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 lower-quality varieties and focus domestic resources on the development, production, and marketing of higher-quality varieties. Firms' reactions also motivate a new offshoring measure based on 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] Low-wage imports have also been associated with decreased wages, rising inequality, worsening health, and political polarization.[2] Even as manufacturing employment has declined, however, the share of manufacturing real value-added in GDP has been relatively steady. This divergence between manufacturing output and employment may be related to offshoring. In the United States, it is typified by the computer electronics industry, which has experienced dramatic quality improvements boosting its real output even with concurrent growth in Chinese imports (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), increasing innovation (Bloom et al., 2016; Gutiérrez and Philippon, 2017), upgrading quality (Khandelwal, 2010; Hombert and Matray, 2018), or focusing on core products (Bernard et al., 2011). These reactions center on firms changing their domestic activities to escape competition. From a domestic producer's perspective, however, the same changes in trade costs or foreign productivity growth that lead to increased import competition may also present an opportunity to reorganize production processes and lower costs by relocating certain activities abroad.

This paper studies firms' decisions to offshore production to low-wage countries, and the impact of these decisions on domestic production and employment. We exploit a unique Danish survey to show that, after offshoring, firms increase their imports of the same detailed goods they produced domestically. When firms increase these 'produced-good' imports, they shed production workers at home, but increase both the share and level of domestic employment in technology-related occupations. The data also show that most firms continue domestic production of the same goods they import, and that domestic varieties have higher prices that rise after offshoring begins. This reorganization suggests that offshorers reallocate domestic production towards vertically superior varieties, support that production with greater employment in innovation and product-development occupations, and shift production of vertically inferior goods to low-wage economies.

Prior work on offshoring has often relied on imports or foreign affiliate activity to infer firms' production relocation decisions.[3] Using a unique firm-level survey that covers the majority of

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

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

[3] Early work focused on imported inputs at the industry level (Feenstra and Hanson, 1999; 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." Monarch et al. (2017) use Trade Adjustment Assistance petitions to measure offshoring. The most similar analysis is Fort (2017) who shows that US firms that purchase contract manufacturing services offshore import

manufacturing output of the Danish economy, we identify firms that offshore their main activity to both affiliated and unaffiliated firms between 2001 and 2006.[4] The survey shows that 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 collected under the same classification system to analyze precisely how importing and domestic manufacturing evolve after offshoring.

As expected, offshoring firms disproportionately increase their imports from the offshore location. In contrast to the typical assumption that offshoring necessarily entails imported intermediate inputs, however, the data show that offshorers' import growth is concentrated in goods they also produce domestically: 91 percent of their import growth occurs in the same detailed eight-digit Combined Nomenclature (CN8) products that the firm produces in Denmark. Offshorers' imports of goods they never produce fall, not only in shares, but also in levels. By contrast, non-offshorers' imports and import growth are concentrated in products that they never produce domestically. This sharp divergence in the composition of imports forms the basis for our novel firm-by-product (Harmonized System six-digit) measure of offshoring: the share of a firm's produced-good imports from a region in its total imports. This measure is available for all manufacturing firms, has both intensive and extensive-margin variation, controls for overall firm growth, and can be constructed for any region or time period.

The most surprising finding from the linked data is that domestic production at these same offshoring firms does not fall, even as their produced-good imports increase. In fact, offshorers' production of goods they also import rises over the period, while production of goods they do not import falls. This combination of domestic production and importing occurs in detailed (HS6) product categories, and to our knowledge has not been documented elsewhere.

The disproportionate increase in offshoring firms' produced-good imports, and their continued domestic production of the same products, may seem at odds with prior work that defined offshoring as imports of intermediate inputs that the firm sources from the lowest-cost location. However, a broader view of the production process is one in which manufacturing entails not only physical transformation activities, but also design, engineering, product development, marketing, and distribution. Under this view, imports of produced, or "final," goods also capture fragmentation of production, with the pre- and post-production stages occurring in different countries from manufacturing stages. We observe precisely these types of compositional shifts in firm employment: offshoring firms' shares of technology and support workers rise, while production worker shares fall.

To provide causal evidence on the effects of low-wage offshoring, we construct an instrument that captures production-cost savings opportunities for Danish firms in the New Member States of the EU in Eastern Europe (NMS), their main offshoring location. The NMS underwent significant

disproportionately more from low-wage countries, and China in particular.

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

reforms starting in the 1990s as part of the planned EU accession in 2004 and 2007. We measure changes in NMS comparative advantage over this period using (HS6) product-level variation in the region's market share gains in the rest of the world. Since offshorers' import growth is concentrated in products they initially produced, we calculate a firm-specific measure of exposure using the firm's initial period production by product.

Our approach has two key differences from the widely used method introduced in Hummels et al. (2014). First, we reduce the possibility that correlated foreign demand shocks drive our instrument by using changes in NMS market shares, instead of the level growth of exports. Second, because we use a firm's initial production set to allocate those changes, this instrument is available for all manufacturing firms, instead of just for importers based on their prior product-country imports. The instrument thus identifies how changes in firms' production-cost savings opportunities affect firm-level outcomes, and allows us to control for broad sector-level trends and detailed measures of import competition.[5]

The IV results indicate that, 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. Instead, domestic production continues at similar levels, and offshorers reorganize their activities and employment to increase their shares of workers in technology (e.g., R&D and engineering) and support (e.g., customer service) occupations. Reallocation is most pronounced for tech workers, who increase not only in shares but also in levels, and is matched by anecdotal evidence on Danish firms' responses to the integration of Eastern Europe. For example, the Danish pump manufacturer Grundfos, opened two pump manufacturing plants in Hungary in 2000 and 2001, while focusing on developing and producing pumps with new digital monitoring systems at a Danish plant.[6]

We assess the extent to which this type of vertical differentiation is evident in the data. We first show that unit values of imported varieties for the same firm-CN8 product combination are almost 60 percent lower than those for domestic varieties. Consistent with offshoring to low-wage locations to reduce costs, unit values for imports from NMS and China are the lowest. In addition, after the firm begins to import a particular good from NMS or China, its domestic unit value rises even as its quantity falls. These patterns are reminiscent of prior work that shows firms respond to competition by focusing on their core products (Mayer et al., 2014; Bernard et al., 2011), but highlight a new margin of adjustment: offshorers specialize in their core competency goods, but expand their production and vertical scope by manufacturing them in multiple countries. Examples of this vertical differentiation in production are not limited to Denmark. When China joined

[5]While the instrument works well in our setting, it may not predict produced-good import growth for all regions or periods. For example, Chinese market share growth does not predict produced-good import growth into Denmark once we control for Chinese import penetration.

[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`.

the WTO, Cummings offshored production of its low-end diesel engines there, while continuing production of the high-end, turbo diesel engines in the United States. Byrne et al. (2017) provide systematic evidence that firms source production of lower-price and less technologically advanced semiconductors in China relative to the ones produced in Taiwan.

We make three distinct contributions to the literature. First, we add to a large body of work that studies the motives and implications of offshoring. The literature has traditionally defined offshoring as imports of intermediate inputs that the importing manufacturing industry or firm did, or could have, produced domestically.[7] Input trade has received considerable attention since it can lower costs, thus increasing productivity in an offshoring sector or firm (Amiti and Konings, 2007; Grossman and Rossi-Hansberg, 2008; Halpern et al., 2015; Antràs et al., 2017; Blaum et al., 2018; Boehm et al., 2019). A key focus in these papers is fragmentation of the manufacturing process itself, with each input or task produced in the lowest-cost location.[8] Our contribution is to show that offshoring not only entails imports of intermediate inputs into manufacturing, but also includes relocation of the manufacturing stage for a good, with retention, or even expansion, of pre- and post-production stages at home. We show that offshorers both produce domestically and import the same detailed (CN8) products, which corroborates prior use of a firm's imports in its own output industry to measure offshoring as proposed in Hummels et al. (2018), but suggests that it captures imports of "final" goods rather than intermediate inputs. Although export platform models of FDI predict that firms will produce some goods abroad and import them into their domestic market (Tintelnot, 2017), we show that domestic varieties have higher unit values that grow after offshoring begins. These patterns are suggestive of a new motive for offshoring based on vertical differentiation in production, with higher-quality varieties, or those closer to the technology frontier, being produced at home.

We also contribute to a literature that examines the relationship between offshoring and innovation. Prior work finds that R&D and imported inputs are complementary through a scale effect, since both require fixed costs and lead firms to grow (Bøler et al., 2015). The mechanism we document here is different: offshoring firms shrink their aggregate domestic employment, even as they increase workers in innovation-related occupations. Existing theory predicts that offshoring will lead high-wage countries to specialize in pre- and post-production activities (Antràs et al., 2006;

[7]Feenstra and Hanson (1999) first defined offshoring as a four-digit SIC industry's cost share of imported inputs, and introduced a "narrow" definition of offshoring that only includes imported inputs in the same two-digit sector of the industry. Similarly, Hummels et al. (2014) employ a "narrow" definition of offshoring that contains manufacturers' imports of goods in the same HS4 industry of their domestic production. These "narrow" measures aim to capture the relocation of production overseas, or foreign production of goods that could have been manufactured domestically. For example, Feenstra and Hanson explain that a car manufacturer's import steel, that does not capture relocation of their domestic production, while their imports of car parts does. As an extreme example, consider a chocolate manufacturer's imports of cocoa beans. Since cocoa beans cannot be produced in many countries, those imports do not constitute offshoring, even though they are an input into chocolate.

[8]Some models are based on an Armington, love-for-variety, assumption in which domestic versus foreign inputs are imperfect substitutes and more imported varieties lower firm costs. Antràs et al. (2017) show this is isomorphic to the assumption that firms source each input from the lowest-cost location.

Rodríguez-Clare, 2010; Arkolakis et al., 2018). While there is evidence that manufacturing firms have reallocated employment towards more innovation-related occupations in conjunction with rising low-wage imports (Fort et al., 2018; Bloom et al., 2019; Ding et al., 2020), we are one of the first to provide reduced-form, micro evidence that this type of reallocation is a direct consequence of firms' production relocation decisions. Our approach is most similar to Hummels et al. (2014), who show that offshoring increases workers' skill premiums and employment in high-skill, less routine-task occupations. While that paper focuses on worker outcomes, we develop a new instrument to show that offshoring to low-wage countries leads firms to increase employment in technology occupations, and is accompanied by shifts in domestic production towards higher price varieties. Since offshoring models with this type of reallocation predict that it will increase aggregate growth, our findings highlight an overlooked trade-off between the reduction in production worker employment that has been the focus of the literature, versus the increase in innovation occupations that we document here.

Finally, we add to work that studies the relationship between low-wage imports and innovation. Existing papers use changes in industry-level import penetration to document both positive (Bloom et al., 2016) and negative (Autor et al., 2020a) effects on innovation. Those differing results can be rationalized by an "escape competition" motive, with heterogeneous effects depending on where firms lie on the technology frontier (Aghion et al., 2005). Related work finds evidence of a similar escape competition response to imports via vertical differentiation within products (Khandelwal, 2010; Amiti and Khandelwal, 2013; Hombert and Matray, 2018). By contrast, our analysis shows that low-wage imports also reflect an "exploit opportunities" motive: firms relocate production of lower quality or less technologically advanced varieties to low-wage countries, while increasing employment in innovation-related occupations at home and domestic goods' unit values.[9] Prior work has documented systematic differences in unit values across locations (Schott, 2004) and over time (Schott, 2008), but we are one of the first to analyze *within-firm* price differences across locations and over time that relate to firms' low-wage country imports. Given the importance of vertical product expansion for growth (Grossman and Helpman, 1991; Braguinsky et al., 2020), recognizing this "exploit opportunities" channel is crucial not only for modeling the effects of globalization, but also for assessing the implications of policies to tax firms' offshore production.

The rest of the paper proceeds as follows. In Section 2 we describe the new offshoring survey and additional data on imports, output, and employment. Section 3 provides descriptive evidence on offshoring versus non-offshoring firms and their employment composition. We analyze offshorers' imports and domestic production in Section 4, and introduce a new measure of offshoring. In

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

Section 5 we exploit foreign changes in comparative advantage to provide causal evidence on the effects of offshoring on domestic employment and production. Section 6 documents variation in unit values between domestic and imported varieties at the same firm. 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.[10] The Danish survey achieved a response rate of approximately 98 percent, which translates to 4,161 firms.

The survey asked firms about their decisions to relocate, either in part or entirely, nine different business functions: core activity, distribution and logistics, marketing, sales and after sales services (including help desk and call center), ICT services, administrative and management functions, engineering work and other technical services, R&D, facility management (cleaning, security, food, etc...), and other functions. We focus on a firm's decision to offshore its core business activity to a foreign location, the most prevalent form of offshoring.[11] The survey instructions specify that a firm's core activity corresponds to its primary industry classification, and includes only those functions that were previously performed domestically, either by the firm itself or by another domestic firm. The offshoring question specifically excludes foreign activities that are new to the firm, i.e. a foreign subsidiary in a new line of business, which are covered separately.

The specific language in the survey asked firms whether they moved a particular activity to one or more of seven distinct regions.[12] 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;[13] 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

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

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

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

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

core activity to a foreign country, regardless of whether this relocation occurred within or outside the boundary of the firm. In practice, the survey suggests that both integrated and outsourced offshoring are important. Approximately 44 percent of firms that offshored their core activity did so to other foreign companies (with no ownership or less than 50 percent ownership). The remaining offshored to a partner with an ownership relationship.

2.2 Additional data sources

We combine the offshoring survey data with six different data sources on Danish firms and workers. We use the Firm Statistics Register (FirmStat), which is based on Value-Added Tax (VAT) administrative data, to gather information on firm sales, material expenditures, total employees, and industry (six-digit NACE). We use these data, which are available for the population of Danish firms, to construct a firm-level panel from 1998 to 2008.[14]

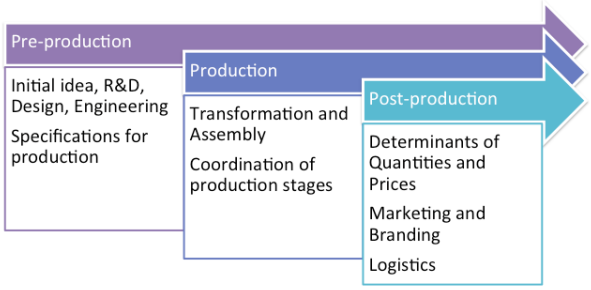
We augment the VAT data with product-level information about the values and quantities of firm production from manufacturing surveys (ProdCom). ProdCom data are available beginning in 1997 and cover all manufacturing firms with at least ten employees. They provide information on manufacturing firms'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

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

We link these data to the Danish Foreign Trade Statistics Register. The trade data are based on Customs declarations and cover all international trade transactions of Danish firms by CN8 product and destination or origin. A significant benefit of the Danish data is that products in the trade data are classified using the *same* CN8 codes as the production data. This is a unique feature of the Danish data that allows us to compare firms' production, imports, and exports at the detailed CN8 level without using any concordances. The CN classification system maps to the Harmonized System (HS) at the six-digit level allowing an easy link to public trade data. We use public data from Comtrade on HS6 exports from NMS to other countries in constructing an instrument in Section 5. We adapt the algorithm developed by Pierce and Schott (2012) to construct consistent HS6 codes from 1996 to 2008.

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

Figure 1: Complete stages of production activities



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

A critical element in our analysis is detailed information about the population of Danish individuals over the period 1998 to 2008 from the matched employer-employee data in the Integrated Database for Labor Market Research (IDA). These data cover the universe of the Danish population aged 15-74, including the unemployed and those outside of the labor force. They provide information on workers' gender, age, experience, tenure, wage, education level, and occupation. Workers are linked to the plant and firm where they are employed.

We use the IDA data to define worker occupation groups. Following Bernard et al. (2017), we exploit the detailed occupation codes to assign workers to seven distinct occupational categories based on what workers do: managers; production workers; technology workers (R&D workers, engineers, programmers, and technicians); support workers (office jobs, data entry, legal work, accounting, customer service); sales workers (sales, financing, and procurement); and other blue collar workers (transportation and warehousing).[15] These categories allow us to map occupations to pre-production, production, and post-production activities, as depicted in Figure 1. Tech workers fit most closely in pre-production stages, production workers in the production stages, while support and sales occupations correspond to post-production stages; other blue collar workers are likely active in both production and post-production stages.

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

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

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 firm employment and imports.

3.1 Offshoring firm activities

We first provide descriptive statistics on the number and industry distribution 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. The majority of these firms are classified in manufacturing industries. The left panel of Figure 2 shows how offshoring firms are distributed across sectors, using the firm's industry in 2001. We present the top 9 offshoring sectors, along with the distribution of non-offshoring firms in each of these sectors for comparison. Machinery is the largest broad manufacturing sector in Denmark and accounts for more than half of all offshorers versus a quarter of non-offshorers.[16] The remaining offshoring firms are spread across other manufacturing services, as well as Wholesale/Retail and Business services, though non-offshorers are more prevalent in those sectors.

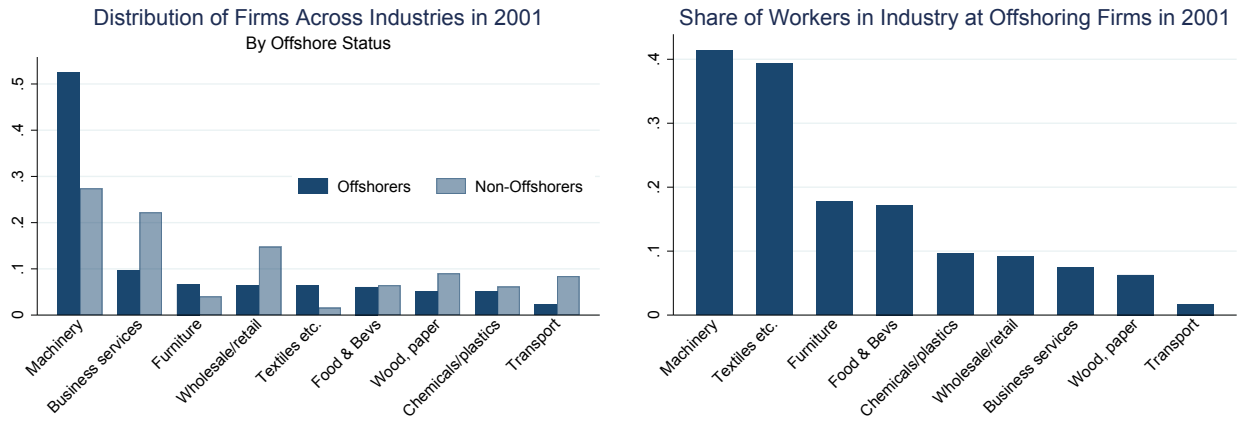
The share of industry employment at offshoring firms is also highest in manufacturing. The right panel of Figure 2 depicts the share of workers within sector at firms that offshore. About 40 percent of workers in the Machinery and Textile and Apparel sectors work at firms that offshore from 2001-2006.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

3.2 Offshoring locations and importing

The offshoring survey also provides information about the locations to which firms offshore. Table 1 breaks out offshoring by destination. Between 2001 to 2006, the majority of offshoring firms relocated their core activity to low-wage countries. The main offshoring destination (54 percent) is the group of 12 New Member States (NMS) that join the European Union (EU) in 2004 or 2007. Approximately one third of these firms also offshored 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 (Appendix Table A.2).

[16] 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: Industry shares of offshoring firms and workers



(a) Offshorers and Non-Offshorers Across Sectors

(b) Offshorers' Worker Shares Within Sectors

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

The shares in Table 1 highlight the importance of low-wage countries in firms' extensive margin offshoring decisions from 2001 to 2006. Offshoring is often equated with importing. To assess the extent to which these firms' offshoring decisions are related to 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.[17]

3.3 Employment and innovation responses at offshoring firms

As discussed in the introduction, prior work has used firm-level data to document negative employment consequences of offshoring, particularly for low-skill workers. The left panel of Figure 3 depicts the weighted average employment for a balanced panel of both offshoring and non-offshoring firms from 1998 to 2008.[18] As expected offshoring firms are much larger than non-offshorers at all points in time. However, over the sample period, offshoring firms reduce their average employment while non-offshorers' average size trends upward, in line with results from other studies including

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

[18]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: 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

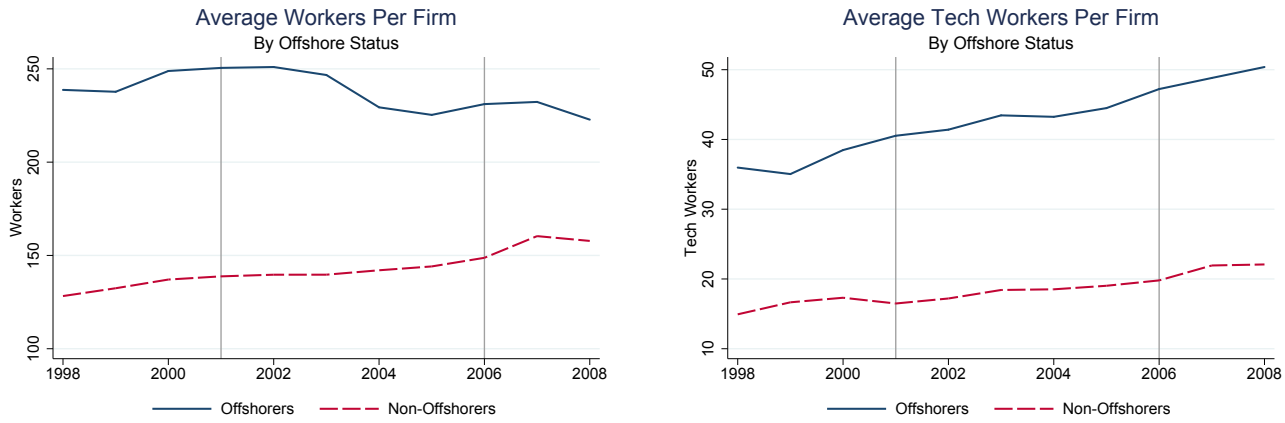
Notes: Table presents the foreign locations to which firms relocated their core activity between 2001 and 2006. "New Member States" count includes all firms that relocate to the 12 NMS (countries that joined the EU in 2004 or 2007), except those that also report relocating to China. "NMS & China" includes 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.

those on Danish manufacturing (e.g., Hummels et al., 2014).

The decline in total employment masks important differences in the levels and changes of employment composition across occupations at offshoring versus non-offshoring firms. Table 2 presents weighted average employment shares across seven occupation categories over the period 1998 to 2008. We focus on the seven occupation categories described in Section 2.2: managers, technology, support work, sales, production work, and other blue collar. To control for industry compositional differences evident in Figure 2, we divide a firm's employment share in a category by the average employment share in the firm's primary two-digit NACE industry. A value of 1.0 indicates that the firm-level average is equal to the industry-level average.

There 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 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 1.

Figure 3: Employment differences by firms' offshore status



(a) All Workers

(b) Tech Workers

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.

It is possible that the rising share of tech workers at offshoring firms is due to their falling total employment. The right panel of Figure 3 plots the average number of tech workers by firms' offshore status. In contrast to total employment declines at offshorers, the average number of tech workers grows throughout the offshoring period. Offshorers' reorientation towards technology activities is a combination of rising employment in innovation-related occupations and a reduction in production workers.

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 with declining total employment, especially of production workers, and rising shares and levels of tech workers. While these patterns are consistent with offshoring causing firms to reorient their domestic workforce towards innovation, both offshoring and reorganization are endogenous decisions of the firm, so they do not establish a causal link. In Section 5 we implement a new IV strategy to 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 and import transactions data to detailed information on firms' domestic production activities.

4 Production and Imports by Offshoring Firms

In this section, we link the offshoring survey to firms' sales, production, input purchases, and trade flows to analyze how each of these activities evolves after offshoring. We show that offshoring involves imports of the same goods that firms were producing and continue to produce domestically,

Table 2: Employment type

Relative worker occupation shares by offshore status

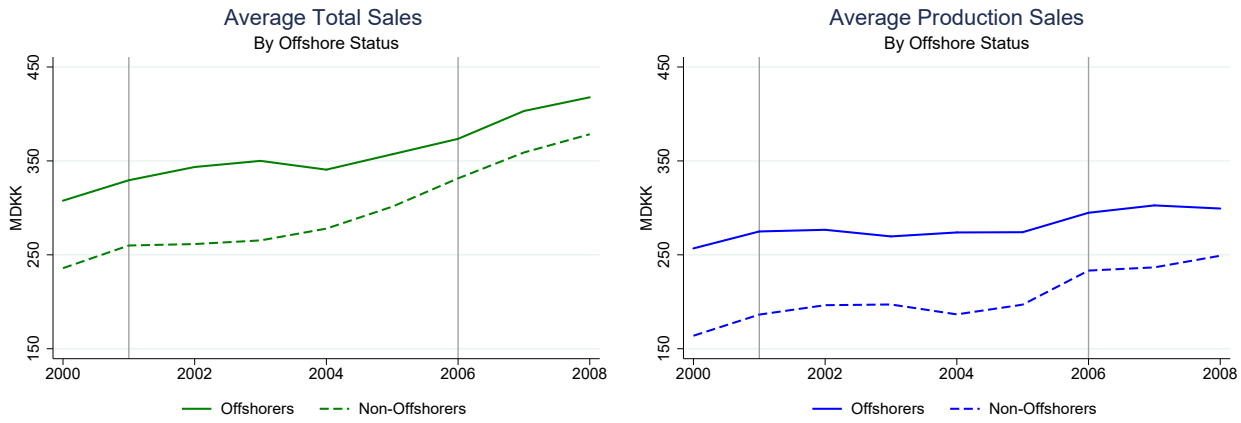
Panel A: Offshoring firms	1998	2001	2006	2008
Production workers	1.10	1.07	0.96	0.88
Other blue collar	0.83	0.89	0.71	0.73
Tech workers	**1.26**	**1.26**	**1.36**	**1.45**
Support workers	0.92	0.95	1.02	1.08
Sales workers	0.92	0.93	0.99	0.98
Managers	0.87	0.87	0.96	1.00
NEC	0.78	0.72	0.78	0.70
Panel 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. Production workers include a wide range of production activities across sectors; "Other blue collar" workers include transportation and warehousing jobs; Tech workers include R&D workers, engineers, programmers, and technicians; Support workers include office jobs, data entry, legal work, accounting, customer service; Sales workers include sales, financing, and procurement. Offshoring firms report relocating their primary activity to new foreign locations between 2001 to 2006, while non-offshorers do not. Sample is a balanced panel of firms in the offshoring survey that exist from 1998 to 2008.

and that these produced-good imports seem distinct from the canonical view that offshoring necessarily entails imports of intermediate inputs.[19] We then introduce a new measure of offshoring based on these facts which can be constructed at the product level and would be available to researchers even without a direct offshoring survey. In contrast to the analysis above, in this section we limit the sample to firms in ProdCom so that we can identify their domestic manufacturing activity.

[19] As discussed in the introduction, produced-good imports, or imports of goods that are "final" from the perspective of the firm can also considered inputs when using a broad perspective of production that includes pre- and post-manufacturing stages. This is quite different from many current approaches.

Figure 4: Firm sales and production by offshore status



Notes: Figure presents the weighted-average of firm sales in millions of Danish kroner. Left panel depicts total sales from VAT data. Right panel depicts ProdCom "sales of own goods," (*i.e.*, goods produced by the firm). VAT sales are larger than ProdCom since they include firms' non-manufacturing activity, commercial resales, and other sales, as well as sales by firms that exit ProdCom over the period. Offshoring firms are those that report locating their core activity to new locations between 2001 to 2006. Sample is a balanced panel of firms in the offshoring survey that exist from 2000 to 2008 and report production in ProdCom in at least one of these years. There are 257 offshoring firms and 1308 non-offshorers.

4.1 Sales, production, and imports after offshoring

We examine how firm sales and domestic production change over the offshoring period by using VAT data on total firm sales and ProdCom data on manufactured goods sales. We focus on the ProdCom category of "Own Goods" since it covers sales of domestic production by the firm and explicitly excludes imports.[20] The sample is a balanced panel of firms in the offshoring survey that are *ever* in ProdCom from 1999 to 2008, including firms that enter or exit ProdCom over the period. Thus the sample captures changes in offshoring firms' production activities, even for firms that exit manufacturing.

Figure 4 shows total VAT sales and sales of domestically produced goods for both offshorers and non-offshorers during the offshoring period. The left panel depicts the weighted-average of firms' total sales, which rise throughout the period for both types of firms despite the declining employment at offshorers shown in Figure 3. The growth in sales, even as employment falls, is consistent with offshoring models' predictions that lower production costs will enable offshorers to grow, even as foreign employment substitutes for domestic employment.[21]

Domestic production of goods, the largest component of total sales (70-83%), is shown in the

[20] Online Appendix Figure B.2 depicts all sales reported in Prodcom, by firm offshoring status and type of sale. Domestic sales of goods that the firm imports and then repackages are included in a separate category, Commercial Resales, which comprises approximately 7 percent of firms' total sales.

[21] Grossman and Rossi-Hansberg (2008) emphasize the idea of a "productivity" effect in which lower costs may lead an offshoring sector to grow more than enough to compensate for its substitution of domestic employment. The positive effect of lower costs on firm sales is also a feature of firm-level offshoring models (e.g., Antràs et al., 2017; Boehm et al., 2019).

right panel of Figure 4. Production sales are about a quarter smaller than total sales on average because VAT sales include non-manufacturing sales, as well as sales by firms that exit ProdCom. Even as offshoring firms are substantially reducing total employment, and production workers in particular, production sales do not fall. The resilience of offshorers' domestic production sales indicates that they are not "hollowing out" to become mere conduits of imports (e.g., wholesalers). Instead, offshoring is coupled with continued domestic production.[22]

To understand the details of offshorers' rising sales and imports and their stable domestic production, we combine product-level information on manufacturing output and imports. A unique feature of the Danish data is that production and imports are collected under the same product classification system at the eight-digit level in the Combined Nomenclature (CN8). This enables us to make direct comparisons of production and imports for very detailed products without the need to concord across systems. We use these data to identify all six-digit (HS6) goods that the firm produces prior to the offshoring period, i.e., in 1999 and or in 2000.[23] We also identify all HS6 goods that the firm produces in each subsequent year t (where $2001 \leq t \leq 2008$), and all goods that it imports in each subsequent year t.

We emphasize two main messages from these data, one on domestic production and one on imports. First, the left panel of Figure 5 shows that production of goods that the firm also imports in that year comprises the vast majority of domestic production at all firms, and rises in importance for offshorers. Offshorers' production share of these produced-and-imported goods increases over the offshoring period (72 to 84 percent), while it remains constant at non-offshorers (71 percent). Second, the right panel of Figure 5 depicts a stark divergence in the composition of offshoring firms' imports. Imports of goods that the firm ever produced (in the pre-period and or in the import year) rise substantially in importance for offshorers, from 40 to 57 percent, whereas they are flat for non-offshorers.

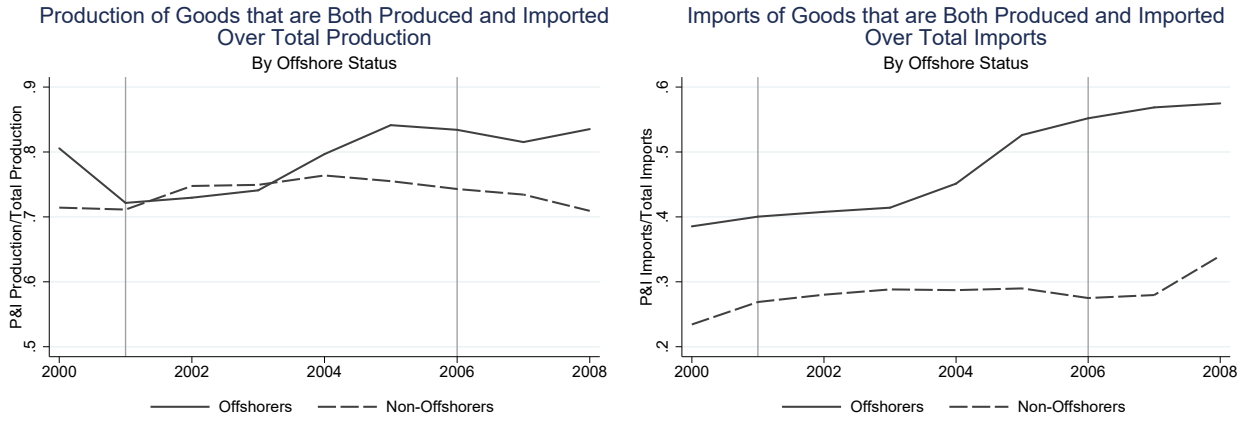
Figure 5 shows that firms produce and import the same goods. This combination of domestic production and importing occurs in detailed (HS6) product categories and to our knowledge has not been documented elsewhere. In addition, both production and imports of these produced-and-imported goods grow in importance for offshoring firms, while they remain constant shares at non-offshorers. These patterns are at odds with the premise that imports replace domestic production, and instead suggest that offshorers specialize in their comparative advantage goods by producing them in multiple countries.

While Figure 5 illustrates the distinct compositional shifts in offshorers' production and imports,

[22]There is net exit from ProdCom by offshorers from 238 in 2000 to 223 by 2008, which accounts for the flattening of ProdCom sales in this group (Online Appendix Figure A.3). The number of non-offshoring firms rises slightly from 1,150 to 1,171.

[23]We use two years of data to account for the lumpiness of some types production. We perform the main analysis at the HS6 level to allow for comparability as most researchers have access to data at the HS6 level, and because the instrument used in Section 5 relies on trade data only available at the HS6 level. We show that the difference between using HS6 and CN8 levels is quite small in Section 4.3.

Figure 5: Imports and production of produced-and-imported goods, by firm offshore status



Notes: Left panel presents production of HS6 goods that the firm both produces and imports over total production. Right panel presents imports of HS6 goods that the firm both imports and produces (in the import year and or prior to 2001) over total imports. Offshoring firms are those that report locating their core activity to new locations between 2001 to 2006. Sample is a balanced panel of firms in the offshoring survey that exist from 2000 to 2008 and report production in ProdCom in at least one of these years. There are 257 offshoring firms and 1308 non-offshorers.

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

Table 3 reports weighted averages of firms' production and imports at the beginning and end of the offshoring period for the six categories of firm-products. The first 3 rows in each panel correspond to HS6 goods the firm imports and ever produces, and provide further evidence on the importance of these produced-and-imported goods for offshoring firms.[24] On the production side, offshorers' domestic production of produced-and-imported goods rises in levels, with HS6 products in both the prior and current set (row 1) dominating in importance. Offshorers' production of non-imported goods actually *decreases* substantially over the period (rows 5 and 6). By contrast, non-offshorers grow their production of imported and non-imported HS6 goods. On the import

[24]These rows 1-3 correspond to the shares depicted in Figure 5.

Table 3: Average production and imports by HS6 good production and import status, and by firm offshore status

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

Notes: Table presents the weighted-average of firm production and imports in millions of Danish kroner by HS6 good import and production status by year. "Production (1999-2000)" indicates whether goods were produced by the firm in 1999 and or 2000 (prior to offshoring); "Production (t)" indicates whether goods are produced by the firm in year t; "Imports (t)" indicates whether goods are imported by the firm in year t. Rows labeled 1 and 2 therefore capture goods that are both produced and imported by the firm in the same year. Sample is a balanced panel of firms in the offshoring survey that exist from 2000 to 2008 and report production in ProdCom in at least one of these years. There are 257 offshoring firms and 1308 non-offshorers.

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

The stark difference in the changing composition of imports between the two types of firms forms the basis for our novel offshoring measure. Most notable is import growth of HS6 products that firms produced prior to the offshoring period: these rise from 39 to 50 percent for offshorers, but fall from 26 to 24 percent for non-offshorers.[25] In Section 5, we exploit variation in a firm's

[25]These imports are in rows 1 and 3. For offshorers, they are ((26+3)/75)= 0.39 in 2001 and ((39+12)/100)= 0.50

prior production set to identify new offshoring opportunities that vary within sector but across firms. Before that, we address potential data concerns about measuring produced-good imports and production, and show that produced-good imports from a region are a strong predictor of offshoring to that region.

4.2 Additional details on the data

In this section, we address two potential concerns about the production and import data. Table 3 highlights the importance of produced-good imports for offshoring firms, both in terms of growth and levels. One potential question that arises is why offshorers' imports of produced-goods are considerably higher than non-offshorers' *before* offshoring begins? This is mainly due to the fact that offshorers import produced goods from the original EU member countries prior to 2001. In Appendix Figure B.3, we show that the aggregate produced-good import growth depicted in Table 3 is driven by firms' imports from the new regions to which they offshore, i.e., China and the NMS. This motivates our use of the share of produced-good imports from a particular region as a new measure of offshoring to that region.

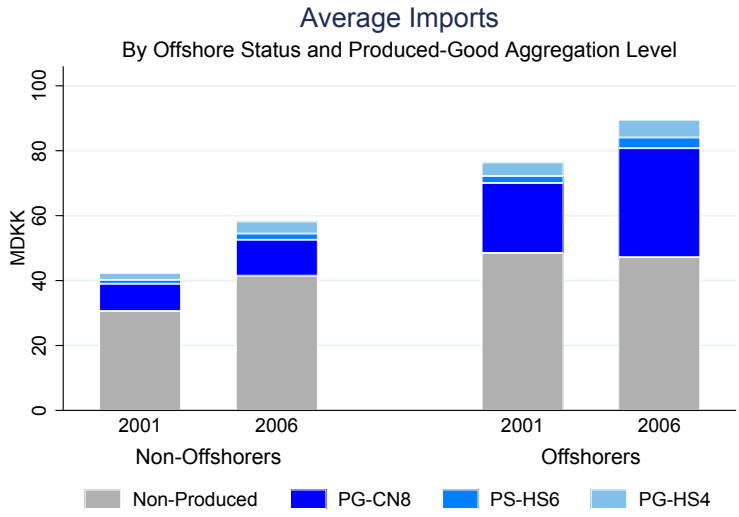
A potential data concern about our measure of produced-good imports is whether Danish firms may be importing HS6 products and then relabeling them as goods manufactured by the firm. To avoid this problem, we restrict our measure of domestic production to ProdCom's "Own Sales" variable. This category contains only manufactured goods – it explicitly excludes traded goods and resales, which are collected separately under "Commercial Resales." Moreover, the value of offshorers' "Own Sales" is over five times greater than their imports of the same goods (Table 3, row 1), indicating that if imports were being relabeled as production, they would be subject to implausibly high markups. Finally, in Section 6 we use an event study framework to show that firms increase the domestic unit values of CN8 products after they import them, but decrease their quantities. If firms were relabeling imports as domestic production, we would expect the domestic and imported quantities of a particular product to evolve similarly, yet they move in opposite directions: domestic quantities fall after offshoring, while import quantities rise (Figures 8 and D.1).

4.3 Produced-good versus intermediate inputs

In this subsection, we exploit more detailed product-level data and a new input survey to analyze how produced-good imports relate to imports of intermediate inputs. The literature has traditionally defined offshoring as imports of intermediate inputs that the importing manufacturing industry or firm had, or could have, produced domestically. To identify these imported inputs, much work has focused on imports of inputs within the offshoring industry or firm's domestic production sec-

in 2006. For non-offshorers, they are ((10+1)/42)= 0.26 in 2001 and ((12+2)/59)= 0.24 in 2006.

Figure 6: Imports by goods' domestic production status and aggregation level, and firm offshore status



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

tor. Most recently, Hummels et al. (2018) propose a "narrow" definition of offshoring that consists of a manufacturer's imports of goods in the same HS4 industry as its domestic production. The rationale for this approach comes from the well-established fact that the diagonal elements of the I-O matrix are quite important (i.e., an industry typically uses other products from the same industry as inputs), and because it seems likely that a firm could have produced inputs within its domestic output sector.

We argue that imports of produced-goods are conceptually different from intermediate inputs, and that using HS6, or even more detailed CN8, goods produced by the firm decreases confusion between outputs and inputs. An HS4 industry often contains one or more distinct HS6 products labeled as "Parts" (see Appendix B.3 for examples). In this sense, imports of goods in an HS4 industry of the firm's domestic production may capture some of its inputs as well as some of its produced goods. However, as shown in the appendix examples, the more detailed HS6 or CN8 products are less likely to include both the good and its constituent components. We exploit the CN8 product-level data to assess prior offshoring measures based on HS4 aggregation, as well as our HS6 aggregation above.

Figure 6 decomposes firm imports into goods that the firm did not produce in the same year and goods that it both produced domestically and imported in that year. The latter category is created

at three levels of aggregation: produced-imported that are the same at the CN8 level (PG-CN8), those that are the same only at the HS6 level (PG-HS6), and those that are the same only at the HS4 level (PG-HS4).[26] Figure 6 shows that the vast majority (91 percent) of offshorers' import *growth* from 2001 to 2006 is driven by CN8 products that the firm both produces and imports in the same year; and that most HS4 produced-good imports are produced and imported at the CN8 level (79 percent in 2006). A growing number of papers uses imports of goods in the firm's HS4 output sector as a measure of offshoring and interprets their results as evidence of the effects of imported inputs.[27] We concur with Hummels et al. (2018) that these imports capture the relocation of production abroad, but offer caution that HS4 imports may be less likely to contain intermediate inputs and instead consist of similar manufactured output that offshoring firms produce at home.

Finally, in Appendix Section B.4 we exploit a new input purchase survey to analyze how firms' imports of inputs evolve after offshoring. The survey contains information on firms' input purchases by HS4 industry. We flag all products in HS4 sectors for which the firm reports purchasing inputs as imported inputs, and then separate these imported imports into goods that the firm produces at the CN8 level, those that it produces only at the HS4 level, and those that it does not produce at all. We stress two main results from this analysis. First, offshorers' share of imported inputs that the firm does not also produce falls over the period, from 33 percent in 2001 to 28 percent in 2008. By contrast, this share is a constant 37 percent for non-offshorers. Second, offshorers' share of imports that it both purchases as inputs and produces rises dramatically from 29 to 44 percent over the period, while it is flat at 17 percent for non-offshorers. However, consistent with our results above, the vast majority of this growth – about 90 percent – is of goods that the offshorer also produces at the CN8 level.

In sum, imports of inputs that the firm does not produce fall in importance after firms relocate production, whereas imports of the same detailed goods they manufacture domestically rise. While we cannot rule out the possibility that firms use some of these produced-good imports as inputs, the data clearly indicate that they are importing goods in the same detailed categories that they produce and sell to other firms at home. This fact contrasts with the canonical view that offshoring necessarily entails locating different stages of the manufacturing process in different countries. Instead, and consistent with the descriptive patterns we document in Section 3, offshorers may replicate similar manufacturing stages across countries and reorganize their domestic activities towards pre- and post- production stages such as innovation. In the next section, we provide causal evidence on how new offshoring opportunities lead to precisely this type of reallocation.

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

[27] See, for example, Olney and Pozzoli (2021); Ghose and Wang (2021).

4.4 Produced-good import measure of offshoring

We conclude this section by introducing a new product-level measure of offshoring to a region: the ratio of a firm's imports of produced-imported HS6 goods from that region to its total imports. This measure captures the main source of offshoring firms' import growth (in our sample), is available for all years and firms with production and trade data, and is not driven by firm-level shocks that scale with total import growth. In the next section, we exploit this detailed product-level measure to estimate the causal impact of offshoring on firms' employment, production, and workforce composition. 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 a firm reports offshoring to a region in the survey, as a function of the change in its produced-good import share. Specifically, we estimate:

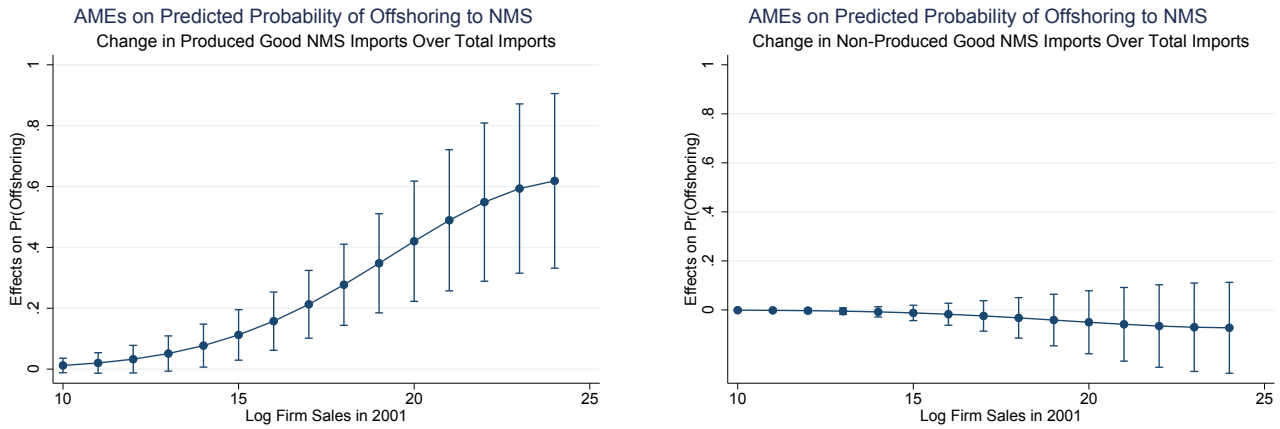
$$Pr(\Delta Off_f^{NMS} = 1|X_f) = \alpha + \beta_{PG}\Delta\frac{PG\ Imports_f^{NMS}}{Imports_f} + \beta_s log(sales_f^{2001}) + Ind_f, \qquad (1)$$

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 A.6.

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

The attributes of the Danish offshoring survey, production data, and input survey provide new insights about how firms' domestic activities evolve after offshoring. Our results on production and imports are surprising. Instead of reducing domestic output and importing more intermediates, most offshoring firms increase production of the same goods they import. These findings from the offshoring survey underpin a new measure 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 all manufacturing firms in Denmark over a longer time horizon.

Figure 7: Offshoring and Produced-Good Imports



(a) Produced good import share

(b) Non-Produced good import share

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

5 Causal Impact of Offshoring

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. As in Section 4, this analysis is limited to firms that manufacture goods, though our new measure of produced-good imports allows us to expand beyond the firms and time period included in the offshoring survey.

5.1 Identification strategy

We analyze the impact of offshoring to the New Member States (NMS), firms' main offshoring location, 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 the

NMS 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 our full panel from 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 of produced-good imports rather than levels is we might understate offshoring for firms that only grow their imports of produced-goods. We use the share approach since it captures the changing composition of offshorers' imports documented in Section 4, controls for any aggregate shock to the firm that increases all imports, and is more likely to bias the 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 in order to reorganize its domestic workforce. Omitted variables may bias the OLS estimates in either direction. For example, firms may offshore in response to import competition, which itself may decrease firm employment, thus biasing down the OLS estimates on offshoring. Although we control directly for import competition in robustness checks, other shocks that affect offshoring and employment 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 NMS by exploiting changes in that region's 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 required to join the European Union (EU) in 2004 and 2007. These internal changes led to large shifts in the composition of their exports, and the five-year changes provide a strong first stage in predicting firms' produced-good import shares. An increase of the export share by NMS to the rest of the world (ROW), excluding Denmark, signals increasing NMS comparative advantage.[28]

This measure of foreign exposure differs from those used in Autor et al. (2013) and Hummels et al. (2014), since we follow Antràs et al. (2017) and use changes in NMS export shares to the ROW rather than level growth in their exports to third markets. This reduces the possibility that growth in the instrument is driven by aggregate demand or technology shocks that increase exports

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

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.

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

$$Shock_f^{NMS} = \sum_{p \in f} ProdShare_{fpt_0} \times \underbrace{\Delta \frac{Exports_p^{NMS}}{Exports_p^{World}}}_{\substack{\text{NMS comparative} \\ \text{advantage growth}}}, \tag{3}$$

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 these export shares and lag the shares by two years to reduce the possibility of Danish firms' offshoring decisions driving NMS export shares.[29]

Relative to the widely used identification strategy first developed in Hummels et al. (2014), in which a firm's exposure to other countries is limited to prior imports in particular country-product pairs, this measure is available for all manufacturing firms. It assumes that firms initially producing goods in which newly globalizing low-income countries have comparative advantage will be best-suited to exploit those countries as new low-wage production locations. Our approach thus captures 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.

One concern with this approach is that firms within industries may not differ in their product mix. We document 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.[30]

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

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

Using the firm-specific offshoring shock defined in equation (3), our first-stage regression is

$$\Delta \frac{PG\ Imports_f^{NMS}}{Imports_f} = \alpha + \beta_{Shock} Shock_f^{NMS} + Ind_{ft} + \varepsilon_f, \tag{4}$$

where we predict changes in a firm's produced-good import share from NMS as a function of changing comparative advantage in that region in the mix of products that the firm made in the pre-period. The key identifying assumption is that NMS market share gains in a product are due to increased NMS productivity or decreased trade costs. The exclusion restriction requires that improvements in NMS comparative advantage in a firm's products only affect the firm's domestic activities through the offshoring decision. By including two-digit sector fixed effects, we control for broad industry trends in a manner that is not feasible with more aggregated measures of offshoring, and that addresses many concerns about correlated industry-level demand and technology shocks biasing the results.

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

$$\Delta ImpPen_f^{Source} = \sum_{p \in f} ProdShare_{fpt_0} \times \Delta \frac{Imports_{DKp}^{Source}}{Imports_{DKp}^{World} + DomProd_{DKp}}, \tag{5}$$

where the source regions are NMS and China, respectively, $Imports_{DKp}$ are imports of product p into Denmark, and $DomProd_{DKp}$ is Danish production of product p. We exclude each firm's own imports and production when calculating its import penetration measure. As when constructing the instrument, we weight changes in product-level import penetration using the firm's initial-period production across products. Directly controlling for these measures of import competition does not materially affect our first stage estimates, and we present robustness analyses of the reduced-form and second stage estimates with these controls in Table 7 and Appendix Table C.4. Our analysis therefore shows the effect of new offshoring opportunities, netting out any potential role for import competition.

Table 4: First Stage Estimates

Dependent variable is $\Delta PG\ ImpSh_f^{NMS}$				
	(1)	(2)	(3)	(4)
$\Delta ExportSh_f^{NMS}$	0.361***	0.333***	0.362***	0.334***
	(0.120)	(0.115)	(0.121)	(0.116)
$\Delta ImpPen_f^{NMS}$		0.183**		0.186**
		(0.077)		(0.076)
$\Delta ImpPen_f^{China}$			0.022	0.043
			(0.139)	(0.136)
KP-Fstat	8.995	8.303	9.005	8.278
Observations	5,160	5,160	5,160	5,160

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

5.2 Results

Results from the first stage estimation for two stacked five-year differences for 1998 to 2008 are presented in Table 4. Changes in the firm's product-weighted NMS export shares are positively and significantly correlated with changes in its share of produced-good imports from the NMS. This relationship holds even after controlling for import penetration from China and the NMS. Reassuringly, the coefficient estimate is relatively stable across all specifications, suggesting that import competition from the NMS into Denmark is sufficiently different from Danish offshoring to NMS to identify its effect. Since the instrument is constructed from product-level shocks, we cluster the standard errors by two-digit HS sectors. The Kleibergen-Paap F-Statistic in our baseline specification (Column 1) is of reasonable magnitude, at 9.0.[31] To address potential concerns about weak instruments, we also report the reduced-form estimates and the Anderson-Rubin Chi-squared statistic in all the two-stage least squares (2SLS) estimates.

Table 5 contains the main results on the effects of offshoring on the organization of the firm.

[31] As a comparison, the first-stage F-statistics reported by Hummels et al. (2014) when instrumenting for offshoring and controlling for firm-level characteristics were slightly lower.

Table 5: Firm Outcomes - Output, Employment and Workforce Composition

A: OLS	Δ log Emp	Δ log Production	Δ Share of Workers in Tech	Support	Production
$\Delta PG\ ImpSh_f^{NMS}$	-0.192***	0.000	0.020**	0.040***	-0.070***
	(0.072)	(0.090)	(0.008)	(0.009)	(0.015)
R^2	0.04	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)
R^2	0.04	0.07	0.03	0.04	0.05
C: IV Estimates					
$\Delta PG\ ImpSh_f^{NMS}$	-2.022*	-0.129	0.215**	0.243*	-0.589**
	(1.168)	(2.665)	(0.099)	(0.140)	(0.257)
KP-Fstat	8.995	8.995	8.995	8.995	8.995
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: Dependent variables are the change in the firm outcome noted in column headers. $\Delta PG\ ImpSh_f^{NMS}$ is the change in the firm's produced-good import share from NMS, based on the firm's initial-period domestic production. $\Delta ExportSh_f^{NMS}$ is a firm-specific weighted average of the change in NMS market shares by product in ROW, based on the firm's initial-period domestic production shares. Panel C uses $\Delta ExportSh_f^{NMS}$ as an instrument. Two stacked five year differences for 1998 - 2008. Regressions are weighted by initial employment and include industry (NACE2) and year fixed effects. Standard errors in panels B and C clustered by HS2 sector. * p<0.10, ** p<0.05, *** p<0.01.

We report results from estimating equation (2) via OLS, 2SLS, and 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.

Consistent with the descriptive evidence from 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, also in line with the survey results, there is no significant reduction in domestic production. These results provide a potential explanation for the divergence between output and employment in certain industries with large import penetration increases, such as computers and electronics in the United States. Manufacturing employment declines as the firm exploits low-cost production opportunities overseas, imports produced-goods from those countries, and reorients its domestic activities towards pre- and post-production stages (see Fort et al., 2018; Bloom et al., 2019, for evidence consistent with this type of reorientation by US manufacturing

Table 6: Firm Outcomes - Growth Rates and Switchers

A: OLS	Growth Rate of Workers in			Δ Share
	Tech	Support	Production	Tech Switchers
$\Delta PG\ ImpSh_f^{NMS}$	0.038	0.058	-0.221***	0.001
	(0.097)	(0.076)	(0.065)	(0.003)
R^2	0.02	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)
R^2	0.02	0.04	0.06	0.06
C: IV Estimates				
$\Delta PG\ ImpSh_f^{NMS}$	2.473*	0.078	-2.863**	0.086*
	(1.429)	(1.295)	(1.298)	(0.051)
KP-Fstat	8.995	8.995	8.995	8.995
AR Chi-sq P-val	0.02	0.95	0.01	0.04
Observations	5,160	5,160	5,160	5,160

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

firms).

The effects of offshoring on the reorganization of 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 one percentage point increase in the share of produced-good imports leads to a 0.22 point increase in the share of tech workers. The average tech worker share increase over this period was only 0.01 points, so this is an economically large effect. That same increase in offshoring leads to a 0.59 point decline in the production worker share. Offshoring firms are not merely shrinking at home, they are changing what they do. These offshoring firms are reorganizing themselves to focus on non-manufacturing aspects of value-added creation by focusing on pre-production and post-production stages as shown in Figure 1.

In Table 6, we examine growth rates in levels of the three types of workers to assess whether

the growth in non-production worker shares is driven solely by falling total employment. We follow Davis et al. (1998) and define growth rates of worker types as $\frac{(Occup_{f,t+5}-Occup_{f,t})}{0.5(Occup_{f,t+5}+Occup_{f,t})}$ 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 within the firm. The final column of Table 6 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 one percentage point increase in offshoring leads to 0.031 point increase in the share of tech switchers. Since the average change in the share of these switchers is only 0.0004, this is an economically large effect, and highlights an important role for the firm in facilitating reallocation. Offshorers both hire new tech workers and shift existing workers into tech occupations.

5.3 Robustness

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

Table 7 presents robustness of the reduced-form estimates, which we focus on here to avoid any concerns about coefficient bias due to weak instruments. The IV estimates are similarly robust (Appendix Table C.4). The estimated coefficients on NMS offshoring opportunities are unchanged in sign, significance, and magnitude. Offshoring reduces firm employment with no effect on domestic production. Within the firm, the shares of tech and support workers rise, while the number and share of production workers falls. The estimated coefficient on NMS import competition is negative (though insignificant) for both tech worker shares and levels. Not surprisingly, increased import

Table 7: Robustness of the Reduced Form Estimates

	Δ log Emp	Δ log Production	Δ Share of Workers in Tech	Support	Production
$\Delta ExportSh_f^{NMS}$	-0.829**	-0.024	0.087**	0.101*	-0.234***
	(0.331)	(0.989)	(0.036)	(0.058)	(0.089)
$\Delta ImpPen_f^{NMS}$	-0.389	0.622	-0.016	0.023	0.000
	(0.335)	(0.843)	(0.010)	(0.029)	(0.045)
$\Delta ImpPen_f^{CN}$	-0.647	0.111	0.029	0.103*	-0.228**
	(0.401)	(0.548)	(0.037)	(0.059)	(0.094)
MNC	0.019	0.069	-0.006*	-0.006*	0.006
	(0.047)	(0.048)	(0.004)	(0.003)	(0.007)
$log(emp_f^t)$	-0.039***	0.007	0.003***	0.005***	-0.005**
	(0.010)	(0.020)	(0.001)	(0.001)	(0.002)
R^2	0.06	0.08	0.04	0.05	0.06
Observations	5,160	5,160	5,160	5,160	5,160

	Growth Rate of Workers in Tech	Support	Production	Δ Share Tech Switchers
$\Delta ExportSh_f^{NMS}$	0.881**	0.009	-1.205***	0.031**
	(0.411)	(0.447)	(0.346)	(0.015)
$\Delta ImpPen_f^{NMS}$	-0.241	0.047	-0.155	0.003
	(0.311)	(0.300)	(0.266)	(0.012)
$\Delta ImpPen_f^{CN}$	-0.174	-0.368	-1.079***	0.016
	(0.449)	(0.482)	(0.334)	(0.015)
MNC	0.002	0.009	0.052	0.000
	(0.048)	(0.042)	(0.053)	(0.001)
$log(emp_f^t)$	-0.011	-0.002	-0.054***	0.000
	(0.010)	(0.010)	(0.012)	(0.001)
R^2	0.02	0.04	0.09	0.06
Observations	5,160	5,160	5,160	5,160

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

competition from China is associated with a reduction in the share and level of production workers.

In sum, new offshoring opportunities lead firms to decrease total employment and reallocate domestic workers towards pre- and post- production activities. This reallocation is strongest for technology workers, which increase in both shares and levels. Some of these workers change occupation within the firm, and the increase in tech workers is evident even controlling for direct measures of import penetration from the NMS and China. In the next section, we examine firm production in even more detail to understand why offshorers import the same products that they produce domestically, and how their domestic production evolves in conjunction with offshoring.

6 Vertical differentiation and offshoring

Using both the direct survey and the new measure of offshoring – the share of produced-good imports – we have documented substantial reorganization of both production and employment in firms that offshore. Although offshoring firms decrease their total domestic employment, their employment of technology workers rises. In addition, offshorers grow the value of their imports *and* domestic production in the subset of goods that they produce domestically and import, while imports of never-produced goods and production of non-imported goods both decrease. These patterns suggest that offshoring firms specialize in a set of their core competency products, which they produce (or source) both domestically and from low-wage countries.

The integration of the NMS and China may enable offshorers to produce relatively lower-quality or less-technologically advanced varieties of their core products in those regions, while focusing domestic activities on production of higher quality or more technologically advanced varieties. There are numerous examples of firms focusing on innovation in the domestic market while offshoring manufacturing activities to low-wage countries, including pumps by Grundfos, phones and tablets by Apple, vacuum cleaners and hand dryers by Dyson, and diesel engines by Cummings. Fuchs (2014) argues that innovation and production of goods close to the technology frontier often need to occur within close geographic proximity and where the pool of skilled labor is sufficiently high.

We assess the extent to which this type of vertical differentiation is evident in the data by exploiting detailed (CN8) product-level unit values available for both domestic production and imported goods. We first show that unit values of imported varieties for the same firm-CN8 product combination are almost 60 percent lower than the domestic variety, and that import unit values for varieties from NMS and China are the lowest of all. We then focus only on a firm's domestic unit values and show that, after the firm begins to import a particular good from NMS or China, its domestic unit value rises, even as its quantity falls.

6.1 Unit values for domestic versus imported varieties

If offshoring firms focus domestic production on high-quality or more technologically advanced varieties of their core products, while sourcing less sophisticated, lower-quality versions from low-wage locations, we should observe systematic price differences across locations. Prior work documents lower prices for US imports of the same goods from low-wage countries in the cross-section (Schott, 2004), and within a country over time as the country develops (Schott, 2008). Using detailed information on product characteristics, Byrne et al. (2017) show that for semiconductors, a large portion of price differences across countries are accounted for by differences in the technological sophistication of the products, i.e., the higher-priced varieties are closer to the technology frontier.

To assess whether offshoring firms seem to import lower quality or less advanced varieties from low-wage countries, we compare the unit values of the same CN8 product produced domestically and imported by the same firm in the same year.[32] Since we consider imports of produced goods offshoring, this sample effectively includes all firms that offshore some activity. Specifically, we estimate

$$log(UV_{fpct}) = \alpha_t + \gamma_{fp} + \beta Dom_{fpct} + \varepsilon_{fpct}, \tag{6}$$

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

We limit the analysis to a sample of firm-CN8 products from 2000 to 2008 with both production in Denmark and imports in the same year.[33] 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 8 presents the results from estimating equation (6) via OLS. The coefficient on domestically-produced varieties is large, positive, and statistically significant. Column 1 shows that, on average, domestic varieties' unit values are 60 log points higher than their imported counterparts within the same firm and year. This large difference favors the explanation that firms offshore lower quality versions of the goods they produce domestically.

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.[34] Since there is no

[32] 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.

[33] 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.

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

Table 8: Comparison of domestic and import unit values for the same firm-product

Dependent variable - the log unit value of a CN8 product

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

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

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 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.

6.2 Evolution of domestic unit values after importing

While the systematic variation in unit values across locations is consistent with lower-quality varieties being sourced from China and NMS, it relies on different data sources that may contain variation in markups. To address this concern, we now focus exclusively on the evolution of firms' domestic unit values. If offshoring enables firms to focus on higher quality or more technologically advanced varieties at home, the domestic unit value of offshored goods should rise after firms begin to import them.

To assess the extent to which offshoring firms' domestic prices change 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 domestic production after the initial importing. 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

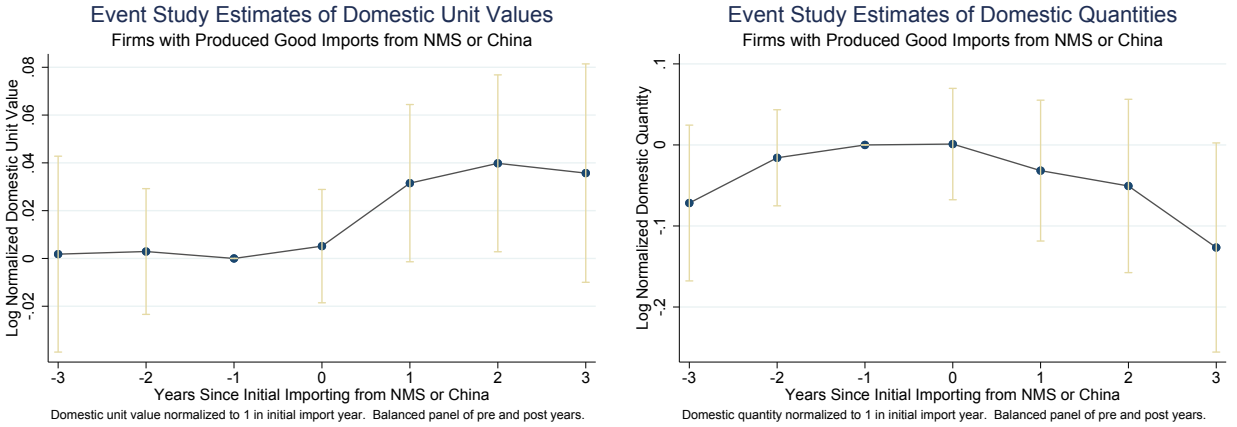
$$log(UV_{fpt}) = \alpha_t + \sum_k \beta_k \Delta Imp_{fp,t+k} + \varepsilon_{fpt}, \tag{7}$$

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 8 presents the event study coefficients (also in Appendix Table D), and shows a clear increase in domestic unit values after firms begin offshoring the good.

To gain a sense of whether this increase reflects offshorers' ceasing domestic production of lower

quality versions (e.g., as proposed in Schott, 2008), we estimate a variant of equation (7) using the log of the normalized quantity of the domestically-produced good as a dependent variable. The right panel of Figure 8 depicts the evolution of the amount of domestic production. Consistent with firms shifting production of their lower-quality versions to low-wage countries, the quantities of the domestically-produced varieties fall gradually over time, and are approximately 10 percentage points lower three years after offshoring begins. This pattern of rising unit values and falling quantity is consistent with firms focusing domestic production on higher quality or more technologically advanced varieties in their home market.

Figure 8: Evolution of domestic unit values and quantities after offshoring



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

One potential question about the rising domestic unit values for the CN8 products that firms begin to import from NMS or China is whether they reflect market power on the part of the Danish importer. For example, if Danish manufacturers also set up production in NMS to lower their costs, they might then raise prices and restrict quantity from NMS to Denmark. Although this seems unlikely given Danish firms' small role in Europe and especially China, we assess this possibility by examining the evolution of imported unit values for firms that produced a CN8 domestically and then begin to import the good. If firms were using market power to raise prices, we would expect unit values of imported varieties to rise over time, as firms exercised their market power. Similarly, if a firm-product demand shock led firms to raise prices of domestic unit values, we would expect similar patterns for foreign varieties. Appendix Figure D.1 shows that import unit values of these goods that the firm both produces and imports fall over time, after the firm begins to import them. This result contrasts sharply with the rising domestic unit values depicted above, and shows another clear divergence between the same CN8 goods that the firm produces domestically versus

imports consistent with the premise that firms offshore production of lower-quality varieties to low-wage countries. The stark divergence in domestic versus imported quantities of a CN8 good that the firm both produces and imports is also reassuring evidence that firms are not importing products, slapping a label on them, and claiming to have produced them in Denmark.

6.3 Increased R&D workers and expenditures by offshoring firms

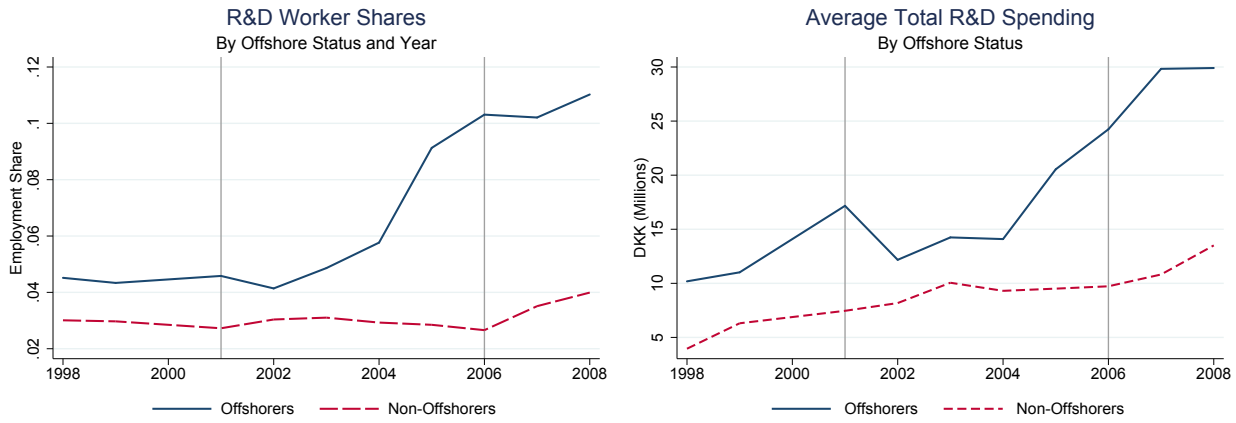
The levels and changes of unit values suggest that offshoring firms are splitting production of narrowly-defined products across locations. Earlier results showed that in addition to shifting production, offshoring firms reorganize domestic employment towards innovation activities. For example, as Grundfos offshored some of its pump manufacturing to Hungary, it focused Danish production on new, more-advanced varieties with digital monitoring systems. In this section we examine the innovation activities of offshoring firms. Measuring innovation outcomes within firms is notoriously difficult as many of the outputs are not sold to the market or captured in firm-level datasets. We use a separate R&D survey to provide empirical support for increased innovation activities with simple descriptive evidence on firms' research and development (R&D).[35]

The left panel of Figure 9 shows that offshoring firms increase their share of R&D workers, as explicitly defined in the R&D survey, over the offshoring period, while non-offshorers do not. This pattern corroborates our definition of tech workers available for all firms, and suggests that firms are indeed reorienting their domestic workforce towards innovation. The right panel depicts the weighted average of firms' total R&D spending which rises substantially over the period for offshoring firms and is largely unchanged at non-offshorers. In this smaller sample of firms we see evidence that the rise of technology-related employment is mirrored in the increase in innovation activities at offshorers.

The richness of our data provides novel evidence on how firms respond to the integration of low-wage countries into the global economy. While rising imports from low-wage countries are often categorized as import competition, we show that firms import the same detailed product categories they produce domestically. Notably, the domestically produced varieties have higher unit values that rise over time, suggesting that offshoring allows for increased vertical differentiation of the same goods across locations. This response to trade liberalization has previously been attributed to import competition, though most of that work relied on aggregate industry-level penetration measures that could not distinguish between imports of competing versus offshoring firms. The evidence we present here suggests a very different channel – production relocation and vertical specialization rather than the prior "escape competition" motivation.

[35]The R&D survey covers a rotating panel of approximately 4,300 firms per year. We match about 38 percent of the offshoring firms to the R&D survey.

Figure 9: R&D workers and expenditures by offshore status



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

7 Conclusion

The rise of low-wage production locations such as China and Eastern Europe has disrupted manufacturing industries in advanced economies. The literature has consistently documented negative effects of increased low-wage imports on manufacturing employment, wages, and health. The evidence on firms is more mixed. Some work links low-wage import penetration to decreased firm sales, survival, and innovation, but other results point to rising innovation and productivity. In most cases, low-wage imports are viewed through the lens of increased foreign competition, and domestic firms must either shrink or change to escape it. This paper offers a new perspective: low-wage countries also provide an opportunity for domestic firms to reorganize their activities as they exploit new low-cost production locations through offshoring.

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

import competition from foreign firms. An open question for future work is the extent to which this transfer occurs, and how offshoring will change as countries' comparative advantage continue to evolve (endogenously) along with these activities.

The survey also provides new evidence on how offshoring relates to domestic production. Rather than hollowing out domestic manufacturing and transitioning to pure wholesalers, most offshoring firms continue to produce the same goods they import. While the value of domestic production of offshored goods does not fall, firms shift towards making higher-priced varieties. Unit values of domestically produced varieties are substantially higher than import values, and they rise after importing begins, even as their quantity falls. These findings suggest that offshorers have product-specific capabilities and exploit low-wage destinations for the production of vertically differentiated varieties of the same goods they manufacture at home. An accurate assessment of this exploit opportunities channel is crucial, not only for developing models that capture the motives and implications of low-wage imports, but also for analyzing economic policies.

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

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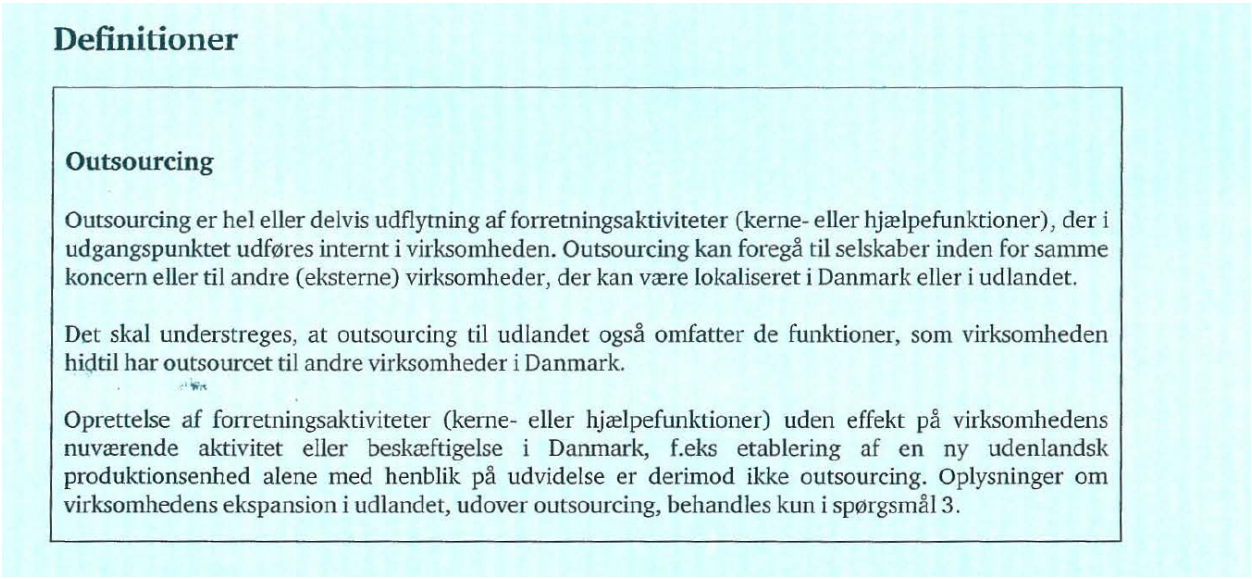
Appendices

A Additional statistics on the data

A.1 Offshoring survey question

Figure A.1: Question on offshoring in Danish



Definitioner

Outsourcing

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

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

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

Figure A.1 presents the original survey question in Danish. The work "udflytning" translates to "move out". The full survey is available here `https://www.dst.dk/da/Statistik/Publikationer/VisPub?cid=13110` from Statistics Denmark, or archived here `http://faculty.tuck.dartmouth.edu/images/uploads/faculty/teresa-fort/Danske_virksomheders_outsourcing_2007.pdf`.

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 survey defines the core activity as the primary industry of the firm. The bottom row displays the total number of firms that relocate each activity. Offshoring of ICT services is the most prevalent of these other activities, though the number of firms engaged in this offshoring is still well below the 380 firms that relocate their core activity.

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

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

Notes: 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 A.2: Offshoring of core activity by region

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

B Details on production and imports

B.1 Production by good type

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 B.1 presents the documentation from the Denmark's survey on production. The description of "Own

Figure B.1: ProdCom definitions

2.4 Statistical concepts and definitions

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

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

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

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

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

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

goods" explicitly states that "Traded goods are not included." In addition, goods that the firm buys and resells without processing are explicitly reported as "Commercial (resale) turnover," and that description notes that goods that the firm repackages have not been processed. Repackaged goods are thus categorized as Resales, not as Own Goods.

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

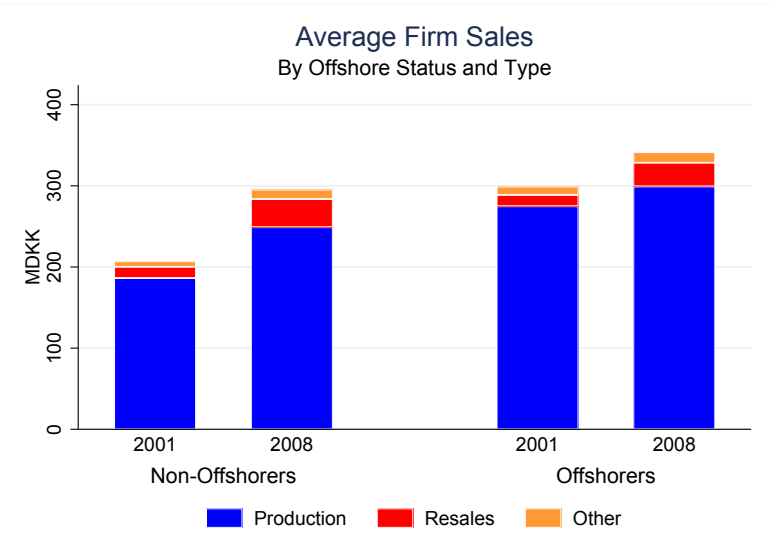
B.2 Produced-goods imports by region

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

We decompose firm imports by region of the imports, for firms that offshore to NMS and China. The top, left panel of Figure B.3 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 B.3 shows similar patterns for firms that offshore to China, with even higher levels of produced good imports from the old EU in 2001, and slight declines in those imports in the initial years of the offshoring period.

To understand how firms' offshoring decisions may be interrelated across space, the bottom panel of Figure B.3 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

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



Notes: Figure presents the weighted-average of total firm sales reported in ProdCom, split apart by type of sales. Production is "sales of own goods," (i.e., goods that are produced by the firm). Resales are sales of goods that are bought and sold without any processing, where repackaging does not constitute processing. Other includes contract work, installation, and packaging and repair. Sample is a balanced panel of firms in the offshoring survey that exist from 2000 to 2008 and report production in ProdCom in at least one of these years.

NMS offshorers grow those imports as they also increase their produced good imports from the NMS countries. In contrast, firms that offshore to China but not the NMS exhibit declines in their average produced good imports from the old EU. These figures not only show how closely produced-good imports match with an explicit relocation of production as identified by firms, but also highlight the potential for produced-good imports to show how global value chains are structured across space.

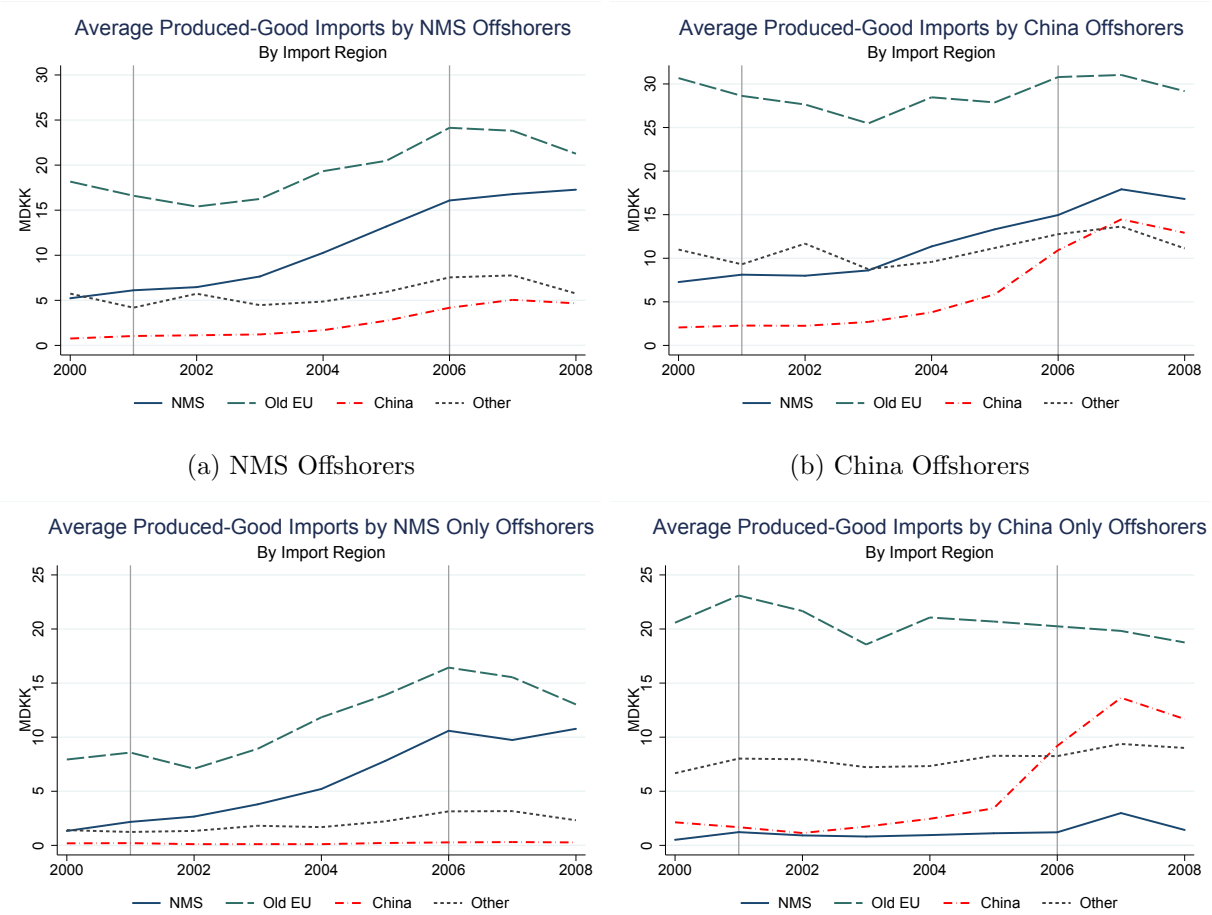
B.3 Product aggregation levels and descriptions

In this section, we show that within an HS4 category, parts are often separated as a distinct HS6 product. In this sense, HS4 imports of the same goods a firm produces might capture the parts associated with the production of those more detailed products.

B.4 Offshoring and input imports and purchases

In this section, we use a new input survey to identify a firm's input industries. The survey provides firm input purchases as the HS4 industry level for manufacturing firms with at least 50 employees. We use the survey to flag all imports of CN8 products that belong to those input industries as inputs. We also use the detailed CN8 production data to identify which products a firm produces at the CN8 or HS4 (but not CN8) levels. Table B.2 presents the results. In the top panel, we present import shares of CN8 goods that are within HS4 input industries of the firm, separately by their production status (not produced at the HS4 level, produced at the HS4 but not the CN8

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



(a) NMS Offshorers

(b) China Offshorers

(c) NMS Only offshorers

(d) China Only Offshorers

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

level, produced at the CN8 level). The bottom panel presents import shares of goods outside the firms' HS4 input industries, separately by their HS4 production status.

Table B.2 shows that a considerable portion of firms' imported inputs are outside of their HS4 production sector (over 30 percent for both firm types in 2001). The data also show a dramatic compositional change in offshorers' imports driven by a rising share of goods that are inputs and produced at the CN8 level. It is thus primarily imports of the same detailed products the firm produces that are associated with offshoring, while imports of goods in industries that they use as inputs but do not produce actually fall in importance. The opposite pattern is evident for non-offshorers.

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

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

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

Table B.2: Import shares by imported good input and production status, and firm offshore status

		Non-offshorers		Offshorers	
Input Status	Production Status	2001	2006	2001	2006
Input (HS4)	Not Produced	37.2	38.3	32.7	30.9
Input (HS4)	Produced (HS4 not CN8)	4.3	5.6	6.3	6.3
Input (HS4)	Produced (CN8)	13.0	12.6	22.6	32.6
Not Input	Produced (HS4)	15.0	17.0	16.0	13.7
Not Input	Not Produced	30.6	26.5	22.3	16.5

Notes: Table presents the percent of imports by the input and production status of the imported good, and firm offshore status. The input survey identifies a firm's purchase of inputs from an HS4 industry. The first three rows report the percent of imports that are inputs at the HS4 level, separated based on whether they are not produced at the HS4 level, produced at the HS4 but not CN8 level, or produced at the CN8 level. Sample is limited to a balanced panel of firms in the offshoring survey and in the input survey from 2001 to 2008, that are in ProdCom in at least one of these years. The input survey is sent to manufacturing firms with at least 50 employees. There are 138 offshoring firms and 504 non-offshorers in this sample.

C Support for the regression analysis

C.1 Summary statistics for regression variables

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

Table C.1: Summary statistics for regression variables, Table 5

	$\Delta \frac{PG\ Imports_{ft}^{NMS}}{Imports_{ft}}$	$Shock_f^{NMS}$	Change in firm				
			log emp	log prod	share tech	share support	share prod
Mean	0.0067	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 C.2: Summary statistics for regression variables, , Table 6

	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

C.2 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.3 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) do 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 a better predictor of non-produced good imports rather than produced-good imports.

Table C.3: OLS estimates of offshoring to China

	Δ log Emp	Δ log Production	Δ Share of Workers in Tech	Δ Share of Workers in Support	Δ 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.

C.3 Robustness of the IV regressions

Here we present robustness of the IV estimates in Section 5.2.

Table C.4: Robustness of the IV Estimates

	Δ log Emp	Δ log Production	Δ Share of Workers in Tech	Support	Production
$\Delta PG\ ImpSh_f^{NMS}$	-2.321**	-0.067	0.244**	0.283**	-0.655**
	(1.147)	(2.735)	(0.112)	(0.141)	(0.276)
$\Delta ImpPen_f^{NMS}$	-0.009	0.634	-0.058*	-0.026	0.112
	(0.283)	(0.978)	(0.030)	(0.039)	(0.072)
$\Delta ImpPen_f^{CN}$	-0.561	0.113	0.020	0.092*	-0.204
	(0.549)	(0.547)	(0.052)	(0.052)	(0.126)
MNC	-0.003	0.069	-0.004	-0.004	0.000
	(0.050)	(0.059)	(0.003)	(0.004)	(0.008)
$log(emp_f^t)$	-0.020	0.007	0.001	0.003	0.001
	(0.013)	(0.029)	(0.001)	(0.002)	(0.004)
KP-Fstat	9.052	9.052	9.052	9.052	9.052
AR Chi-sq P-val	0.01	0.98	0.01	0.08	0.01

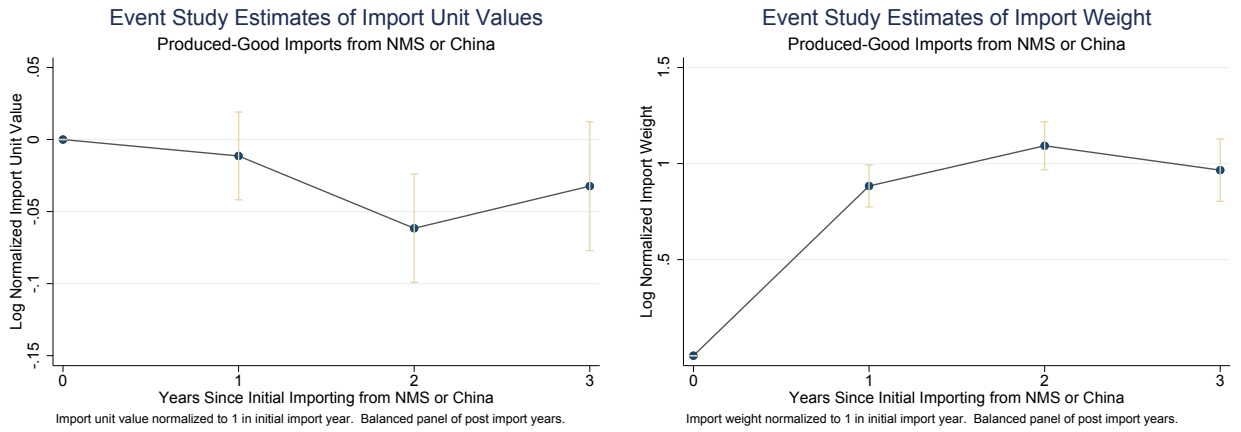
	Growth Rate of Workers in Tech	Support	Production	Δ Share Tech Switchers
$\Delta PG\ ImpSh_f^{NMS}$	2.465*	0.025	-3.374**	0.088*
	(1.476)	(1.235)	(1.368)	(0.051)
$\Delta ImpPen_f^{NMS}$	-0.664	0.043	0.423	-0.012
	(0.519)	(0.351)	(0.297)	(0.017)
$\Delta ImpPen_f^{CN}$	-0.265	-0.369	-0.955	0.013
	(0.567)	(0.489)	(0.609)	(0.017)
MNC	0.026	0.010	0.019	0.000
	(0.046)	(0.042)	(0.064)	(0.001)
$log(emp_f^t)$	-0.032*	-0.002	-0.025	-0.001
	(0.017)	(0.016)	(0.018)	(0.001)
KP-Fstat	9.052	9.052	9.052	9.052
AR Chi-sq P-val	0.03	0.98	0.00	0.03
Observations	5,160	5,160	5,160	5,160

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

D Unit value analysis

One potential question about the rising domestic unit values for the CN8 products that firms begin to import from NMS or China is whether they reflect market power on the part of the Danish importer. For example, if Danish manufacturers also set up production in NMS to lower their costs, they might then raise prices and restrict quantity from NMS to Denmark. Although this seems unlikely given Danish firms' small role in Europe and especially China, we assess this possibility, by examining the evolution of imported unit values for firms that produced a CN8 domestically and then begin to import the good. Figure D.1 shows the import unit values of these goods that the firm both produces and imports fall over time, after the firm begins to import them. This result contrasts sharply with the rising domestic unit values depicted in Section 6, and shows another clear divergence between the same CN8 goods that the firm produces domestically versus imports consistent with the premise that firms offshore production of lower-quality varieties to low-wage countries.

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



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

We present the event study coefficient estimates in Table D.1.

Table D.1: Event Study Regressions

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

Notes: The log unit values and quantity or weight are normalized to one in the initial import year. Coefficients normalized to zero in the initial import year $(t-1)$. The domestic specifications include year fixed effects, while the import specifications include year and country fixed effects. Domestic unit value sample limited to firms that produce a CN8 good at least two years without importing, begin to import the CN8 good from NMS or China in year t, and continue to produce the CN8 good domestically for at least 3 more years. Import unit value sample limited to firms that produce a good in $t-2$ and or $t-1$, start to import the good in year 0, and continue importing the good for at least 3 years. Standard errors clustered by CN8 product. * p<0.10, ** p<0.05, *** p<0.01.

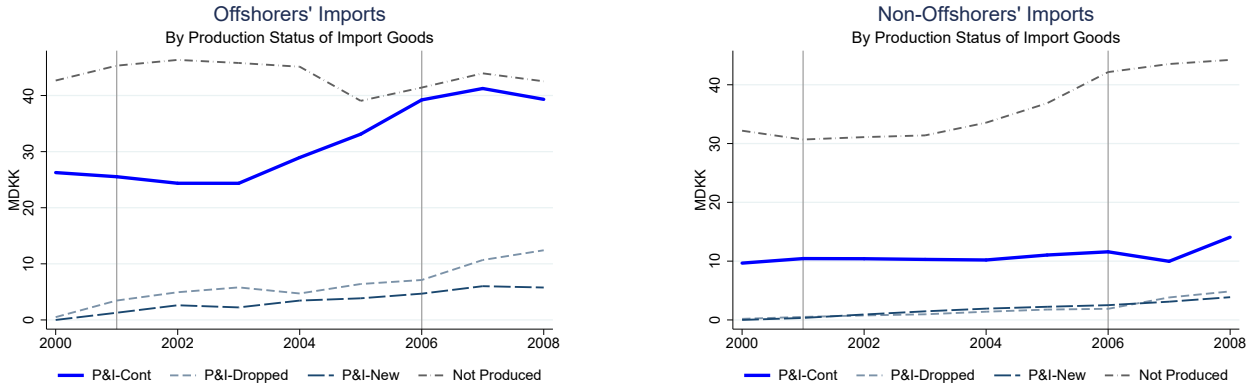
For Online Publication Only: Online Data Appendix for Heterogeneous Globalization: Offshoring and Reorganization, *by:* Bernard, Fort, Smeets, and Warzynski

This online Appendix for Bernard, Fort, Smeets, and Warzynski (2021) provides additional details on the data construction and the empirical patterns documented in the paper.

A A deeper look into produced-good imports

In Figure A.1 we plot firm imports by detailed, mutually-exclusive and exhaustive categories of firm-good production status. As demonstrated in the main text, offshorers' imports of produced goods grow considerably over the period so that they are almost as large as their non-produced good imports by 2008. In contrast, non-offshorers produced-good imports are flat. The figure also shows that offshoring firms decrease the level of their non-produced good imports, while non-offshorers grow their imports of these goods more than any form of produced-good imports.

Figure A.1: Average firm imports by type of good

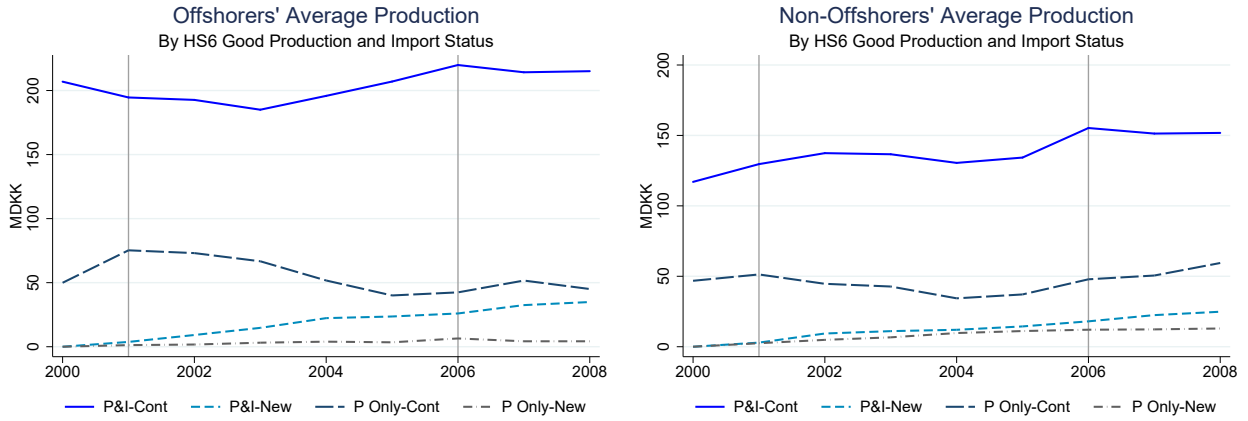


Notes: Figure presents the weighted-average of firm imports, by the production status of the imported goods. "P&I-Cont" are goods produced in 1999 and or 2000 and still produced in t. "P&I-Dropped" are goods produced in 1999 and or 2000, but not produced in t. "P&I-New" are goods not produced in 1999 or 2000, but produced in t. Offshoring firms (left panel) are those that report locating their core activity to new locations between 2001 to 2006. Non-offshorers (right panel) do not relocate their core activity over the period. Sample is a balanced panel of firms in the offshoring survey that exist from 2000 to 2008 and report production in ProdCom in at least one of these years. There are 257 offshoring firms and 1308 non-offshorers.

In Figure A.2 we plot firms' domestic production by detailed, mutually-exclusive and exhaustive categories of firm-good initial production and import status. As demonstrated in the main text, offshorers' production of goods they also import considerably over the period. In contrast, their production of goods they do not import falls. The figure also shows that non-offshoring firms grow both types of production.

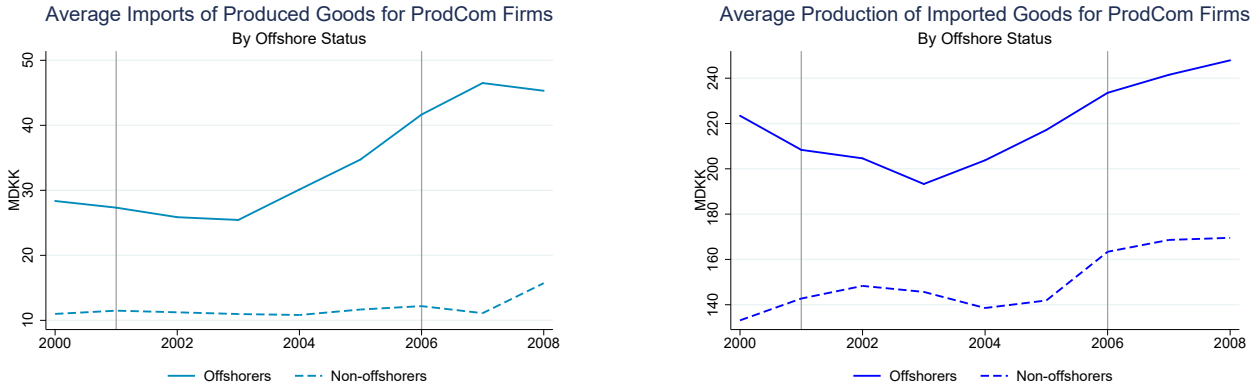
Figure A.3 depicts imports (left panel) and production (right panel) of goods that the firm produces and imports in the same year. This figure is limited to firms that are in ProdCom in a particular year. For this subset of firms, domestic production rises steadily after the offshoring period.

Figure A.2: Average firm production by initial production and import status of good



Notes: Figure presents the weighted-average of firm imports, by the production status of the imported goods. "P&I-Cont" are goods produced in 1999 and or 2000 and still produced in t. "P&I-Dropped" are goods produced in 1999 and or 2000, but not produced in t. "P&I-New" are goods not produced in 1999 or 2000, but produced in t. Offshoring firms (left panel) are those that report locating their core activity to new locations between 2001 to 2006. Non-offshorers (right panel) do not relocate their core activity over the period. Sample is a balanced panel of firms in the offshoring survey that exist from 2000 to 2008 and report production in ProdCom in at least one of these years. There are 257 offshoring firms and 1308 non-offshorers.

Figure A.3: Imports and production of goods that are produced *and* imported by ProdCom firms

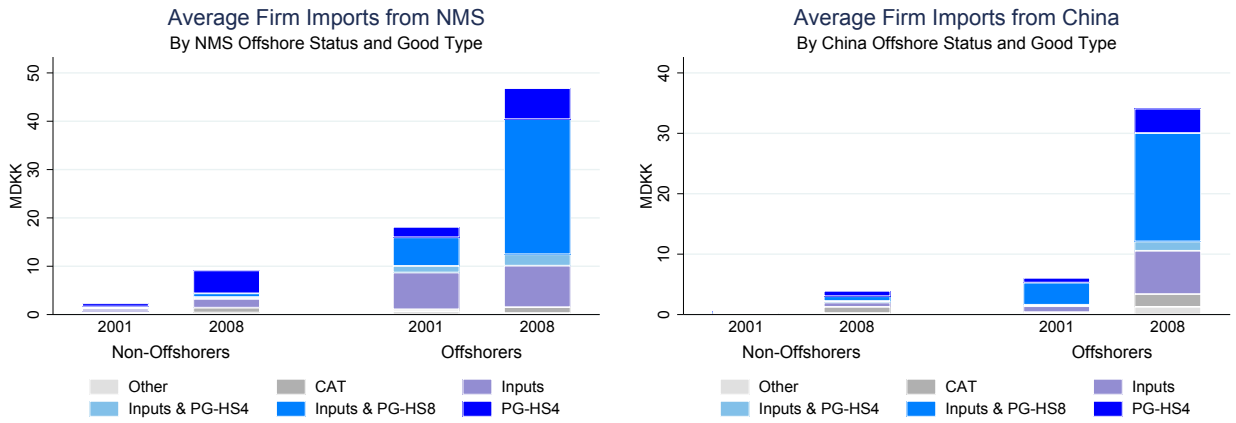


Notes: Left panel presents the weighted-average of firm imports of HS6 products that were produced by the firm in 1999 or 2000, and continue to be produced by the firm. Right panel presents domestic production of the same goods. Note that axes are on different scales. Offshoring firms are those that report locating their core activity to new locations between 2001 to 2006. Sample is a balanced panel of firms in the offshoring survey that exist from 2000 to 2008 and report production in ProdCom in each year.

A.1 Produced-goods versus input imports by region

In this subsection we show that the aggregation and input versus produced-good import patterns documented in Section 4.4 are also evident for NMS and for China offshorers. By the end of the offshoring period, the majority of offshorers' imports from the offshore region are in the same detailed CN8 goods that they also produce domestically. This contrasts sharply with firms that do not offshore.

Figure A.4: Average Imports by Good Type and Offshore Region

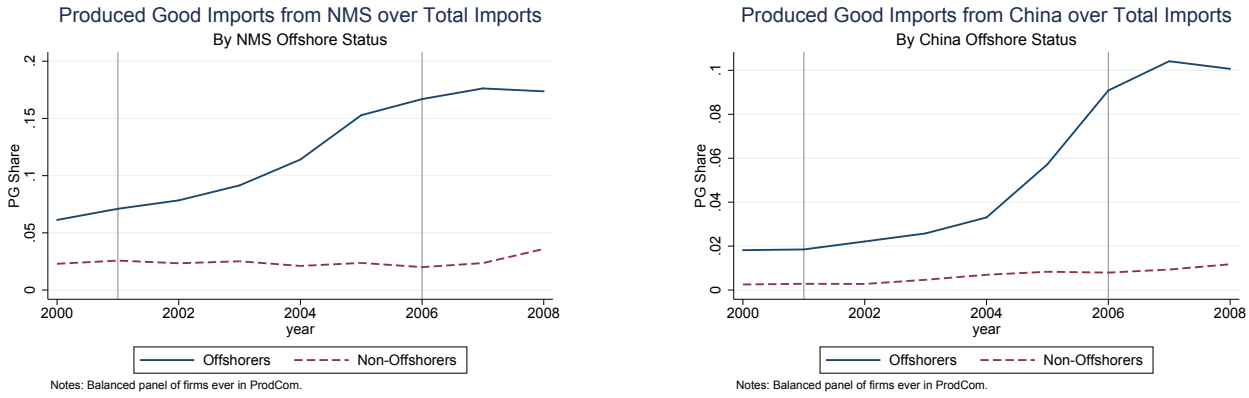


Notes: Figure presents the weighted-average of firm imports from a region by type of imported good. Inputs are imports of HS4 industries that the firm reports purchasing as inputs. Inputs & PG-HS4 are imports of HS4 products that the firm reports purchasing as inputs and producing. Inputs & PG-HS8 are imports of HS4 products that the firm reports purchasing as inputs, and HS8 products that it produces. PG-HS4 are imports of HS4 products the firm reports producing, but does not purchase as inputs. The top three (blue) bars thus contain the total imports of HS4 products that the firm also produces. Sample is a balanced panel of firms in the offshoring and material surveys that exist in 2001 and 2008, and that report production in ProdCom in at least one of these years.

A.2 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 A.5 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).

Figure A.5: 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.

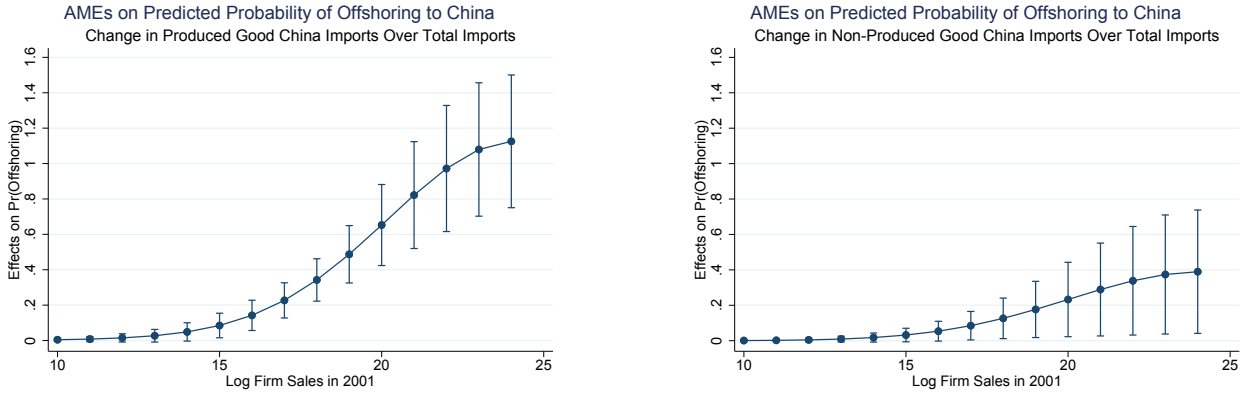
A.3 Produced-good imports and offshoring to China

Here we also present the results from estimating

$$Pr(\Delta Off_f^{China} = 1) = \alpha + \beta_{PG}\Delta\frac{PG\ Imports_f^{China}}{Imports_f} + \beta_s log(sales_f^{2001}) + Ind_f, \tag{8}$$

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 A.6a 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 A.6b 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 A.6: 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.

A.4 Regression coefficients for Section 4.4

Here we present the coefficient estimates for estimating equation (1) via Logistic regression. The marginal effects that correspond to these estimates are presented in Figure 7, evaluated at different measures of firm size.

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

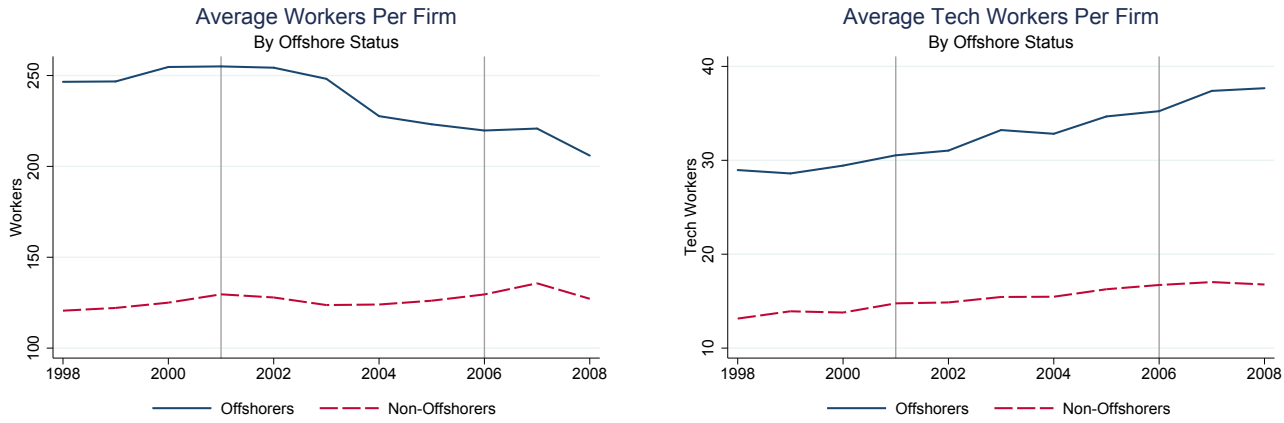
Dependent variable is an indicator if firm offshores to:				
	NMS		China	
$\Delta PG\ ImpSh_f^{Region}$	1.713***		3.117***	
	(0.413)		(0.535)	
$\Delta NPG\ ImpSh_f^{Region}$		-0.199		1.069**
		(0.258)		(0.492)
$log(sales_f^{2001})$	0.208***	0.218***	0.278***	0.265***
	(0.043)	(0.043)	(0.052)	(0.051)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

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

A.5 Employment patterns for regression sample

Here we replicate Figure 3 for the sample of firms in the regression analyses, i.e., those that are ever in ProdCom. Tech workers grow faster at offshoring firms in this sample.

Figure A.7: Employment by firms' offshore status



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

B 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.[36] 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.

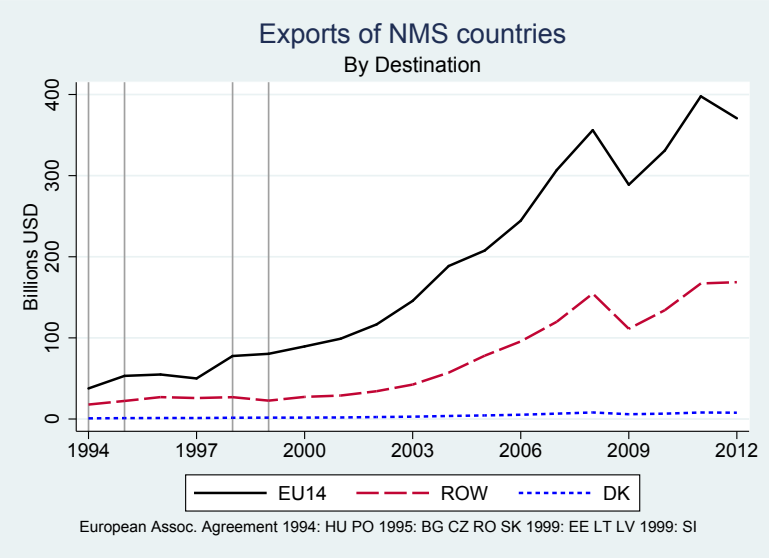
The occupation types are listed in a separate file available here: `http://faculty.tuck.dartmouth.edu/images/uploads/faculty/teresa-fort/occupation_list.pdf`.

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

C Aggregate NMS exports

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

Figure C.1: Aggregate exports by NMS countries



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