incentives for firms to innovate (e.g., Impullitti and Licandro, 2017; Fieler and Harrison, 2018). Import competition may also lead firms to offshore (e.g., Rodriguez-Lopez, 2014). In line with this type of negative selection, we find that increased Chinese import competition in a firm's industry is associated not only with an increased likelihood of offshoring to China, but also with an increased probability of offshoring to the NMS.

An alternative channel through which offshoring may affect innovation is by the formation of international production teams. In Antràs et al. (2006), production requires solving problems. Workers of different ability sort into teams, choosing whether to be problem-solvers or production workers based on the relative returns to each activity, which in turn depend on their skill. Offshoring occurs when production teams can form across countries, with problem-solvers in one country combining with production workers in another. The theory predicts that new offshoring opportunities will lead to an increase in the number of problem-solvers in skill-intensive countries, with workers in those countries shifting from production to problem-solving activities as the relative return to the latter increases.

To tease apart these channels, we first propose a new offshoring measure: changes in a firm's share of imports of produced goods over total imports. This measure captures intensive and extensive margin offshoring decisions at a detailed product level. We then identify changes in firm-level offshoring due to factors external to both the firm and Denmark. In

particular, we exploit the fact that the 12 NMS countries underwent significant changes in their institutions when they joined the European Association Agreement (EAA) and the World Trade Organization (WTO).³ These changes led to increased economic growth and integration with the rest of the world, though their impact naturally varied across goods.

We measure variation in the NMS countries' comparative advantage growth across detailed product categories using changes in six-digit HS product export shares by the NMS countries to the rest of the world (ROW), excluding Denmark. Using changes in NMS export shares rather than changes in levels rules out growth that might be driven by aggregate demand or technology shocks that could increase trade in particular products across all countries. We construct a firm-specific measure of offshoring exposure by assigning the product-level shocks to firms based on the firm's pre-period production shares across products. The measure of potential offshoring opportunities is available for all manufacturing firms, regardless of their pre-period import status.

Our IV strategy identifies changes in firm-level offshoring to the NMS countries as a result of improved productivity in those countries in products relevant to the firm. The key identifying assumption is that the common within-product component of the relative increase in regional productivity is due to increases in NMS productivity. The exclusion restriction requires that the foreign region's increased productivity only affects a firm's innovative activities through its impact on the offshoring decision. This restriction would be violated if improvements in NMS comparative advantage also led to increased competition from NMS countries, and that increased competition directly affected firms' innovative activities (e.g., as in Bloom et al., 2015). Fortunately, we can control for this concern directly using a comparable measure of NMS import competition into Denmark in the firm's pre-period products. Our instrument thus captures the portion of NMS market share growth by product in the ROW that is orthogonal to NMS import competition in Denmark. All specifications are run

³The Czech Republic, Hungary, Malta, Romania, Slovakia, Poland, Cyprus, and Slovenia joined the WTO in 1995. Bulgaria joined in 1996, Latvia and Estonia joined in 1999, and Lithuania joined in 2001. Malta and Cyprus had been members of the EAA since the early 1970s, while the remaining NMS all joined between 1994-1999.

in first differences and also include industry fixed effects, which capture broad industry-level changes, such as increases in import competition.

The IV estimates point to a positive impact of offshoring on firms' share of technology workers. A ten percentage point increase in a firm's share of NMS produced good imports leads to a 6.5 point increase in the firm's share of technology workers. This represents almost a 40 percent increase relative to the average offshoring firm's pre-offshoring technology worker share. The IV results also show that offshoring firms increase their share of high skilled workers (those with at least a Bachelor's degree), and, perhaps most surprisingly, that they introduce more new domestically-produced goods relative to non-offshorers. These results are indicative of an important role for offshoring in firms' allocation of resources towards innovative activities.

This paper contributes to a significant empirical literature on offshoring and workforce composition. There is evidence that offshoring is related to the rising skill premium (Feenstra and Hanson, 1999), increased shares of high skill workers within the firm (Mion and Zhu, 2013), and to greater polarization (Harrigan et al., 2016). The paper is most closely related to Hummels et al. (2014), who also analyze Danish firms' importing behavior. Although their primary focus is on the wage responses, they also find offshoring increases high skill worker employment and decreases low skill worker employment. We extend those results by studying a later time period in which offshoring to low wage countries is more prevalent. Using a firm's pre-period production, rather than its pre-period imports, to create the instrument allows us to capture both intensive *and* extensive margin offshoring decisions, the latter being particularly relevant for offshoring to low wage locations. We also show that offshoring does not replace domestic production, that it leads firms to increase technology-related occupations, and that it results in increased product introductions.

This paper also adds to a growing body of work on offshoring and innovation (Bøler et al., 2015; Arkolakis et al., 2018). We provide evidence that offshoring to NMS countries induces a firm to reallocate workers to technology-related activities, and that this occurs even when

controlling for changes in firm sales over the offshoring period. This reallocation of workers and change in occupations in response to new offshoring opportunities is consistent with firms organizing workers to leverage knowledge across countries, as Helpman (1984) and Antràs et al. (2006, 2008). Reallocation is also a key feature of Rodríguez-Clare (2010), in which offshoring lowers real returns to production work in the north, thereby also lowering the opportunity cost to innovate. That theory highlights the potential for worker switching from production to innovation to raise aggregate productivity and growth in the offshoring country in the longer term.

We also add to work that develops new measures of offshoring. Feenstra and Hanson (1999) introduce one of the first industry-level measures of offshoring by using input-output tables to calculate each industry’s share of imported inputs. More explicit firm-level measures of offshoring highlight significant heterogeneity in offshoring, even within detailed industries (Fort, 2017; Monarch et al., 2017). A number of recent papers measure offshoring as any imports by a manufacturing firm, and Hummels et al. (2014) focus on imports of four-digit HS products that the firm also produces domestically. Using the direct measure from the unique offshoring survey, we show that produced goods imports are a good predictor of offshoring. Studies that exploit industry variation in import penetration changes may thus confound the effects of import competition with those of offshoring.⁴

The rest of the paper proceeds as follows. In section 2 we describe the new offshoring data and the other linked data. Section 3 documents the differences between offshoring and non-shoring firms. Section 4 discusses how we exploit the productivity changes within NMS countries to identify the effects of offshoring. We present results from this analysis in section 5, and in section 6 show that offshoring is also associated with increased R&D spending. The last section concludes.

⁴This general finding is consistent with Kovak et al. (2017) who study US multinationals and find employment gains for those multinationals that offshore vertical tasks, but negative employment effects for domestic firms that compete with offshorers. Antràs et al. (2017) provide a theoretical framework that captures these effects. Offshoring firms lower prices and expand, but the lower price index leads non-offshorers to shrink.

2 Data

In this section, we describe our novel measure of offshoring. We combine this measure with information from several other sources to construct a rich dataset of firm and employee characteristics.

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. The survey was part of a larger effort designed by Eurostat to assess European firms' global production decisions. While the original Eurostat survey was aimed at all private sector firms with at least 100 employees, Statistics Denmark surveyed all firms with more than 50 employees that existed in 2005, and firms with 20-50 employees in selected industries.⁵ 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.⁶

The specific language in the survey asked firms whether they moved a particular activity to one or more of seven distinct regions.⁷ 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. It does not include foreign locations of activities which are new to the firm, which are covered in a separate part of the questionnaire.

⁵Certain industries, such as government services were deemed less relevant for measuring offshoring.

⁶The survey instructions specify that a firm's core activity corresponds to its primary industry classification.

⁷The actual Danish language is "...udflytning...", which literally translates to "move out." The precise question is presented in the online appendix.

The survey also asked firms to identify the country or regions to which they offshored. The survey used the following breakdown of sourcing by location: “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;⁸ other European countries; China; India; other Asian countries and Oceania; US and Canada; Central America; and Africa. Firms were also asked to identify whether they offshored their core activity to new and/or existing firms within the same business group, or to separate firms.

The survey therefore provides a direct measure of a firm’s decision *to begin* offshoring in the period from 2001 to 2006. We focus solely on the relocation of the firm’s activity to a foreign country, regardless of whether this relocation occurred within or outside the boundary of the firm. In practice, the survey suggests that both integrated and outsourced offshoring are important. Approximately 44 percent of firms that offshored their core activity did so to other foreign companies (with no ownership or less than 50 percent ownership). The remaining offshored to a partner with an ownership relationship.

2.2 Additional data sources

We combine the offshoring survey data with a number of different data sources on Danish firms. 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 2008.⁹ 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

⁸The 12 NMS countries are Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, and Slovenia, and Slovakia.

⁹Some of the firm-level data continues past 2008 but we have chosen to end the sample to avoid the great recession.

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 same HS6 level of aggregation as the production data, though in practice firms often report at the more aggregated HS4 level.

We also link our data set 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 benefit of the Danish data is that products in the trade data are classified using the same HS codes as the production and input use data. This facilitates comparisons of Danish firms' production, input purchase, and trade decisions.

A critical element in our analysis is to exploit detailed information about the population of Danish individuals over the period 1991 to 2008. To do so, we use data extracted from Integrated Database for Labor Market Research (IDA). These data cover the universe of the Danish population aged 15-74, including the unemployed and those outside of the labor force. They provide information on workers' gender, age, experience, tenure, wage, education level, and occupation. Workers are linked to the plant and firm where they are employed. The dataset also provides a six-digit NACE industry code for the economic activity of each worker's plant.

We use the Integrated Database for Labor Market Research (IDA) data to define worker occupation groups. Following Bernard et al. (2017), we determine the number of workers for five different 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 (line 1)

and the others, mostly involved in the production process (line 2).¹⁰

We also add data from R&D surveys that span the period from 2000 to 2010. These surveys are only available for between 3,500 and 4,500 firms 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 the share of R&D expenditure in total revenue, as well as the share of R&D workers in total employment.

3 Offshorers versus Non-Offshorers

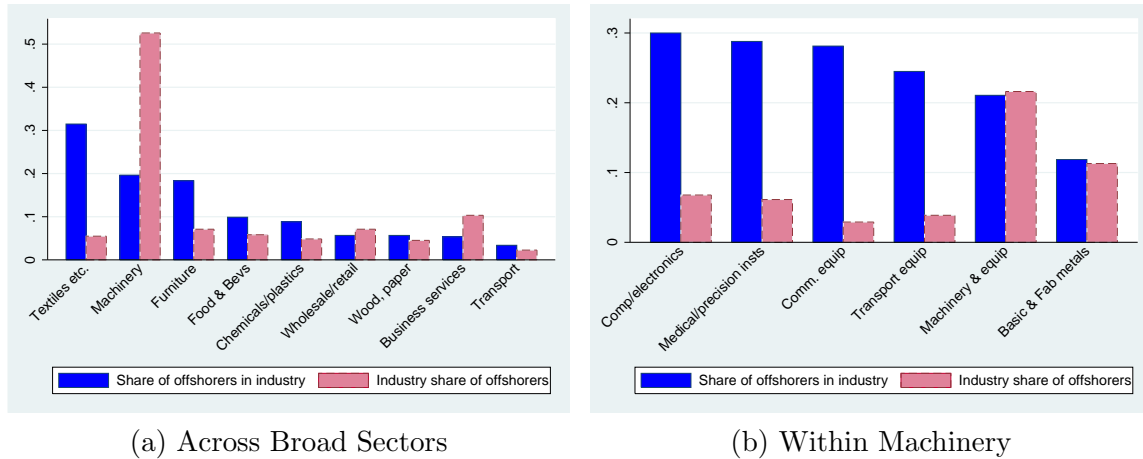
The availability of a new, direct measure of offshoring provides a unique opportunity to consider the differences between offshoring and non-offshoring firms both before and after the core activity is moved abroad. In particular, this section provides summary statistics of the new offshoring data and descriptive evidence on how offshoring relates to changes in firms over time. A particular focus is on the interaction between offshoring and importing, with a goal of better understanding the nature of imports by offshoring firms.

3.1 Summary statistics about offshoring

We first describe the distribution of offshoring activities across sectors. Figure 1 shows two views of the distribution of offshoring across broad sectors. The industries are sorted by the share of firms that offshore in the sector between 2001 and 2006 - the solid (darker) blue columns. Textile and Apparel has the greatest share of offshoring firms, more than 30 percent, while almost 20 percent of firms in the Machinery and Furniture sectors report offshoring their main activity between 2001 and 2006. At the other extreme are Business Services and Transport where fewer than 5 percent of firms offshore.

¹⁰See the online data appendix for the definition of these groups based on the ISCO code.

Figure 1: Industry distribution of offshoring firms



Notes: Figure plots the share of offshoring firms within each industry (first/blue bars) and the share of offshoring firms across industries (second/red bars). Note that the red bars do not sum to 1 since only the top industries are presented to minimize disclosure concerns.

The (lighter) red columns show the share of that industry in total offshoring, again using firm counts. Machinery is the largest broad manufacturing sector in Denmark and accounts for more than half of all offshoring firms.¹¹ While a small share of Business Services firm offshore, the large size of the sector in the overall economy mean that it accounts for more than 10 percent of all offshoring firms.

Panel (b) of Figure 1 takes a more disaggregated look at the Machinery sector itself. Offshoring firms comprise about 30 to 12 percent of firms in each industry. Machinery and equipment hosts the largest share of offshorers, with over 20 percent of all offshoring firms classified in that industry.¹²

The data show that just over nine percent of firms in the survey relocate their core activity to a foreign region/country between 2001 and 2006. Table 1 presents the count of firms that offshore, by region to which they relocated. The two most popular destinations are the new member state (NMS) countries and China. More than one third of Danish offshorers choose

¹¹In later sections of the paper, we are forced to restrict our sample to firm with production, thereby increasing the importance of the Machinery sector in our results.

¹²Similar patterns hold at the worker level, see the Appendix. The main difference for workers is that the share of workers at offshoring firms within industries in the Machinery sector ranges from 20 to over 60 percent.

Table 1: Offshoring of core activity by region

Offshoring of core activity by detailed region		
Region	Firm count	Share
NMS	139	0.37
NMS & China	66	0.17
China	60	0.16
Other	115	0.30
Total Offshorers	380	1.00

Notes: Locations to which firms relocated their core activity.

NMS (but not China) as an offshore destination, while another 17 percent offshore to both NMS countries and China. China, but not NMS, is a destination for just over 15 percent of Danish offshoring firms. Almost one third of Danish firms offshore to “Other” regions, without also offshoring to either the NMS countries or China.¹³

3.2 Offshorer premia

Firms that engage in international activities such as exporting, importing and foreign direct investment are well known to be significantly different from purely domestic firms (Bernard et al. (2018)). They are usually larger, more skill- and capital intensive, and more productive. Given the different definition of offshoring used in this paper, we compare offshoring Danish firms to their non-offshoring counterparts in the year before offshoring activity begins.

Column 1 of Table 2 reports premia from a simple regression of the (log) characteristic in 2000 on a future offshoring dummy including industry fixed effects. Offshorers are substantially larger in terms of sales and employment than non-offshoring firms in the same industry. They also are more likely to either export or import. Surprisingly, labor productivity, measured as sales per worker and value added per worker, is not different at offshoring firms compared to non-offshorers.¹⁴ These results are broadly consistent with the charac-

¹³See the Appendix for a breakdown of the other regions. Some firms that offshore to China and NMS also offshore to other regions, but they are too few to report separately.

¹⁴The difference between value-added and total sales comes from the resales of goods without transformation, materials, and the cost of subcontractors. More work is needed to see which of the last three

teristics of firms that engage in foreign markets more generally, with the exception of labor productivity.

Table 2: Offshorer versus Non-Offshorers

	Level (2001)	Change (2001-2006)
log FTE	0.57***	-0.17***
log Sales	0.62***	-0.08*
log Sales/Worker	0.06	0.08**
log VA/Worker	-0.03	0.00
Importer	0.18***	-0.02
Exporter	0.19***	-0.01
Imports/Sales	0.05***	0.02***
Exports/Sales	0.16***	0.00

Notes: Each entry is the estimated coefficient from regressing the variable in column 1 on an indicator for whether the firm offshored its primary activity between 2001 to 2006. For the column titled “Level” the dependent variables is the (log) level of the variable in 2001 and the controls include NACE4 industry fixed effects. For the column “Change”, the dependent variable is the change from 2001-2006 and the controls include NACE4 industry fixed effects.

Column 2 of Table 2 shows the changes in these same firm characteristics from 2001 to 2006, the period when the offshoring is undertaken. While both employment and sales growth are significantly lower at offshorers, the relative changes lead to a significant increase in sales per worker. The measure of labor productivity, value-added per worker, grows at the same rate for both groups of firms over the interval while import shares rise at offshoring firms.

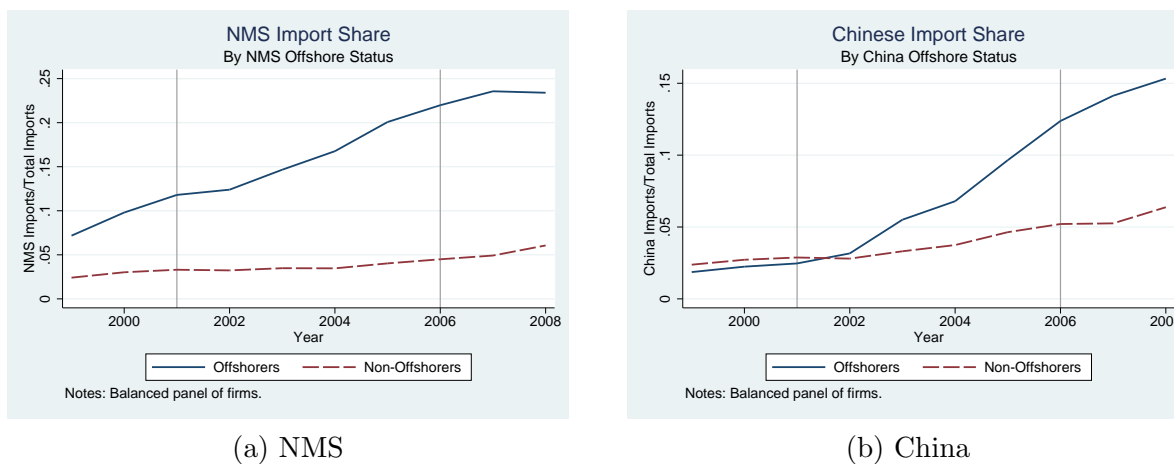
3.3 Offshoring firms’ import behavior and domestic production

An important contribution of this paper is to document the relationship between an explicit firm-level measure of offshoring and firms’ import behavior. Offshoring is often equated with imported intermediates, but it can take place in a variety of forms. It is not evident that a adjustments explain the difference between the sales per worker and value-added per worker premia.

firm relocating its main activity to a foreign country will necessarily import intermediates. In fact, offshoring need not entail any importing by the firm back to the home country. Many firms offshore assembly of the final product, and others offshore the entire production activity of a product.¹⁵

For the top two sourcing locations, NMS and China, we analyze how offshoring relates to firm import behavior. Figure 2 shows that firms re-orient the sources of their imports towards the offshoring regions. The left panel shows that firms that offshore to NMS countries more than double their share of imports from NMS over the offshoring period. The right panel presents similar results for firms that offshore to China.¹⁶ These results provide reassuring evidence that the offshoring survey is capturing real changes in firm behavior, and support prior work that has argued for using imports as a measure for offshoring.

Figure 2: Imports from offshoring region over total imports



We next examine the types of goods that offshoring firms import. To do so, we use data on produced goods from the Prodcom production survey described above to identify whether a firm's imports constitute domestically produced goods. We identify a firm's production by HS6 product and label all imports that the firm also produces in Denmark as imports of produced goods. The left panel in Figure 3 shows that offshoring firms increase their imports

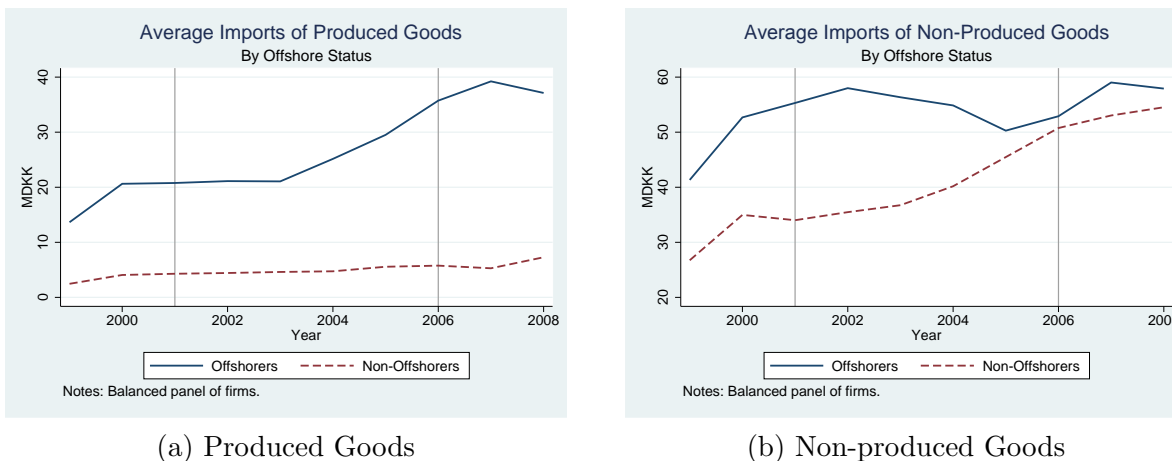
¹⁵For example, firms may engage in platform FDI, as modeled in Tintelnot (2017).

¹⁶In the Appendix, we perform a similar analysis for firm exports. While firms' exports to their offshore locations grow, they do so much less than for their imports.

of goods that they also produce domestically from 20MDKK to about 35MDKK over the offshoring period, while non-offshoring firms' produced good imports are relatively stable.¹⁷ The right panel of Figure 3 shows the opposite pattern for imports of goods that the firm does not produce domestically. Offshorers actually shrink their average imports of these goods, while non-offshorers increase their imports of non-produced goods substantially.

In the Appendix, we also present results analyzing firms' imports of inputs, as reported in the material purchase survey. This survey generally only provides detail at the HS4 product level, so we compare imports of inputs and produced goods with each defined at the HS4 level. The input and produced good classifications need not be mutually exclusive since a firm could both produce a particular product and also purchase it as an input. While offshoring firms increase their share of produced good imports and of imports that are classified as both produced goods and inputs, they do not seem to increase imports of goods classified solely as inputs.

Figure 3: Average imports by good type and offshore status



(a) Produced Goods

(b) Non-produced Goods

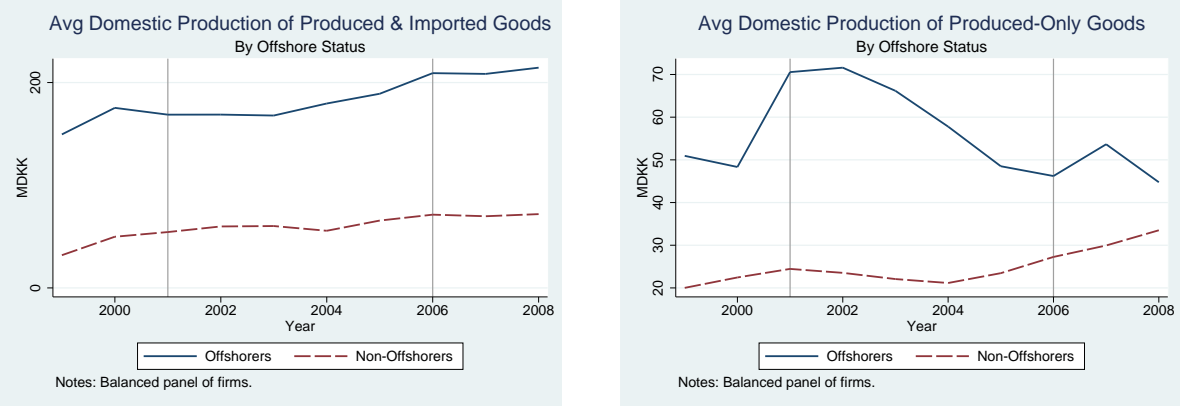
A common preconception about offshoring is that firms' foreign activities substitute for

¹⁷One question raised by figure 3 is why offshoring firms have such high levels of produced good imports in 2001, prior to offshoring. In the Appendix, we show that offshorers in the survey have higher average imports of produced good imports from the old EU countries in 2001. Interestingly, firms that offshore to NMS seem to grow their old EU produced good imports as well, while firms that offshore to China but not the NMS shrink their produced good imports from the old EU and grow their produced good imports from China.

domestic production. From this perspective, an increase in imports should lead to a reduction in production in Denmark. While prior work has shown that access to foreign imports increases domestic productivity (Amiti and Konings, 2007) and that cost reductions in foreign affiliate locations can increase domestic employment (Kovak et al., 2017), the displacement effects of offshoring could be particularly strong when firms import goods that they also produce domestically.

To assess how offshoring affects domestic production, Figure 4 plots firms average production by offshore status. The left panel shows that average production for goods that the firm also produces domestically actually grows over the offshoring period similarly for both types of firms. In contrast, offshoring firms see a sharp decline in the average domestic production of the goods that they do not import. Since average production of non-imported goods is relatively small, offshoring firms’ total average production is relatively steady over the offshoring period, even as their imports of produced goods increase.

Figure 4: Average production by good type and offshore status



(a) Imported Goods

(b) Non-imported Goods

A natural question is why do firms produce and import the same products? The fact that offshoring firms’ domestic production of goods that they also import is thus more resilient than their production of non-imported goods suggests that they may have certain capabilities in those produced and imported goods that they can leverage across multiple production locations. For instance, offshoring firms may maintain domestic production of

a higher quality variety, while they offshore production of lower quality varieties. Table 3 provides evidence consistent with this story. For the sample of firm-products (CN8) from 2000-2008 with both production in Denmark and imports from abroad in the same year, we regress unit values on a dummy for domestic production while controlling for firm-product and year fixed effects.¹⁸

The coefficient on domestically produced varieties is large, positive and significant. Column 1 in table 3 suggests that on average, domestic varieties have unit values 60 percent higher than their imported counterparts within the same firm. A potential concern with this estimate is that the domestic unit values and the import unit values come from different data sources, with the latter excluding any potential mark-ups the offshoring firm may add in the domestic market. We thus examine the extent to which this differential in domestic versus foreign unit values is larger for offshoring firms. The second column includes an interaction between the offshoring dummy from the survey and the domestic unit value and shows that the price gap is 27 percentage points higher for offshoring firms. The final column adds country/region specific indicators for the imported varieties and shows that imports from the China are 42 percentage points lower than imports from all other locations, and NMS imports are 20 percent lower. In contrast, imports from the original 15 EU countries are 12 percentage points higher than imports from other countries. These patterns suggest quality differentiation within a detailed product category that differs systematically across countries (e.g., as in Schott, 2004), with firms offshoring production of low quality versions to China and NMS countries.

If offshoring involves relocating production of low quality versions of particular products abroad, we would 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 offshoring, we estimate how firms' domestic unit values evolve in an

¹⁸The unit value for the domestic variety comes from the Prodcum survey and represents the domestic factory gate price, while the unit value for the imported variety comes from the Danish customs data and represents the imported price.

Table 3: 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*** (0.096)	0.520*** (0.093)	0.566*** (0.117)
Domestic \times Offshorers		0.268** (0.113)	0.205* (0.112)
China			-0.423*** (0.066)
NMS			-0.200*** (0.058)
EU15			0.123** (0.060)
Constant	3.966*** (0.039)	3.966*** (0.039)	3.946*** (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

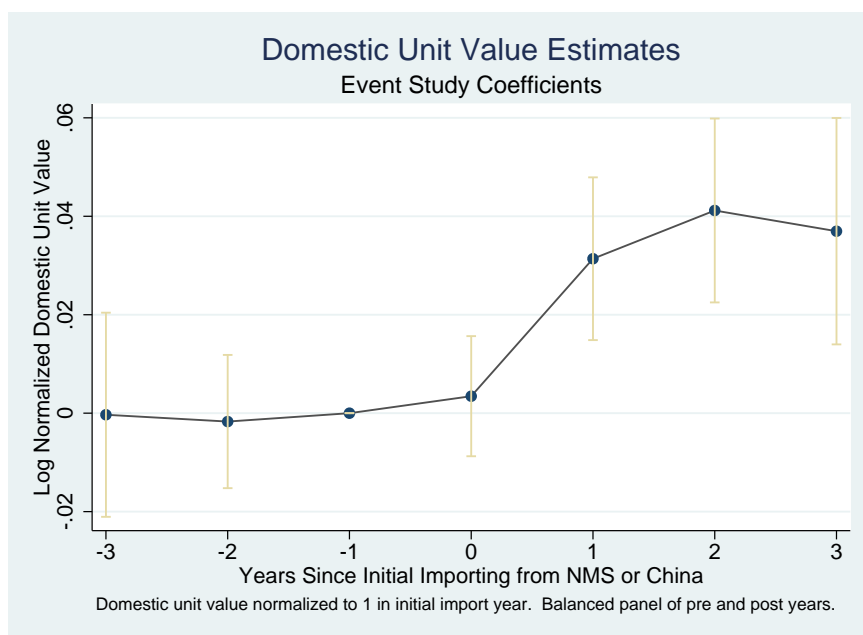
Notes: The sample includes all firm-product-year combinations from 2001-2008 where there is both domestic production and importing of the same CN8 product by the firm in the same year. The dependent variable is the log unit value. “Domestic” is a dummy for whether the variety is produced domestically; “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.

event study setting. We focus on firms that produce the same detailed CN8 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-CN8 product in the firm’s initial import year, and estimate

$$\log(p_{ft}) = \alpha_t + \sum_k \beta_k \Delta Imp_{f,t+k} + \varepsilon_{ft}, \quad (1)$$

where α_t denotes year fixed effects, $\Delta Imp_{f,t+k}$ is a series of indicators that identify the firm’s initial import year, and (p_{ft}) is the normalized domestic unit value. We cluster the standard errors by CN8 product category. Figure 5 presents the event study coefficients, and shows a clear increase in domestic unit values after firms begin offshoring. This increase may reflect offshoring firms abandoning domestic production of lower quality versions (e.g., as proposed in Schott, 2008), or quality of upgrading of their domestically-produced versions as they reallocate domestic resources towards innovation.

Figure 5: Imports from offshoring region over total imports



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 do not seem to decrease 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.

3.4 Offshoring and employment composition

There has been considerable attention paid to the employment effects of offshoring. Table 4 presents summary statistics of the labor composition at offshoring and non-offshoring firms in 2001 and 2008. The top Panel A shows that offshoring firms have seen a large decline in their share of less-educated workers, those with less than a high school degree. These workers fell from 37 percent of the workforce at offshoring firms in 2001, to 30 percent in 2008. In contrast, the share of these workers at non-offshorers stayed constant at 38 percent over the same period. The decline in low-education worker shares at offshorers shows up in large increase in the high education worker share, which almost doubles, and a more modest rise in middle education worker shares. Non-offshorers have a small decrease in the middle category and a small rise in the most educated group.

Panel B of Table 4 presents similar information on labor composition by occupations. The most notable difference between offshoring and non-offshoring firms is in their shares of technology workers. Offshorers start with technology workers comprising 17 percent of their workforce in 2001, but the share climbs about more than 40 percent to 24 percent of the workforce by 2008. In contrast, technology workers increase slightly from 13 to 14 percent of the workforce for non-offshorers over the same interval. Both types of firms see their production worker shares decline, with larger declines for offshorers. While offshorers

Table 4: Labor force characteristics by offshoring status

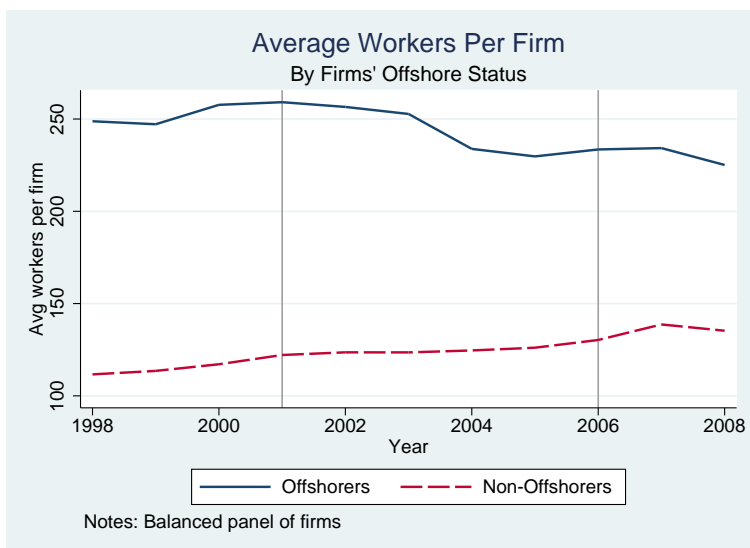
	2001	2008
Panel A: Education		
Offshoring firms		
Education - low	0.37	0.30
Education - middle	0.57	0.59
Education - high	0.06	0.11
Non-offshoring firms		
Education - low	0.38	0.38
Education - middle	0.55	0.52
Education - high	0.07	0.09
Panel B: Occupations		
Offshoring firms		
Managers	0.03	0.04
Production workers	0.54	0.38
Blue non-production workers	0.07	0.06
Tech workers	0.17	0.24
Support workers	0.13	0.18
Sales workers	0.05	0.08
NEC	0.01	0.01
Non-offshoring firms		
Managers	0.04	0.04
Production workers	0.32	0.22
Blue non-production workers	0.09	0.10
Tech workers	0.13	0.14
Support workers	0.27	0.28
Sales workers	0.13	0.21
NEC	0.02	0.01

Notes: Offshoring firms are defined as those that relocated their core activity to a foreign region between 2001 and 2006. Low education workers have less than a high school degree, middle education workers have a high school degree but less than a bachelors degree, and high education workers have a bachelor's degree or above. See the online Appendix for the ISCO codes corresponding to the occupation categories.

increase their technology worker shares relatively more, non-offshorers see bigger increases in their share of sales workers. Sales worker shares increase by 3 percentage points at offshorers, compared to 8 points at non-offshorers.¹⁹

Figure 6 plots the average number of workers at offshoring and non-offshoring firms for a balanced panel of firms from 1998 to 2008. First, it is clear that firms in the offshoring survey are significantly larger than the average firm in Denmark. The average non-offshorer has about 125 employees in 1999. Offshoring firms are almost twice this size, with about 250 employees in 1999. Although offshoring firms start larger, their trends in average firm size are similar from 1998 to 2001. Starting in 2001, however, the offshoring and non-offshoring firms' behavior diverges significantly. The average offshoring firm size drops sharply from 2001 to 2005 and then flattens out. In contrast, non-offshorers display a slight upward trend in their average firm size.

Figure 6: Average firm employment by firm's offshoring status



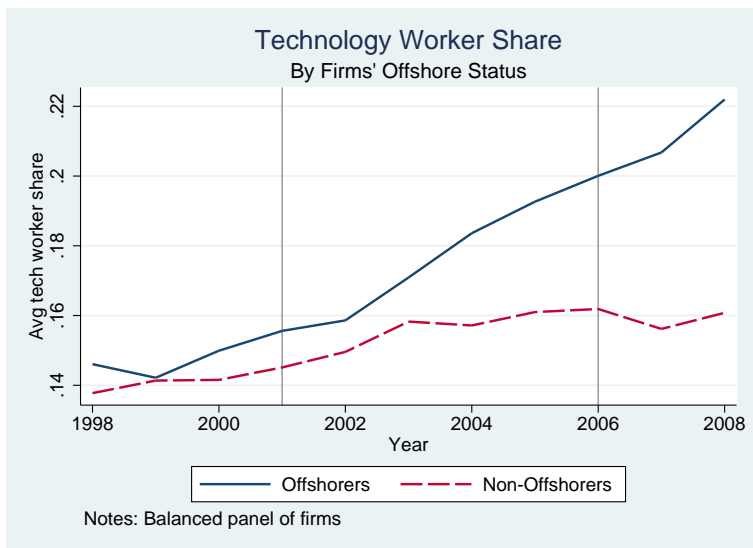
Notes: Figure plots average firm employment for firms in the offshoring survey. Offshoring firms are those that relocated their core activity to a foreign country between 2001 and 2006.

An important contribution of this paper is to show how offshoring relates to a firm's

¹⁹We present the level of employment shares by category, but the patterns depicted here are similar when calculating averages relative to a firm's industry average. The empirical analysis will be based only on manufacturing firms and include industry fixed effects to control for compositional differences by offshore status.

allocation of resources – and in particular employees – towards innovative activities. Figure 7 plots the share of technology workers in total employment for offshoring and non-offshoring firms. Offshoring firms start with slightly higher shares of technology workers, but their share diverges from non-offshoring firms’ technology worker share over the offshoring period. While offshoring firms’ tech worker growth rate increases in 2002, non-offshorers’ growth rate flattens out in about 2003.

Figure 7: Share of technology workers by firm’s offshoring status



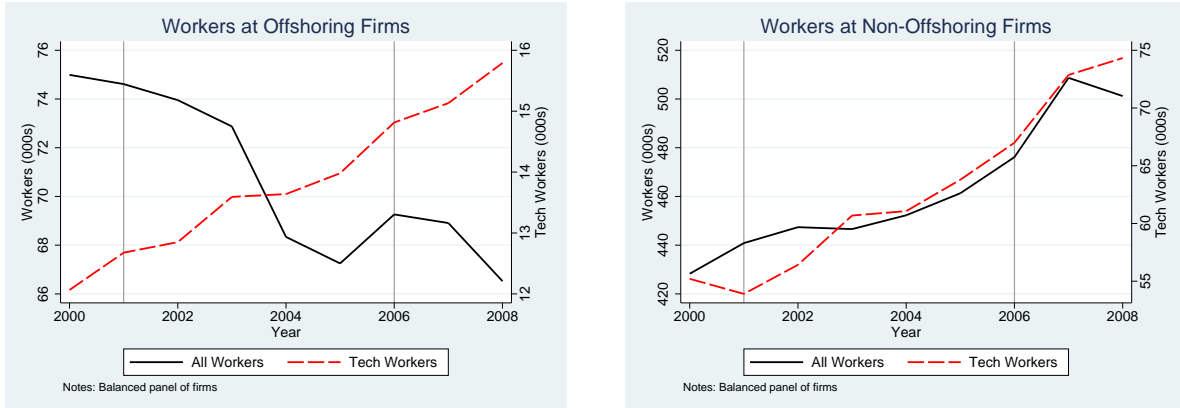
Notes: Figure plots the share of technology workers over total employment for firms in the offshoring survey. Offshoring firms are those that relocated their core activity to a foreign country between 2001 and 2006.

One possible concern is that the rising share of tech workers is due to a decrease in offshoring firms’ average size. Figure 8 shows that this is not the case. Even as total employment at offshoring firms falls, their level of technology workers rises. In contrast, non-offshorers tech workers grow at about the same rate as their total employment.

3.5 Offshoring and product development

To assess outcomes related to this increase in technology workers and the declining share of production workers at offshoring firms, we compare changes in their product-level margins. This exercise is limited to firms with manufacturing production, since production data are

Figure 8: Level of technology worker employment by offshoring status



(a) Offshorers

(b) Non-Offshorers

only available for this sector. Table 5 shows that in 2000, offshorers produce an average of 4.85 distinct products, compared to only 2.89 by non-offshorers. The difference is even larger by 2007, with offshoring firms producing 6.26 products relative to only 3.05 for non-offshorers. The right panel shows that this disproportionate increase in products by offshorers is driven by the fact that almost half of their products in 2007 are new, while less than one third of the products sold by non-offshorers are new introductions after 2000.

Table 5: Product switching by offshore status

	No. of Products		Product changes from 2000-2007		
	2000	2007	Continued	Dropped	Introduced
Non-offshorers	2.89	3.05	2.15	0.74	0.90
<i>percent</i>			<i>74.4%</i>	<i>25.6%</i>	<i>29.5%</i>
Offshorers	4.85	6.26	3.41	1.44	2.85
<i>percent</i>			<i>70.3%</i>	<i>29.7%</i>	<i>45.5%</i>
Total	3.22	3.60	2.36	0.86	1.24
<i>percent</i>			<i>73.3%</i>	<i>26.7%</i>	<i>34.4%</i>
Relative to firm's industry average					
Non-offshorers	0.94	0.90	0.95	0.91	0.81
Offshorers	1.28	1.46	1.22	1.46	1.94

Notes: There are 1,220 firms (207 offshorers) with production data.

The evidence in table 5 suggests that product development may be an important new activity for offshorers. Since offshorers are more concentrated in certain industries, we also calculate within-industry statistics for product counts. The bottom panel of table 5 presents average product counts by offshore status, normalized by each firm's industry average. In both 2000 and 2007, non-offshorers produced fewer products than the average firm in their industry. Offshorers produced 28 percent more products than their industry average in 2000, and almost 50 percent more by 2007. As in the raw count data, new products represent the most important margin of adjustment for these differences. While non-offshorers introduced only 81 percent of their industry average, offshoring firms introduced almost twice as many new products over the period.

The descriptive evidence here is suggestive of a casual relationship between offshoring and a firm's allocation of resources towards innovative activities. In the next section, we discuss potential theoretical channels that might drive this evidence and outline an empirical strategy to analyze the relationship more rigorously.

4 Theoretical motivation and empirical approach

In this section, we first describe the key theoretical channel through which we expect the relocation of domestic production abroad to affect firms' organization of its domestic workforce. We then discuss several alternative channels and challenges in identifying the impact of offshoring on innovation-related activities, and explain how we will assess or control for their impact in our analysis. Finally, we present an identification strategy to address these issues and to provide information on the various potential channels.

4.1 Theoretical channels for offshoring and innovation

We investigate how offshoring affects innovation by allowing firms to leverage knowledge through the formation of international production teams. In Antràs et al. (2006), production

requires solving problems. Workers of different ability sort into teams, choosing whether to be problem-solvers or production workers based on the relative returns to each activity, which in turn depend on their skill. Offshoring occurs when production teams can form across countries, with problem-solvers in one country combining with production workers in another. The theory predicts that new offshoring opportunities will lead to an increase in the number of problem-solvers in skill-intensive countries, with workers in those countries shifting from production to problem-solving activities as they form teams with production workers in lower wage countries.

In a related fashion, offshoring also leads production workers in the north to switch into innovation-related activities in Rodríguez-Clare (2010). Since offshoring lowers the real production worker wage in the north, it also lowers the opportunity cost to innovate. Workers that were previously indifferent between production or innovation in the north will thus switch into innovation. The key mechanism in both these models is a change in the relative return to production work versus innovation that leads workers to change what they do. When new offshoring opportunities arise, for example as a result of the EU accession process in the NMS or China's WTO entry, this lowers the return to production work in Denmark for those firms that can offshore. The relative return to innovation thus rises, providing an incentive for the firm to reallocate resources towards innovation, and for workers to switch from production to innovation-related occupations.

Heterogeneous firms models with fixed costs to offshore and to innovate provide an alternative channel through which offshoring may affect innovation. Bøler et al. (2015) develop a model in which there are strong complementarities between firms' sourcing decisions and their R&D investment. In their model, trade and technology are complementary activities because they both lead firms to become more profitable and thus cover associated fixed costs. Analogously in our work, if firms find offshoring more profitable, this may facilitate an increase in their innovative activities. One way to assess the importance of this channel is to control for changes in firm sales over the offshoring period. If the impact of offshoring on

innovation is due to a firm scale effect, controlling for growth in firm output should eliminate the offshoring effect on innovation.

Offshoring and innovation may also be related if both are optimal responses to increased competitive pressure from abroad, as in Bloom et al. (2015). Bloom et al. (2014) present a framework in which firms that face increased import competition reallocate “trapped” resources within the firm towards R&D activities. In that model, increased competition lowers the opportunity cost to innovate so that firms decrease production and shift workers into innovative activities. A key feature of their theoretical channel is the presence of labor market frictions that make it infeasible (or suboptimal) for the firm to fire workers in response to the increased competition. Denmark has a particularly flexible labor market and it seems unlikely that Danish firms face these types of firing frictions reducing the likelihood of a trapped factors explanation.²⁰

Import competition may also lead firms to innovate by reducing x-inefficiencies (Schmitz, 2005), by changing managerial incentives (Schmidt, 1997; Aghion et al., 2005), or by incentivizing firms to invest in new product varieties that do not compete with foreign imports (Impullitti and Licandro, 2017; Fieler and Harrison, 2018). We therefore focus on empirical specifications in which we control for industry-level import penetration separately from a firm’s decision to offshore.

Offshoring and innovation may also be related if firms’ decisions to relocate overseas increase their access to new ideas or inputs. A number of papers document an important role for imported intermediates in improving firm productivity (Amiti and Konings, 2007; Goldberg et al., 2010; Halpern et al., 2011), and for imports in spreading ideas across countries (Coe and Helpman, 1995; Acharya and Keller, 2009). These channels may be quite important for offshoring by developing countries to more developed countries, but are likely less important when considering Danish firms’ offshoring decisions to low wage countries, such as China and NMS countries. In addition, we focus on Danish firms’ decision to offshore

²⁰Andersen and Svarer (2007) document the flexibility of the Danish labor market.

their main activity, which is potentially distinct from the decision to offshore IT and R&D activities.

4.2 Empirical approach

An important contribution of this paper is to show that offshoring leads firms to reallocate their domestic workers towards innovative activities. A primary concern with estimating this relationship is that firms may offshore production in response to other shocks. One might expect a downward bias on the estimated coefficient of the effect of offshoring on innovation if firms start offshoring in response to negative demand or productivity shocks, for example as in Monarch et al. (2017). In this scenario, firms may seek to lower costs not just by relocating production offshore, but also by reducing domestic expenditure on higher wage occupations. Alternatively, one might expect an upward bias on the OLS estimates if firms offshore their main activities so that they can re-orient domestic resources towards innovation.

Perhaps one of the most obvious challenges to estimating the effect of offshoring to NMS or China is that production cost saving opportunities in these locations may also entail increased import competition. We assess this potential concern by estimating the probability of offshoring to China or NMS as a function of increased import penetration from those regions. Table 6 shows that this concern is empirically relevant for China. Increased import penetration from China in a firm's sector is associated not only with an increased likelihood that a firm will offshore to China, but also that it will offshore to NMS. In contrast, increased import penetration from NMS does not seem to influence firm's offshoring decisions.

The inter-relatedness between import competition and offshoring opportunities is thus an added challenge to distinguishing the effects of a negative demand shock that differs across industries (increased import competition in a firm's industries) from a positive offshoring shock (increased production cost savings opportunities). The results presented in Table 6 also highlight a potential omitted variable concern in prior work. For instance, Bloom et al.

Table 6: Probability of Offshoring to China or NMS

Dep var is indicator equal to one if firm i offshores from 2001-2006 to:

	China		NMS	
$\Delta ChImpPen_j^{2001-2006}$	1.111** (0.537)	1.225* (0.594)		2.543*** (0.613)
$\Delta NMSImpPen_j^{2001-2006}$		0.393 (0.266)	-0.006 (0.652)	0.329 (0.430)
$\log Sales_i^{2001}$	0.029** (0.011)	0.029** (0.011)	0.035** (0.013)	0.038*** (0.012)
Constant	-0.487** (0.186)	-0.503** (0.184)	-0.540** (0.227)	-0.644*** (0.212)
R2	0.03	0.03	0.02	0.04
Observations	1,679	1,679	1,682	1,679

Notes: Import penetration measured at 2-digit NACE industry. Standard errors clustered by industry.

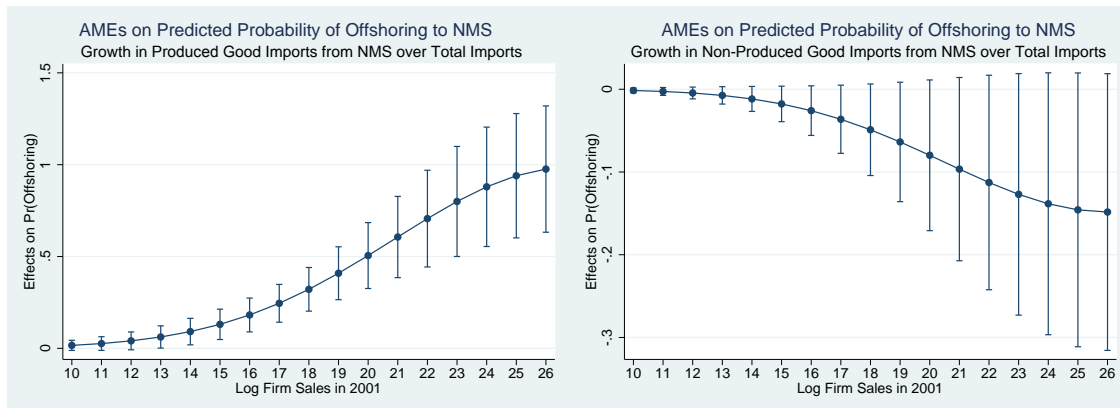
(2015) find that European firms that faced increased Chinese import competition increased their domestic innovation. One possibility is that those firms offshored production to NMS, and that offshoring was actually the channel through which they increased innovation.

To address these issues, we implement an instrumental variables (IV) strategy in which we identify changes in a firm's offshoring decisions due to factors external to both the firm and Denmark. Given the strong correlation between Chinese import competition and offshoring, we focus on firms' offshoring to NMS. We focus on NMS both because it is the main offshoring destination for Danish firms, and because we are better able to distinguish between import competition and offshoring opportunities.

In order to exploit the most detailed product-level data available, and to control for broad industry changes, we do not use the offshoring dummy in this section. Instead we rely on the evidence of the strong relationship between changes in a firm's import share of domestically produced goods and its offshoring decision. The change in the import share of produced goods from the NMS is used as a proxy for firm offshoring to the NMS. The benefit of using changes in firm's produced good import shares is that these can be measured at the detailed six-digit product level and this measure can be employed by researchers without access to

comparable direct surveys on offshoring. Figure 9 shows that this measure is indeed a good predictor of offshoring to NMS, while increased shares of non-produced goods are not.

Figure 9: Average marginal effects of import shares on predicted offshoring to NMS



(a) Produced good import share

(b) Non-produced good import share

Notes: Panel (a) plots the average marginal effects of growth in a firm’s produced good imports over total imports share from 2001 - 2006 on its predicted probability of offshoring. Panel (b) plots a comparable figure for non-produced good import share growth. Produced goods are defined as goods produced domestically by the firm in 2000 or 2001.

With this detailed product-level measure of offshoring in hand, we can exploit the fact that the 12 new EU member states underwent significant productivity growth and changes in comparative advantage across products during the offshoring period due to internal changes required for accession to the EU. We measure variation in their comparative advantage changes across detailed product categories using changes in six-digit HS product export shares by the NMS countries to the rest of the world (ROW), excluding Denmark. This approach is similar to Hummels et al. (2014), although we use changes in NMS’s export *shares* rather than changes in levels to rule out growth driven by aggregate demand or technology shocks that increase demand for particular products across all countries.

The export share growth rates are a product-level measure, but we require a firm-level instrument to predict changes in offshoring. Since offshoring involves imports of goods also produced domestically by the firm, we use each firm’s production across six-digit HS products in 2000 and 2001 to assign the product-level shocks to the firm. Specifically, we aggregate

the change in the export share in product k , $\Delta ExpShare_k^{2001-2006}$, to the firm level according to:

$$\Delta ExportSh_{iNMS} = \sum_k sh_{ik} \Delta ExpShare_k^{2001-2006}, \quad (2)$$

where sh_{ik} is firm i 's share of production of product k in 2000 and 2001.²¹ Single product firms will therefore be assigned the change in the NMS export share for their single product, while multi-product firms, which comprise the majority of the sample, will have a firm-specific shock based on the distribution of their pre-offshoring production.

One concern is that firms within industries may not be different according to their product mix. We find substantially 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.²²

Our IV strategy identifies firms that began offshoring to the NMS as a result of improved NMS exports in products relevant to the firm. The key identifying assumption is that the common within-product component of the relative increase in regional exports is due to relative increases in NMS productivity. The exclusion restriction requires that the foreign region's increased productivity only affects a firm's innovative activities through its impact on the offshoring decision. This restriction would be violated if improvements in NMS comparative advantage also led to increased competition from the NMS, and that increased competition directly affected firms' innovative activities (e.g., as in Bloom et al., 2015). We therefore construct a comparable measure of import competition from the NMS into Denmark in the firm's pre-period products. We measure import penetration at the HS6 level as imports from NMS over total imports and domestic production, but excluding each

²¹We use production data in two years to ensure that we do not miss pre-offshoring production of lumpy goods.

²²As 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).

firm's own imports and production. We calculate changes from 2001 to 2006 and construct a weighted average based on the firm's pre-period production shares. Our identification strategy thus precisely exploits important distinctions between offshoring and import competition. In our first stage, we estimate how 2001 to 2006 changes in a firm's produced good imports from NMS over total imports are predicted by NMS export share growth in the firm's pre-offshoring product mix:

$$\Delta PP ImpSh_{i,NMS} = \alpha + \beta_{Sh} \Delta ExportSh_{i,NMS} + \beta_{Imp} \Delta ImpPen_{i,NMS} + \varepsilon_i, \quad (3)$$

where $PP ImpSh_{i,NMS}$ is the change firm import share of produced products from the NMS, $\Delta ExportSh_{i,NMS}$ is the firm-specific change in NMS export shares in markets outside Denmark, and $\Delta ImpPen_{i,NMS}$ is a firm-specific measure of the change in the import penetration to Denmark from NMS in a firm's pre-period product mix. All variables are changes from 2001 to 2006. Note that estimation of equation (3) is thus similar to a first differences approach since we exploit changes in foreign comparative advantage to identify changes in a firm's offshoring status. All specifications also include two-digit NACE industry fixed effects. Since the regressions are in differences, these fixed effects capture broad industry-level changes in import competition. We weight the regressions by firm employment and winsorize the top and bottom one percent of outliers.

In the second stage regressions, we estimate how firm-level outcomes such as employment and workforce composition change in response to a firm's offshoring decisions according to:

$$\Delta y_i^{2001-2008} = \alpha + \beta_{PP} \Delta PP ImpSh_{i,NMS} + \beta_{Imp} \Delta ImpPen_{i,NMS} + \varepsilon_i^{2001-2008} \quad (4)$$

where $\Delta y_i^{2001-2008}$ is the change in the firm-level outcome variable from 2001 to 2008 and the other variables are as described in equation (3). These specifications again include two-digit NACE industry fixed-effects to control for broad sectoral changes over time. We weight the regressions by firm employment and winsorize the top and bottom one percent of outliers.

5 Offshoring and Firm Outcomes

In this section, we present results from estimating Equation (4) via OLS and when instrumenting for offshoring decisions using the instrument described in section 4.2. We also present the reduced-form results from regressing the firm-level employment outcome variables directly on the instrument described in equation (2).

5.1 OLS and Reduced form results

Table 7 presents OLS results for the IV sample for offshoring to the NMS. The sample size drops substantially to 1,149 firms due to the need for product-level data to construct the measure of firm produced product imports and the instrument itself.

Table 7: OLS results for offshoring to NMS and workforce changes

Dependent variable is 2001-2008 change in :						
	(1)	(2)	(3)	(4)	(5)	(6)
	log empl	Tech Share	Edu Hi Share	Edu Low Share	New Prods	New Prod Sh
$\Delta PGimpSh_{i,NMS}^{2001-2006}$	-0.398* (0.204)	0.081*** (0.026)	0.066*** (0.015)	-0.127*** (0.025)	3.776* (1.984)	0.338*** (0.109)
$\Delta ImpPen_{i,NMS}^{2001-2006}$	-0.320 (0.537)	0.044 (0.068)	-0.044 (0.041)	-0.033 (0.065)	-10.319** (5.088)	-0.495* (0.279)
Constant	-0.229*** (0.018)	0.030*** (0.002)	0.027*** (0.001)	-0.048*** (0.002)	2.752*** (0.172)	0.131*** (0.009)
R2	0.09	0.14	0.22	0.12	0.12	0.12
Observations	1,149	1,149	1,149	1,149	1,026	1,026

Notes: $\Delta PGimpSh_{i,NMS}^{2001-2006}$ is the share of produced goods in total NMS imports for the firm from 2001-2006. $\Delta ImpPen_{i,NMS}^{2001-2006}$ is a firm-specific measure of product import penetration with firm production shares as weights. Regressions are weighted by employment and include 2-digit NACE industry fixed effects. * p<0.10, ** p<0.05, *** p<0.01

Column 1 reports the results for log firm employment. The coefficient on the offshoring variable is negative and significant at the 10 percent level and the magnitude is comparable to that for the firm-level import penetration measure. Columns (2)-(4) report results for

measures of labor force composition within the firm. Offshoring is positively and significantly correlated with the firm's share of technology workers in total employment and the share of workers with a college degree or higher. The share of workers with less than a high school degree is negatively and significantly correlated with offshoring.

The final two columns examine a firm-level measure of innovative activity through the introduction of new products. The dependent variable is the number of new products and the share of new products in the firm product portfolio in columns (5) and (6) respectively. The number of new products is positively related to offshoring, although weakly significant, while the new product share is also positive and significant at the one percent level. While the relationship between offshoring and innovation is positive in these specifications, import competition is associated with relatively fewer new product introductions and shares. These OLS regressions largely conform to the stylized facts presented previously and suggest an important distinction between import competition and offshoring.

Table 8 presents the reduced-form results for the same sample of firms. The main variable of interest is now the change in export share by NMS countries weighted by the firm's pre-period production shares, $\Delta ExportSh_{i,NMS}$. The biggest change occurs in the employment regression where the instrument is essentially zero, in contrast to the negative and significant coefficient in the OLS regression. This result is consistent with the premise that firms offshore in response to a negative shock. The coefficient on import penetration remains negative and essentially unchanged, although still not significant.

For the labor force variables, the results are consistent with the OLS findings with smaller coefficients. Offshoring has a positive effect on tech worker and high education workers shares and a negative effect on the share of the lowest education group. The proxies for innovative activity, new product introductions and new product shares, both have positive and significant coefficients on the offshoring variable.

Table 8: Reduced-form results for offshoring to NMS and workforce changes

Dependent variable is 2001-2008 change in :						
	(1)	(2)	(3)	(4)	(5)	(6)
	log empl	Tech Share	Edu Hi Share	Edu Low Share	New Prods	New Prod Sh
$\Delta ExportSh_{i,NMS}^{2001-2006}$	-0.006 (0.045)	0.038*** (0.006)	0.026*** (0.003)	-0.017*** (0.005)	0.969** (0.434)	0.093*** (0.024)
$\Delta ImpPen_{i,NMS}^{2001-2006}$	-0.318 (0.538)	0.024 (0.067)	-0.058 (0.040)	-0.024 (0.066)	-11.751** (5.089)	-0.629** (0.279)
Constant	-0.236*** (0.024)	0.017*** (0.003)	0.018*** (0.002)	-0.044*** (0.003)	2.504*** (0.230)	0.106*** (0.013)
R2	0.09	0.17	0.25	0.1	0.12	0.12
Observations	1,149	1,149	1,149	1,149	1,026	1,026

Notes: $\Delta ExportSh_{i,NMS}^{2001-2006}$ is a firm-specific measure of the change in product export shares from the NMS excluding exports to Denmark from 2001-2006 with firm production shares as weights. $\Delta ImpPen_{i,NMS}^{2001-2006}$ is a firm-specific measure of product import penetration with firm production shares as weights. Regressions are weighted by employment and include 2-digit NACE industry fixed effects. * p<0.10, ** p<0.05, *** p<0.01

5.2 IV results

The first stage results are given in Table 9. The instrument is significant with the expected sign for both samples. The first-stage F-statistic on the excluded instruments is 87.7 and 110.7, respectively.

Table 10 presents the results from estimating equation (4), while instrumenting for changes in the firm’s share of produced good imports using growth in the NMS’s export shares in the firms’ pre-offshoring product mix. As in the reduced form results, the effect of offshoring on firm employment is not significantly different from zero. The IV estimates again confirm a positive impact of offshoring on firms’ share of technology workers. They suggest that a ten percentage point increase in the share of NMS imports of goods initially produced domestically leads to a 6.5 point increase in the firm’s share of technology workers.²³ This represents an almost 40 percent increase relative to the average offshoring firm’s pre-offshoring technology worker share. The IV results also show that offshoring firms

²³The mean (standard deviation) of the change in the produced good import share at non-offshorers is 0.006 (0.065) versus 0.05 (0.136) at offshorers.

Table 9: First Stage Results

Dependent variable is $\Delta PGimpSh_{i,NMS}^{2001-2006}$:		
	(1)	(2)
$\Delta ExportSh_{i,NMS}^{2001-2006}$	0.059***	0.069***
	-0.006	-0.007
$\Delta ImpPen_{i,NMS}^{2001-2006}$	-0.029	-0.217***
	-0.076	-0.077
Constant	0.001	0.006
	-0.003	-0.003
R2	0.23	0.22
FStat on Excl Ins	87.74	110.70
Observations	1,149	1,026

Notes: $\Delta PGimpSh_{i,NMS}^{2001-2006}$ is the share of produced goods in total imports for the firm from 2001-2006. $\Delta ExportSh_{i,NMS}^{2001-2006}$ is a firm-specific measure of the change in product export shares from the NMS excluding exports to Denmark from 2001-2006 with firm production shares as weights. $\Delta ImpPen_{i,NMS}^{2001-2006}$ is a firm-specific measure of product import penetration with firm production shares as weights. Regressions are weighted by employment and include 2-digit NACE industry fixed effects. * p<0.10, ** p<0.05, *** p<0.01

increase their share high skilled workers and reduce their low skilled worker share.

Offshoring also increases the number of new domestically-produced goods relative to non-offshorers. A ten percentage point increase in the firm's produced good import share leads to a 1.4 new product introductions. In contrast, increased import penetration from NMS is associated with fewer new products at the firm. As is typical, the IV coefficients are substantially larger than the OLS estimates which in turn are larger than the reduced form coefficients.

5.3 Robustness

We report a wide variety of robustness checks on our main specification.²⁴ First we check for the possibility that omitted firm characteristics are driving the results. We include initial firm size to check if the findings are driven by differential changes at large (small) firms

²⁴These results are not yet disclosed, but will be added to the Appendix.

Table 10: IV results for offshoring to NMS and workforce changes

Dependent variable is 2001-2008 change in :						
	(1)	(2)	(3)	(4)	(5)	(6)
	log empl	Tech Share	Edu Hi Share	Edu Low Share	New Prods	New Prod Sh
$\Delta PGimpSh_{i,NMS}^{2001-2006}$	-0.101 (0.742)	0.648*** (0.113)	0.436*** (0.069)	-0.284*** (0.092)	13.980** (6.250)	1.341*** (0.353)
$\Delta ImpPen_{i,NMS}^{2001-2006}$	-0.321 (0.529)	0.042 (0.081)	-0.045 (0.049)	-0.032 (0.066)	-8.724* (5.158)	-0.338 (0.291)
Constant	-0.326 (0.817)	-0.11 (0.124)	-0.066 (0.076)	-0.051 (0.101)	-2.687 (7.175)	-0.213 (0.405)
Observations	1,149	1,149	1,149	1,149	1,026	1,026

Notes: $\Delta PGimpSh_{i,NMS}^{2001-2006}$ is the share of produced goods in total imports for the firm from 2001-2006 and is instrumented by $\Delta ExportSh_{i,NMS}^{2001-2006}$. $\Delta ImpPen_{i,NMS}^{2001-2006}$ is a firm-specific measure of product import penetration with firm production shares as weights. Regressions are weighted by employment and include 2-digit NACE industry fixed effects. * p<0.10, ** p<0.05, *** p<0.01

which are more likely to offshore. The results are all quite similar when we control for initial firm size in the regressions. To account for the possibility that offshorers are inherently more likely to use technology, we include a proxy for IT use by the firm and find that the results are also robust. The results are also robust to controlling for pre-trends in the dependent variable, which we do using changes in the dependent variable from 1996 to 2001. Finally, although the two-digit NACE fixed effects capture broad industry trends, we also control for firm-specific changes in Chinese import competition and find that our estimates are robust to this control.

To assess whether the effects we estimate are likely driven by changes in scale at offshorers, we run a specification with growth in firm sales as an additional control. Our results are generally robust to adding this variable, which suggests that the channel driving our findings is not simply a scale effect.

6 Innovation

In this section, we consider the nature of the increases in technology worker shares and ask whether these increase are driven by external hiring or reallocation of workers within the firm. We also provide additional evidence on innovative activity by offshoring firms by exploiting R&D survey data, available for a subset of firms, to show that offshoring firms increase their R&D expenditures.

6.1 Margins of worker adjustment

The results in Sections 3 and 5 show that offshoring firms are reallocating their activities away from those performed by production workers towards those performed by technology workers. Here we provide descriptive evidence on the nature of those occupation shifts. These changes may mask a large amount of churning of workers inside the firm. Figure 10 shows that the shares of technology workers in firm hires and separations are both higher and increasing from 1998 to 2008 for offshoring firms. In Figure 10a, we show that offshoring firms are increasing their hiring of technology workers relative to overall hires during the period, while non-offshoring firms have relatively constant hiring shares of technology workers. Similarly, Figure 10b shows that separations at offshorers are disproportionately in technology workers, and that prevalence is rising during the period. For non-offshorers, the share of tech workers in separations is lower and constant.

We also examine the composition of workers employed at the same firm from year t to $t + 1$. Figure 11 shows that for workers that remain at the firm, the share of technology workers is higher and steadily rising at offshorers. This stands in sharp contrast to the pattern in non-offshorers, where the share of retained workers in technology occupations remains relatively constant over the period. Approximately one third of the tech stayers within the firm over this period switch into technology occupations from non-technology occupations within the firm. Traiberman (2018) documents high switching costs for workers

Figure 10: Tech worker shares of hires and separations by offshore status



(a) Share of tech worker hires

(b) Share of tech worker separations

Notes: Figure plots the share of technology worker hires over total hires and share of technology worker separations over total separations for firms in the offshoring survey. Offshoring firms are those that relocated their core activity to a foreign country between 2001 and 2006.

switching occupations in response to import competition. The results here highlight the possibility that within-firm switching may mitigate some of these costs.

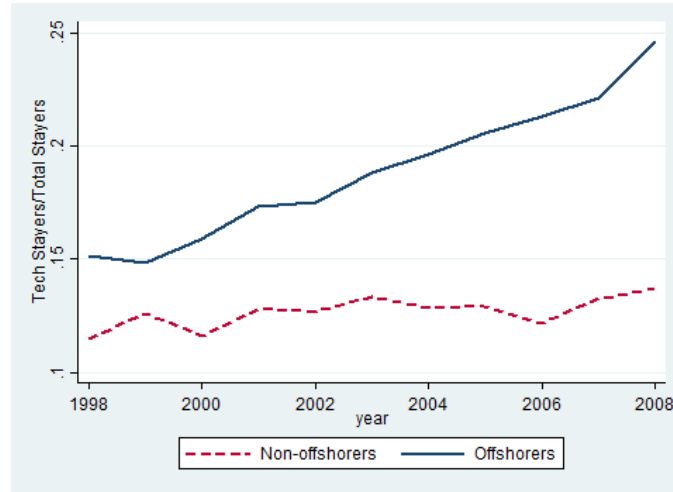
6.2 R&D Expenditure

We conclude this section with simple descriptive evidence on firms' R&D activities. Figure 12 shows (average) total R&D expenditures and R&D worker shares for offshoring and non-offshoring firms from 2001 to 2008. Figure 12a 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.²⁵ A similar stark shift is seen in the share of R&D workers at offshoring firms in Figure 12b. These results provide additional evidence that firms' shift in their workforce composition towards technology workers is indeed related to changes in their innovative efforts.

We further exploit the richness of the R&D survey information to shed light on which

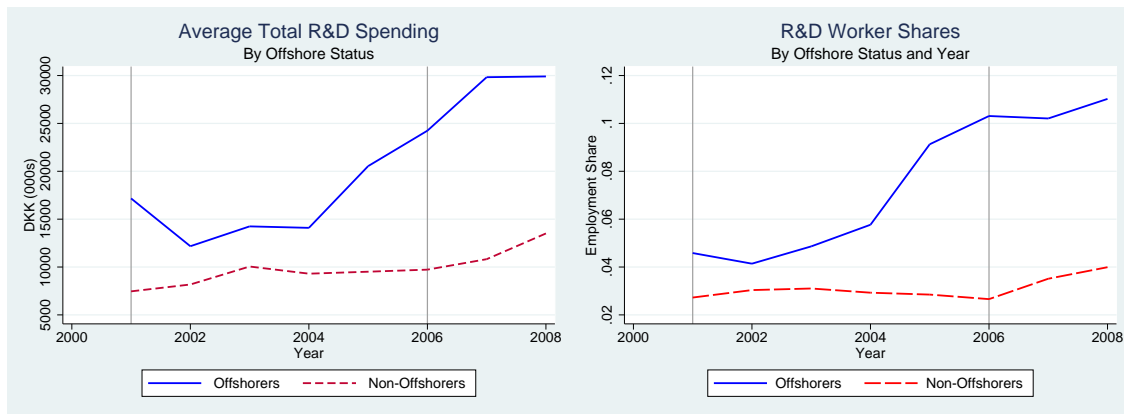
²⁵The share of expenditures shows a comparable divergence starting in 2004, rising from just under 3 to over 4 percent of total expenditures at offshorers.

Figure 11: Share of tech worker stayers by offshore status



Notes: Figure plots the share of continuing technology worker over all continuing workers for firms in the offshoring survey. Offshoring firms are those that relocated their core activity to a foreign country between 2001 and 2006.

Figure 12: Total R&D spending and R&D workers



(a) Total R&D spending

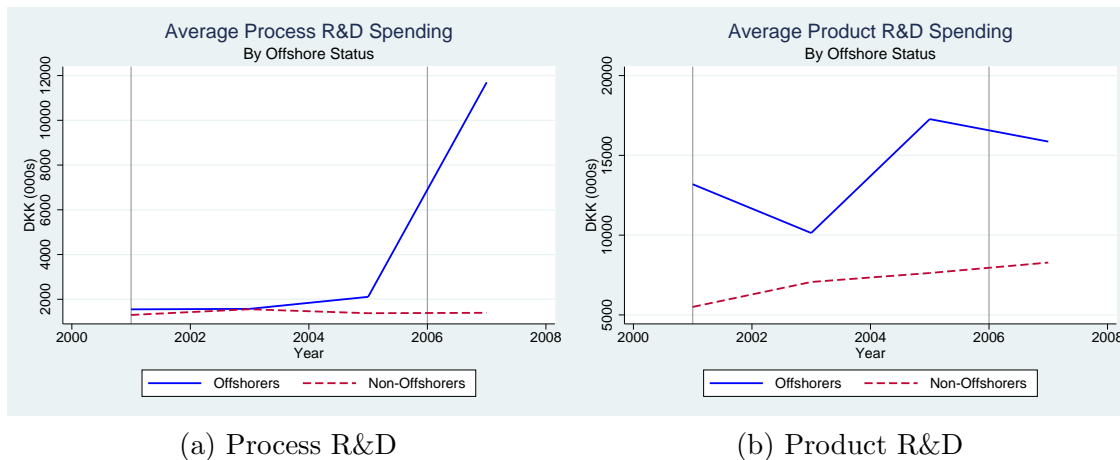
(b) R&D worker share

Notes: Figure plots average product and process R&D expenditure 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.

types of expenditures drive these changes. The survey records process and product R&D expenditures separately every other year. Figure 13 plots firms' average R&D expenditures broken apart by product versus process R&D from 2001 to 2007. The left panel, Figure 13a shows that offshoring firms sharply increase their process innovation spending after 2005.

Non-offshoring firms show little or no process innovation spending throughout the period. This suggests that offshoring entails changes in firms' physical production process which require additional research to implement.

Figure 13: Average product and process R&D expenditure



Notes: Figure plots average product and process R&D expenditure 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.

In contrast, Figure 13b shows that expenditure on product innovation, which is much higher on average than process innovation, rises for offshoring firms towards the end of the offshoring period and stays up in 2007. Non-offshoring firms have much lower levels of product R&D spending and it trends up steadily over the entire period.

This evidence supports the premise that offshoring allows firms to reallocate both workers and financial resources towards innovation, and highlights its potential to increase future growth with the advent of potentially more and better varieties of goods.

7 Conclusion

This paper exploits new information on Danish firms' offshoring to construct a rich dataset on firms' global production decisions. We use these data to analyze how firms' decisions to relocate their primary activities to foreign countries affect not only their aggregate employ-

ment, 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.

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 country are more likely to shift their domestic resources 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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A Data appendix

A.1 Offshoring data details

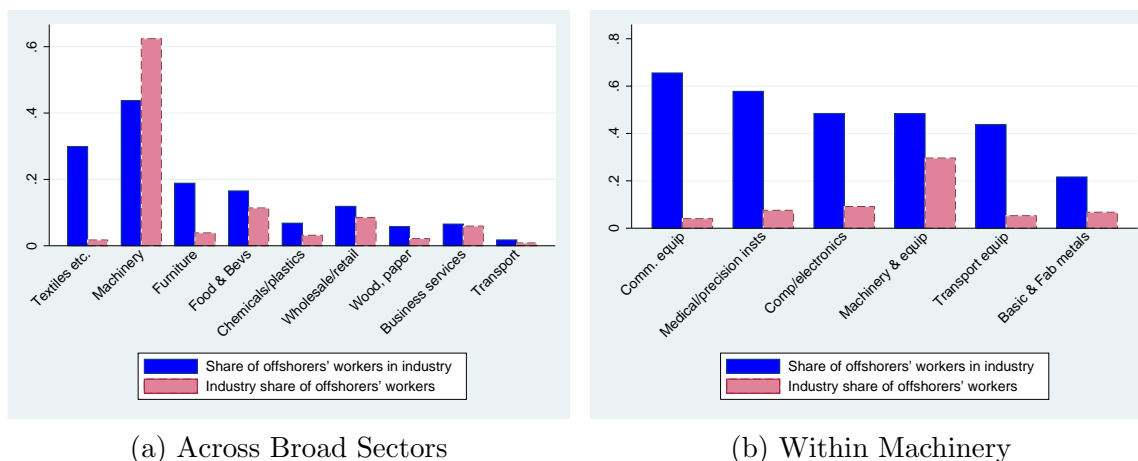
Table A.1 presents all the offshoring location regions to which Danish firms relocate their core activities.

Table A.1: Offshoring of core activity by region

Region	Firm count	Share
EU-12	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: Locations to which firms relocated their core activity.

Figure A.1: Industry distribution of offshoring workers



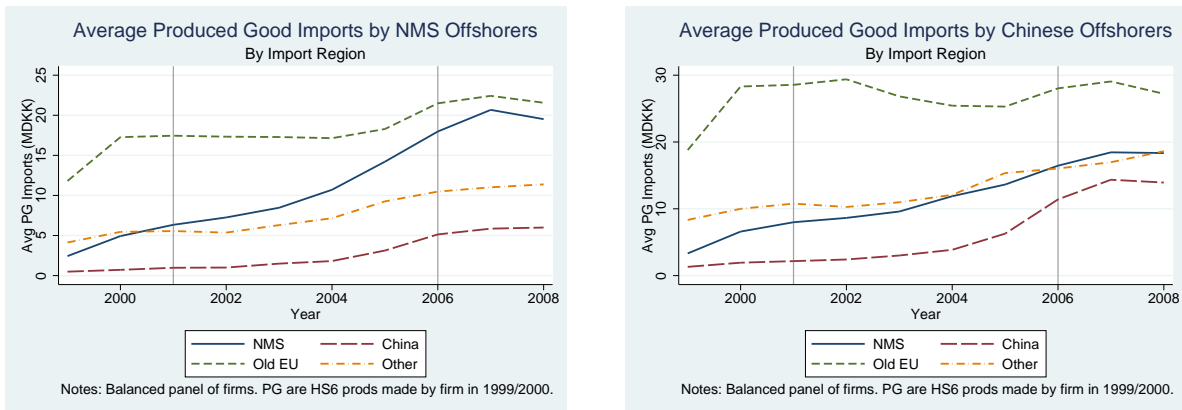
Notes: Figure plots the share of workers at offshoring firms within each industry (first/blue bars) and the share of workers at offshoring firms across industries (second/red bars). Note that the red bars do not sum to 1 since only the top industries are presented to minimize disclosure concerns.

A.2 Imports of produced goods by region

This section decomposes the produced good imports by region of the imports, for firms that offshore to NMS and China. The left panel of Figure A.2 shows that firms that offshore

to the NMS countries between 2001 to 2006 grow their produced good imports from the NMS countries 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, compared both to their produced good imports from other regions, or to non-offshorers' produced good imports which Figure 3 shows is only about 5 MDKK. The right panel of Figure A.2 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 A.2: Average produced good imports by region and offshore status



(a) NMS offshorers

(b) China Offshorers

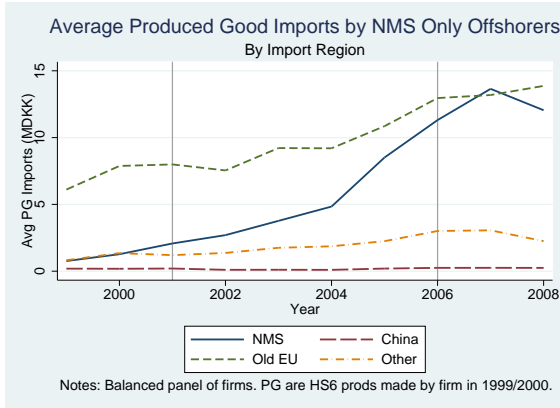
To understand how firms' offshoring decisions may be interrelated across space, Figure A.3 presents similar figures for firms that offshore to NMS but not China and for China, but not the NMS countries. Here, the patterns are more stark. While both sets of firms have high levels of produced good imports 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.3 Imports of produced goods versus intermediates

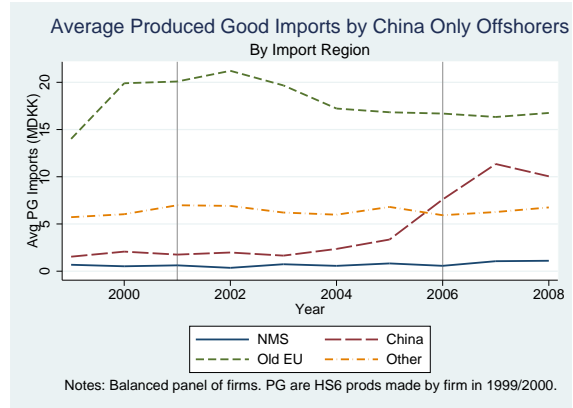
In this section, we use the Prodcom data at the HS4 level and the input purchase data, which are generally available at the HS4 level, to assess the extent to which offshoring firms import inputs and/or domestically produced goods. Figure A.4 shows that firms that offshore to the NMS increase their share of produced good imports, as well as their share of imports of products that they both produce and purchase as inputs ("Both"). In contrast, their share of imported inputs of HS4 products that they do not produce domestically is low and fairly stable.

Given the lack of detail for firms' input purchases, we cannot rule out the possibility that they are importing both inputs and produced goods. It is also possible, however, that

Figure A.3: Average produced good imports by region and offshore status



(a) NMS offshorers



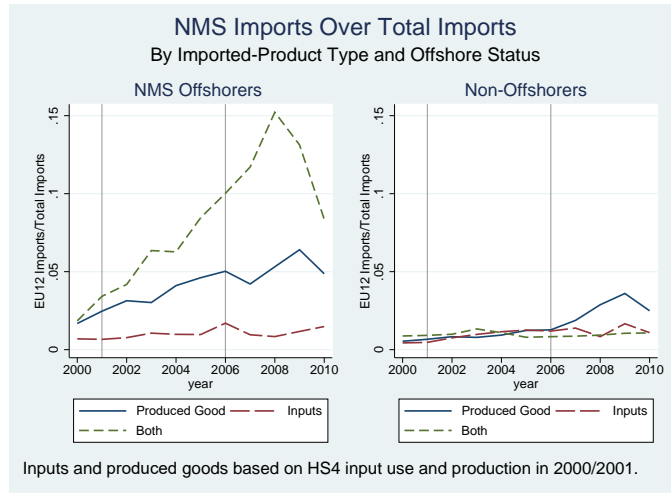
(b) China Offshorers

HS6-level detail on inputs would lead to much smaller shares of imported inputs (whereas the main text shows that firms import the same detailed HS6 products they produce). Given the low share and small changes for imported inputs, it seems that offshoring may be more related to imports of produced goods rather than inputs. Figure A.5 presents similar patterns for firms that offshore to China.

A.4 Offshoring and exporting

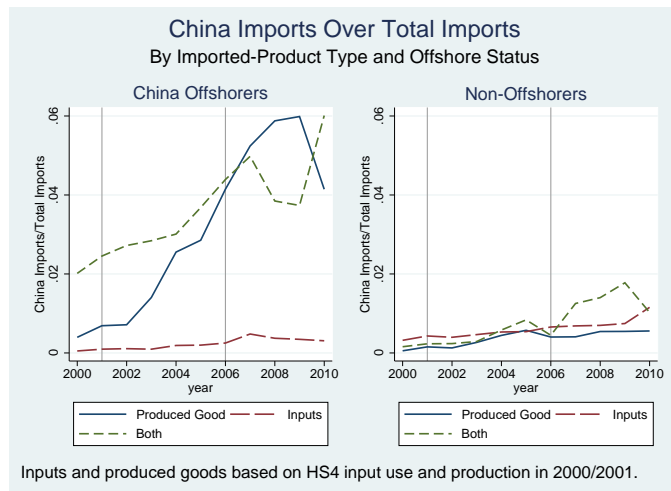
Here we show that offshoring firms shift their exports somewhat towards offshore regions, but that these changes and levels are considerably smaller than the comparable changes observed for firm imports. Offshoring thus seems to entail imports from the offshore location back to Denmark, without considerable exporting of inputs from Denmark to the offshore location. Figure A.6 depicts these patterns.

Figure A.4: NMS imports of inputs and produced goods



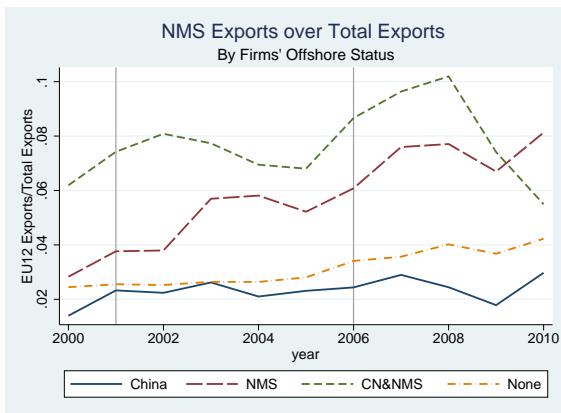
Notes: Figure plots the share of imports from NMS of HS4 products that are “Produced goods”, “Purchased inputs”, or HS4 products classified as “Both” produced goods and purchased inputs over total imports of the firm.

Figure A.5: Chinese imports of inputs and produced goods

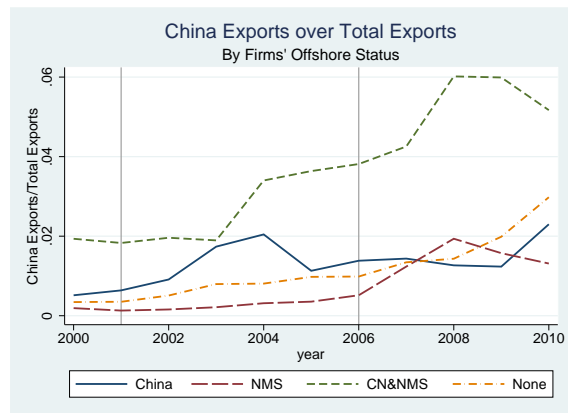


Notes: Figure plots the share of imports from NMS of HS4 products that are “Produced goods”, “Purchased inputs”, or HS4 products classified as “Both” produced goods and purchased inputs over total imports of the firm.

Figure A.6: Exports to offshoring region over total exports



(a) NMS



(b) China