Offshoring and Reorganization

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Abstract

This paper examines the effects of offshoring by analyzing how it affects firms' optimal allocation of resources across activities. We address two key questions. First, we use detailed new data to provide a clear measure of offshoring and to document how it differs along several dimensions from the import of intermediate goods that has been used extensively in prior work. Second, we show how this precisely defined form of offshoring leads firms to reallocate labor away from direct production work towards technology-related occupations. This reallocation of workers is accompanied by increases in offshoring firms' product development and R&D spending. Firm reorganization highlights the importance of a new channel in which offshoring affects innovation, and may ultimately affect economic performance and growth as well.

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1 Introduction

There has been a huge amount of political and academic interest in the effects of offshoring. An extensive body of work documents a role for trade and offshoring in increased inequality (Feenstra and Hanson, 1996, 1999; Hummels et al., 2014) and in decreased employment and wages (Bernard et al., 2006; Ebenstein et al., 2014). In contrast, we know relatively little about how offshoring changes firms' allocation of resources across activities. This is in spite of the fact that offshoring may allow firms to shift from production to innovation-related activities, which may decrease current employment but have a positive impact on future performance and productivity.

In this paper, we study the effects of offshoring by analyzing how it affects firms' optimal allocation of resources across activities. We address two key questions. First, we use detailed new data to provide a clear measure of offshoring and to document how it differs along several dimensions from importing, which is the basis of many existing offshoring measures. Second, we show how offshoring leads firms to reallocate labor away from direct production activities towards research and design activities.

We identify a firm's offshoring decision using novel data from a survey in which Danish firms were directly asked whether they relocated their core activity to a foreign location between 2001 and 2006. This relocation could occur within or outside the boundary of the firm and explicitly covers only those activities that were previously performed in Denmark. The survey was administered in 2007 by Statistics Denmark and sent to all private firms with at least 50 employees, and to firms with 20-50 employees in selected industries. We combine these data with information on firm employment, sales, production, input usage, R&D expenditure, imports, and exports to create a rich new dataset for studying the ramifications of offshoring.

The data show that almost ten percent of surveyed Danish firms relocated their core activity to a foreign region between 2001 and 2006. Among these offshorers, countries that most recently joined the European Union, collectively referred to as the EU12, were the most

popular destinations. 54 percent of Danish offshoring firms located to these EU12 countries. One third of the offshoring firms relocated their core activity to China, making it the second most popular destination. We use the new offshoring data to assess the extent to which offshoring is associated with importing. Not surprisingly, we find that the majority of firms that relocate production to a particular region also import from that region. When we delve into importing further, however, we find that only one quarter to one third of the offshoring firms that import are importing inputs into their production process. In contrast, imports of final goods are more common, with well over half of the offshoring firms importing products that they produce in Denmark. These findings suggest that one cannot reliably use imported intermediates to infer offshoring, since doing so would miss the majority of offshoring firms.

An important contribution of the paper is to show how the decision to offshoring relates to a firm's innovative activities. To assess this relationship, we first provide descriptive evidence that shows offshoring firms increase their share of technology workers from around 0.15 in 1999 to over 0.25 by 2009. In contrast, non-offshorers' share of technology workers remains below 0.15 for the same interval. While this evidence is suggestive of an important role for offshoring in a firm's allocation of resources towards R&D and innovation, it is unclear what drives the relationship. Firms that want to re-focus their domestic attention on innovation may relocate their core activity to a foreign region to facilitate this transition. Alternatively, firms that face new challenges and competition from imports may select into offshoring as a way to lower costs and remain competitive. These firms may also plan to cut back on innovation as a way to shore up resources and avoid exit altogether.

To address these issues, we implement an instrumental variables (IV) strategy in which we identify firms that began offshoring due to factors external to both the firm and Denmark. Specifically, we exploit the significant productivity growth within destination regions prior to the period of the survey to construct industry-level productivity shocks by region. We assign these industry-level shocks to the firm level using the firm's industry in 2001, before the firm's offshoring activity.

Our IV strategy identifies firms that began offshoring to the EU12 as a result of improved productivity in those regions. The key identifying assumption is that the common within industry component of the relative increase in regional productivity is due to increases in foreign productivity. The exclusion restriction requires that the foreign region's increased productivity only affects a firm's innovative activities through its impact on the offshoring decision. This restriction would be violated if improvements in EU12 comparative advantage also led to increased competition from the EU12, and that increased competition directly affected firms' innovative activities (e.g., as in Bloom et al., 2015). We therefore focus on specifications in which we control for changes in import penetration, though we acknowledge that it is hard to disentangle these two channels.

The IV estimates point to a large, positive impact of offshoring on firms' share of technology workers. They suggest that firms that relocate their core activity to EU12 countries between 2001 to 2006 increase their share of technology workers from 2001 to 2008 by as much as 18 percentage points. These results are indicative of an important role for offshoring in firms' allocation of resources towards innovative activities. To the extent that innovation is critical for future performance and growth, they suggest that offshoring may have positive long-term effects, even when their immediate impact on total employment is negative.

This paper contributes to two distinct literatures. First, it adds to an extensive body of empirical work on the employment and wage effects of offshoring. A number of papers find that increases in imported intermediates lead to greater wage inequality by increasing the skill premium (Feenstra and Hanson, 1996, 1999; Hummels et al., 2014). The main differences here are that we exploit a direct firm-level measure of offshoring of the firm's core activity, and examine how it affects the occupations and tasks performed by workers employed at the firm.

A related body of work considers the employment effects of industry exposure to low wage import competition (Bernard et al., 2006) and occupational exposure to offshoring (Ebenstein et al., 2014; Peri et al., 2013). Our main focus is on the reorganization of activity

within the firm. In this sense, our results are close to Harrigan et al. (2016), who find that the increased polarization of French importers is explained by higher shares of technology workers in the firm. Our paper is one of the first to provide empirical evidence on how offshoring, as distinct from firm-level imports, affects the allocation of workers and resources towards innovation. We find that offshoring is associated with increased hiring and firing of technology workers, as well as *within* firm shifts of retained workers into innovative positions. Moreover, we document how these changes in employment composition relate to changes in the firm's innovative activities, such as new product development and R&D expenditure.

Th paper also contributes to work that studies a firm's joint decision to engage in international trade and invest in new technology. Several papers analyze firms' joint decisions to exploit new export markets and invest in new technology (Melitz and Constantini, 2008; Lileeva and Trefler, 2010; Bustos, 2011). This paper is more closely related to Boler et al. (2015), who document increased foreign sourcing by Norwegian firms that had increased their R&D activities due to an exogenous policy shock. The key theoretical channel in all these papers is a firm scale effect, in which technology and trade both require fixed cost payments and also increase profitability. We provide evidence that offshoring to EU12 countries induces a firm to reallocate workers to technology-related activities, and that this occurs even when controlling for changes in firm sales over the offshoring period.

In related work, Bloom et al. (2015) show that increased import competition from China led European firms to upgrade their technology and innovate. Bloom et al. (2014) provide a theoretical explanation for this finding in which import competition leads to a reallocation of "trapped factors" within the firm. Given the flexibility of Danish labor market, it seems less likely that firms cannot fire workers, though the implications for future growth from increased innovation in that model are still relevant for our results. An alternative explanation for the reallocation of workers to technology occupations is that offshoring may have lowered the returns to production work, and therefore the opportunity cost to innovate. This theoretical mechanism was first highlighted by Rodríguez-Clare (2010), who shows that worker

reallocation can lead to higher aggregate productivity and growth in a dynamic setting. Our paper is one of the first to provide empirical evidence on this channel.

The rest of the paper proceeds as follows. In section 2 we describe the new offshoring data and provide descriptive statistics on how it relates to firms' import behavior and employment changes. Section 3 discusses how we exploit the productivity changes within EU12 countries to identify the effects of offshoring. We present results from this analysis in 4, and in section 5 show that offshoring is also associated with new product development and increased R&D spending. The last section concludes.

2 Data

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

2.1 Offshoring survey

We use a 2007 offshoring survey run by Statistics Denmark that asked firms about their offshoring decisions between 2001 and 2006. The survey was part of a larger effort designed by Eurostat to assess European firms' global production decisions. While the original Eurostat survey was aimed at all private sector firms with at least 100 employees, Statistics Denmark surveyed all firms with more than 50 employees that existed in 2005, and firms with 20-50 employees in selected industries.[1] 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

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

management functions; engineering work and other technical services; R&D; facility management (cleaning, security, food, etc...); other functions. We focus on a firm's decision to offshore its core business activity to a foreign location.

The specific language in the survey asked firms whether they moved a particular activity to one or more of seven distinct regions.[2] We emphasize that this offshoring definition includes only those functions that were previously performed domestically, either by the firm itself or by another domestic firm. It does not include foreign locations of newly undertaken activities, which are asked about in another part of the survey.

The survey also asked firms to identify the country or regions to which they offshored. The survey used the following breakdown of sourcing by location: "Old" EU countries (EU15); "New" EU countries (EU12)[3]; other European countries; China; India; other Asian countries and Oceania; US and Canada; Central America; and Africa. Firms were also asked to identify whether they offshored their core activity to new and/or existing firms within the same business group, or to separate firms.

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

2.2 Additional data sources

We combine the offshoring survey data with a number of different data sources on Danish firms. We use the Firm Statistics Register (FirmStat), which is based on Value-Added

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

[3]EU12 countries are Poland, Hungary, Bulgaria, Romania, Slovakia, Czech Republic, Cyprus, Slovenia, Estonia, Latvia, Lithuania, and Malta.

Tax (VAT) administrative data, to gather information on firm sales, value added, material expenditures, capital, total employees, and industry (six-digit NACE). We use these data, which are available for the population of Danish firms, to construct a firm-level panel from 1996 to 2012. This time frame and coverage allow us to analyze potential selection into the offshoring survey, as well as any differential trends for offshoring versus non-offshoring firms.

We augment the VAT data with product-level information about the values and quantities of firm production from manufacturing production surveys (ProdCom). These quarterly surveys are available beginning in 1995 and cover all manufacturing firms with at least ten employees. They provide information on the value of production by six-digit Harmonized System (HS) product codes. We also exploit new data on manufacturing firms' purchases of intermediate inputs. These data are available for all manufacturing firms with at least 10 employees. In principle these data are also available at the same HS6 level of aggregation, though in practice firms often report at the more aggregated HS4 level.

We also link our data set to the Danish Foreign Trade Statistics Register. The trade data are based on Customs declarations and cover all international trade transactions of Danish firms by product and destination/origin. A benefit of the Danish data is that products in the trade data are classified using the same HS codes as the production and input use data. This facilitates comparisons of Danish firms' production, input purchase, and trade decisions.

A critical element in our analysis is to exploit detailed information about the population of Danish individuals over the period 1991 to 2012. To do so, we use data extracted from Integrated Database for Labor Market Research (IDA). These data cover the universe of the Danish population aged 15-74, including the unemployed and those outside of the labor force. They provide information on workers' gender, age, experience, tenure, wage, education level, and occupation. Workers are linked to the plant and firm where they are employed. The dataset also provides a six-digit NACE industry code for the economic activity of each worker's plant.

We use the IDA data to define worker occupation groups. Following Bernard et al. (2017),

we determine the number of workers for five different occupational categories: managers; technology workers (R&D workers and technicians); support activities; sales activities; and line workers. We further decompose line workers into two separate categories: those involved in transport and warehousing (line 1) and the others, mostly involved in the production process (line 2).[4]

We also add data from R&D surveys that span the period from 1998 to 2010. These surveys are only available for between 3,500 and 4,500 firms depending on the year. Firms surveyed are supposed to represent the universe of potential innovators, which means in practice that specific innovative sectors and firms above a certain size threshold are targeted. While the full set of questions in each survey varies by year, we construct a panel of the share of R&D expenditure in total revenue, as well as the share of R&D workers in total employment.

2.3 Descriptive evidence

In this subsection, we provide summary statistics of the new offshoring data and descriptive evidence on how it relates to firms' employment composition.

2.3.1 Summary statistics about offshoring

We first describe the distribution of offshoring activities across sectors. Figure 1 shows two views of the distribution of offshoring across industries with the most offshoring activity.[5] The industries are sorted by the share of firms that offshore in the industry between 2001 and 2006 - the solid blue columns. More than 30 percent of the firms in the textile and motor vehicle sectors offshore their main activity. Other sectors with high rates of offshoring include basic metals, other manufacturing, electrical machinery and machinery and equipment.

The striped red columns show the share of that industry in total offshoring. Most industries have comparable numbers, if not rates, of offshoring firms. One exception is machinery

[4]See the online data appendix for the definition of these groups based on the ISCO code.

[5]Not all industries can be displayed in the figure for disclosure avoidance.

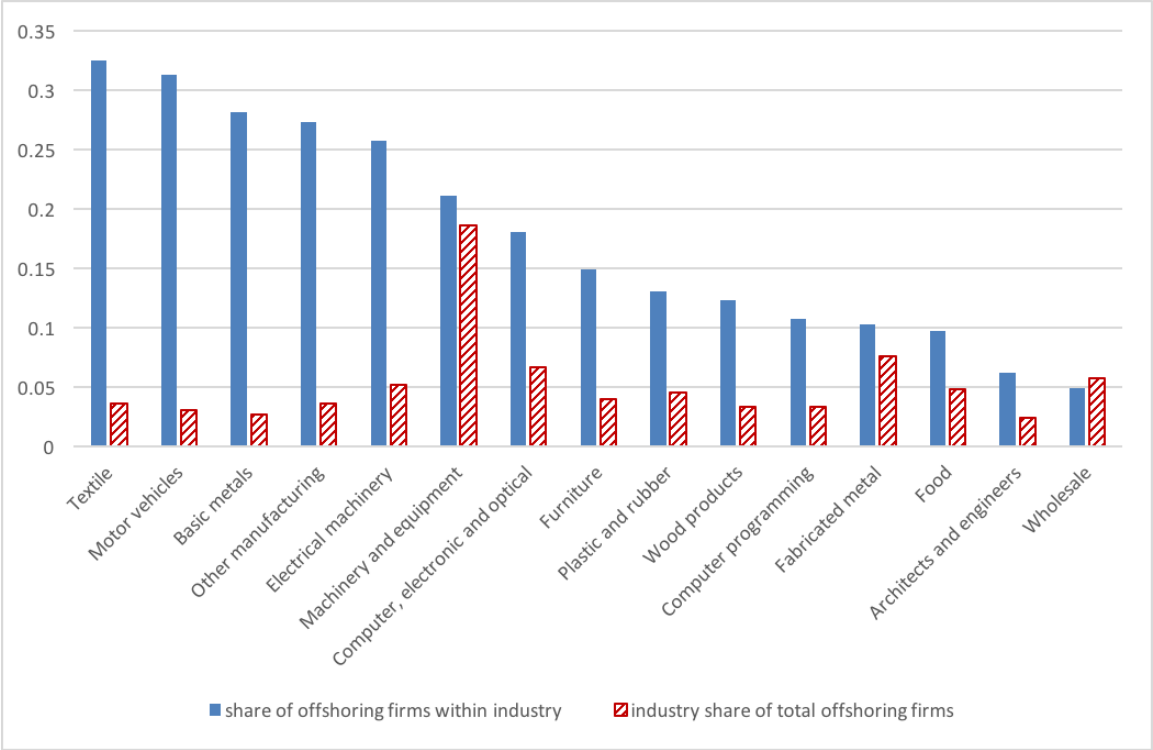


Figure 1: Industry distribution of offshoring firms

and equipment which has both a large fraction of firms that offshore and a large portion of the total number of offshoring firms.

The data show that about nine percent of firms in the survey relocate their core activity to a foreign country between 2001 and 2006. Table 1 presents the count of firms that offshore to each region, along with the fraction of total offshoring firms that they represent. EU12 is the most popular offshoring location, with over half of Danish offshorers relocating their main activity there. One third of the offshoring firms relocate their core activity to China, making it the second most prevalent location. While the majority of firms that offshore do so to only one region, Table 2 shows that about one quarter of the offshoring firms relocate their core activities to two regions, and over ten percent do so to three or more regions.

We also examine the relationship between offshoring and importing. Offshoring is often equated with imported intermediates, but offshoring can take place in a variety of forms. It is not evident that a firm that relocates its main activity to a foreign country will necessarily

Table 1: Offshoring of core activity by region

Region	Firm count	Share
EU-12	205	0.54
China	126	0.33
EU-15	109	0.29
Other Asian countries and Oceania	60	0.16
Other European countries	46	0.12
India	30	0.08
US and Canada	25	0.07
Total offshoring firms	380	0.091

Notes: Locations to which firms relocated their core activity.

Table 2: Number of locations to which firms offshore core activity

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

Notes: Regions are defined in Table 1

import intermediates. In fact, offshoring need not entail any importing by the firm back to the home country. Many firms offshore assembly of the final product, and others offshore the entire production activity of a product.[6]

To analyze the relationship between offshoring and importing, we define a firm as an importer from a particular region if that firm has positive imports during the period of 2001 to 2006. Table 3 shows that the vast majority of firms that report relocating their core activity to a particular region also have positive imports from that region during the period. Among firms that offshore their main activity to the EU12 region, 93 percent also import from one or more of those countries. For firms that offshore to China, the comparable number is 96 percent.

Table 3: Share of firms that import from the region to which they offshore

EU-12	0.93
China	0.96
EU-15	0.89
Other Asian countries and Oceania	0.93
Other European countries	0.95
India	0.82
US and Canada	1.00
All offshoring firms	0.95
All non-offshoring firms	0.70

Notes: Offshoring firms are defined as those that relocated their core activity to a foreign region between 2001 and 2006. Inputs and final production based on the firm's values in 2000. A firm is considered to import from a region if we observe any positive imports between 2001 and 2006.

For the top two sourcing locations, EU12 and China, we also analyze the types of goods imported by offshoring versus non-offshoring firms. We use survey data from the input survey described above to identify whether a firm's imports constitute intermediate inputs. We classify all imported products of the firm as intermediate inputs if the firm lists that product as a purchased input. We use the production survey to identify a firm's production and label all imports that the firm also produces as imports of final goods. These classifications

[6]For example, firms may engage in platform FDI, as modeled in Tintelnot (forthcoming).

need not be mutually exclusive since a firm could both produce a particular product and also purchase it as an input. In this analysis, we examine firms' import behavior in both 2000 and 2007.

The first column in Table 4 shows an increase between 2000 and 2007 in the share of firms that started importing from the region to which they offshored between 2001 and 2006. Of the firms that relocated production to EU12, the share that also imported from EU12 rose only mildly by 4 percentage points, from 0.80 in 2000 to 0.84 in 2007. For firms that offshored to China, that share that also imported increased from 0.63 to 0.99. However, the increases for non-offshoring firms are comparable, remaining stable for EU12 and increasing by 24 percentage points for China. Offshorers are more likely to import from the destinations both before and after they move their primary activity abroad.

Table 4: Share of offshoring firms' that import by region and good type

	Any Imports	Share that imports Inputs	Final Goods
Panel A: 2000			
Offshore to EU12			
No	0.50	0.01	0.13
Yes	0.80	0.06	0.39
Offshore to China			
No	0.27	0.02	0.07
Yes	0.63	0.14	0.32
Panel B: 2007			
Offshore to EU12			
No	0.50	0.09	0.19
Yes	0.84	0.24	0.59
Offshore to China			
No	0.51	0.08	0.17
Yes	0.99	0.36	0.72

Notes: Offshoring firms are defined as those that relocated their core activity to a foreign region between 2001 and 2006. Columns 2 and 3 report the shares of importing firms that import input and final goods from those regions, respectively. Analysis based on the subset of firms for which production and input data are available.

While the vast majority of offshoring firms do import from the region to which they have relocated production, column 2 shows that only a small fraction of these importers import intermediate inputs. By 2007, just under a quarter of firms that offshored to EU12 imported any intermediates from that region. For firms that offshored to China, about a third also imported intermediates. Final good imports are more common. Over half of the firms that began offshoring to EU-12 imported final goods from the region, and three quarters of China offshorers imported final goods from the country.

The richness of these data provides novel evidence on the relationship between offshoring and importing. While it has become common to equate a firm's decision to relocate production to a foreign country with a decision to import intermediates, the results in Table 4 show that this does not occur in the majority of cases. To the extent that researchers have relied on intermediate goods flows to infer the prevalence or importance of offshoring, these findings suggest that those inferences may be flawed.

2.4 Offshorer premia

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

Column 1 of Table 5 reports premia from a simple regression of the (log) characteristic in 2000 on a future offshoring dummy. Column 2 adds industry fixed effects, and column 3 includes industry fixed effects and an importer dummy. Offshorers are substantially larger in terms of sales and employment than non-offshoring firms in the same industry. They also have greater capital-labor ratios, more skilled workers, a greater share of technology workers, and are more likely to either export or import. A simple measure of labor productivity, sales per workers, is lower at future offshorers in 2000. These results are broadly consistent with

the characteristics of firms that engage in foreign markets more generally, with the exception of the lower labor productivity. The latter suggests that offshoring firms are not necessarily more profitable, and that the offshoring decision may reflect selection driven by negative shocks.

Table 5: Offshorer premia in 2000

	No Controls	+Ind Fes	+Imp dummy
log FTE	0.46***	0.57***	0.41***
log Sales	0.45***	0.62***	0.41***
log Y/L	-0.03	-0.03	-0.05*
log K/L	0.25***	0.22***	0.15*
log Skill	0.04	0.37***	0.30***
Tech share	0.02*	0.03***	0.02**
Importer	0.33***	0.18***	-
Exporter	0.32***	0.15***	0.05**

Notes: Each entry is the estimated coefficient from regressing the variable in column 1 on an indicator for whether the firm offshored its primary activity between 2001 to 2006. The column "No Controls" is a bivariate regression with no controls. The column "+ Ind Fes" includes industry fixed effects. The column "+ Imp dummy" includes industry fixed effects and an indicator for whether the firm imports in 2000.

Table 6 shows the changes in these same firm characteristics from 2001 to 2006, the period when the offshoring is undertaken. Employment growth is significantly lower at offshorers while sales growth is lower, although not significant when firm import status is added as a control. Among the other characteristics the only significant difference is for the change in technology worker share, which is higher for offshoring firms.

2.4.1 Offshoring and employment composition

There has been considerable attention paid to the employment effects of offshoring. Table 7 presents summary statistics of the labor composition at offshoring firms. The top Panel A shows that offshoring firms have seen a relatively larger decline in their share of less-educated workers. These workers fell from 40 percent of the workforce at offshoring firms in 1998, to

Table 6: Changes in firm characteristics from 2001-2006, by offshore status

	No Controls	+Ind Fes	+Imp dummy
log FTE	-0.26***	-0.17***	-0.17***
log Sales	-0.14***	-0.08*	-0.07
log YL	-0.01	0.00	0.01
log KL	0.13**	0.07	0.07
log Skill	-0.04	0.01	0.01
Tech share	0.02***	0.02***	0.02***
Importer	-0.04*	-0.02	-
Exporter	0.00	-0.01	0.00

Notes: Each entry is the estimated coefficient from regressing the change from 2001 to 2006 in the variable in column 1 on an indicator for whether the firm offshored its primary activity between 2001 to 2006. The column "No Controls" is a bivariate regression with no controls. The column "+ Ind Fes" includes industry fixed effects for the firm's industry. The column "+ Imp dummy" includes industry fixed effects and an indicator for firms that began importing in the period 2001 to 2006.

30 percent in 2008. In contrast, the share of these workers at non-offshorers stayed almost constant, going from 39 to 38 percent over the same period.

Panel B of Table 7 presents similar information on labor composition by occupations. The most notable difference between offshoring and non-offshoring firms is in their shares of technology workers. Offshorers start with technology workers comprising 15 percent of their workforce in 1998, but the share climbs about 60 percent to 24 percent of the workforce by 2008. In contrast, technology workers increase from 12 to 14 percent of the workforce for non-offshorers over the same decade. Both types of firms see their production worker shares decline, with slightly larger declines for offshorers. While offshorers decrease their technology worker shares relatively more, non-offshorers see bigger increases in their share of sales workers. Sales worker shares increase by 60 percent (3 percentage points) at offshorers, compared to a relative 75 percent (11 points) at non-offshorers.

Figure 2 plots the average number of workers at offshoring and non-offshoring firms from 1998 to 2008. First, it is clear that firms in the offshoring survey are significantly larger than the average firm in Denmark. The average non-offshorer has over 100 employees in

Table 7: Labor force characteristics by offshoring status

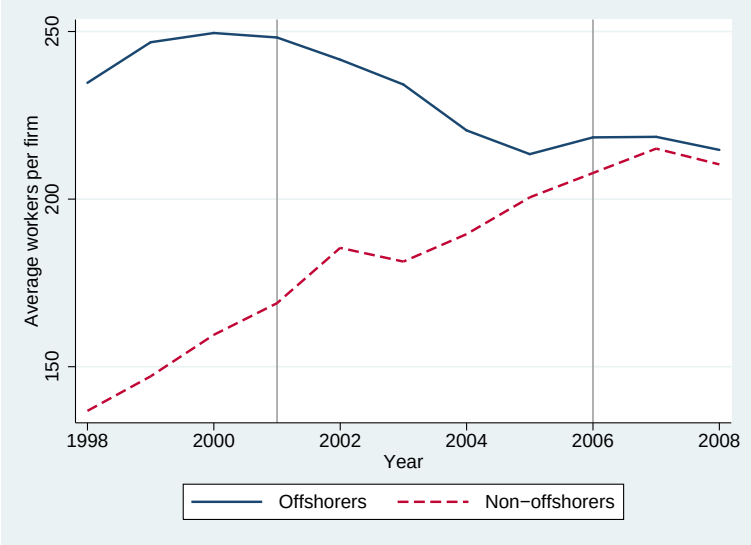
	1998	2001	2006	2008
Panel A: Education				
Offshoring firms				
Education - low	0.40	0.37	0.32	0.30
Education - middle	0.55	0.57	0.58	0.59
Education - high	0.05	0.06	0.10	0.11
Non-offshoring firms				
Education - low	0.39	0.38	0.39	0.38
Education - middle	0.54	0.55	0.53	0.52
Education - high	0.06	0.07	0.08	0.09
Panel B: Occupations				
Offshoring firms				
Managers	0.04	0.03	0.04	0.04
Production workers	0.55	0.54	0.43	0.38
Blue non production workers	0.07	0.07	0.06	0.06
Tech workers	0.15	0.17	0.22	0.24
Support workers	0.14	0.13	0.17	0.18
Sales workers	0.05	0.05	0.07	0.08
NEC	0.01	0.01	0.01	0.01
Non-offshoring firms				
Managers	0.04	0.04	0.04	0.04
Production workers	0.31	0.32	0.25	0.22
Blue non production workers	0.09	0.09	0.11	0.10
Tech workers	0.12	0.13	0.14	0.14
Support workers	0.30	0.27	0.28	0.28
Sales workers	0.12	0.13	0.18	0.21
NEC	0.02	0.02	0.01	0.01

Notes: Offshoring firms are defined as those that relocated their core activity to a foreign region between 2001 and 2006.

1999. Offshoring firms are almost twice this size, with over 200 employees in 1999. Although offshoring firms start larger, their trends in average firm size are similar from 1998 to 2001. Starting in 2001, however, the offshoring and non-offshoring firms' behavior diverges significantly. The average offshoring firm size drops sharply from 2001 to 2005 and then flattens out. In contrast, non-offshorers display a general upward trend in their average firm size. By 2008, the two types of firms' average size is remarkably similar.

In the two panels of Figure 3, we show the comparable path for firms that offshore to the EU12 and to China. The overall pattern of employment changes remains the same. Offshoring firms reduce their employment substantially, while non-offshorers have rising employment levels.

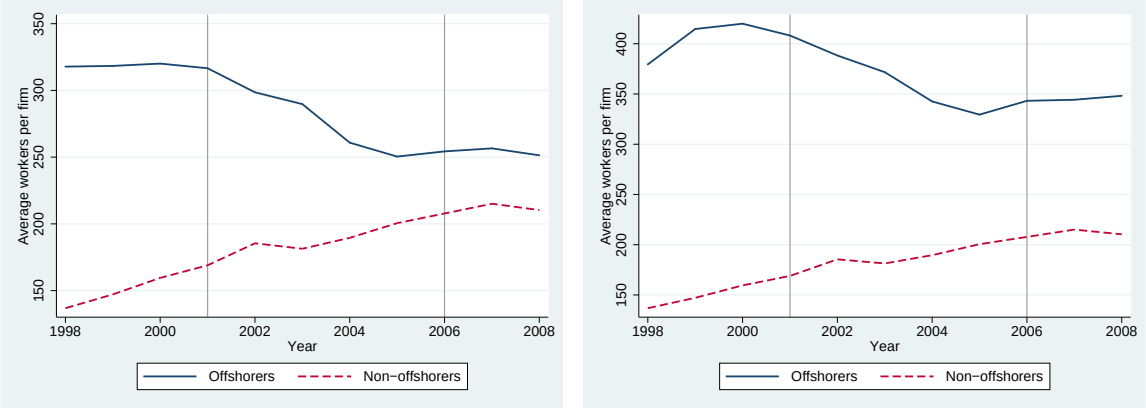
Figure 2: Average firm employment by firm's offshoring status



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

An important contribution of this paper is to show how offshoring relates to a firm's allocation of resources – and in particular employees – towards innovative activities. Figure 4 plots the share of technology workers in total employment for offshoring and non-offshoring firms. Future offshoring firms start with higher shares of technology workers, and over time the difference almost doubles. Offshoring firms display a clear positive increase in their share

Figure 3: Average firm employment by offshore region

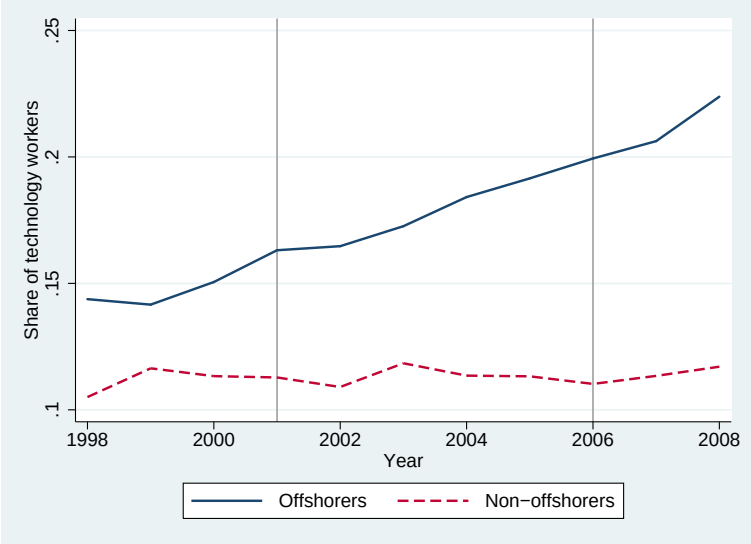


(a) Offshore to EU12 (b) Offshore to China

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

of technology workers over time, while there is no significant change in the share technology workers over the long period for non-offshorers.

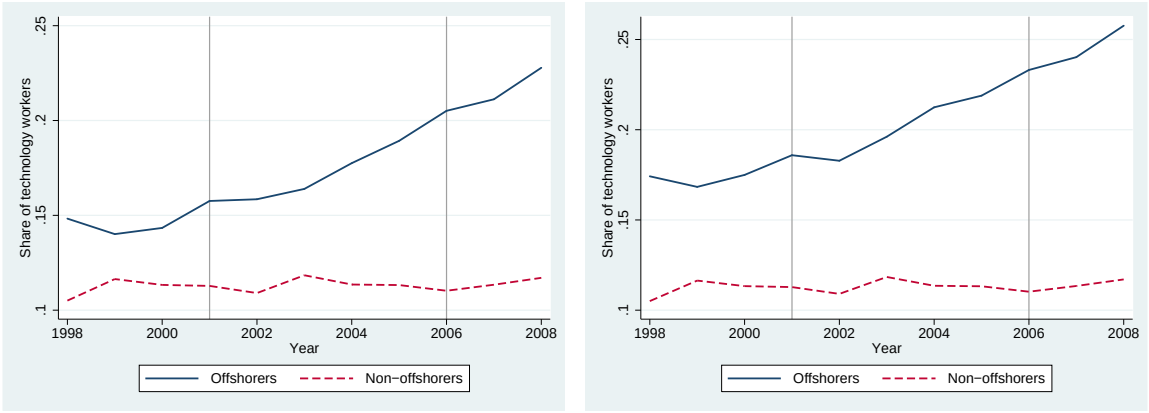
Figure 4: Share of technology workers by firm's offshoring status



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

One possible explanation for the patterns depicted in figures 2 and 4 is that offshoring firms are disproportionately shedding their production workers. Figure 6 shows how firms' share of production workers has evolved over time. Although offshorers have much higher

Figure 5: Share of technology worker employment by offshore region



(a) Offshore to EU12 (b) Offshore to China

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

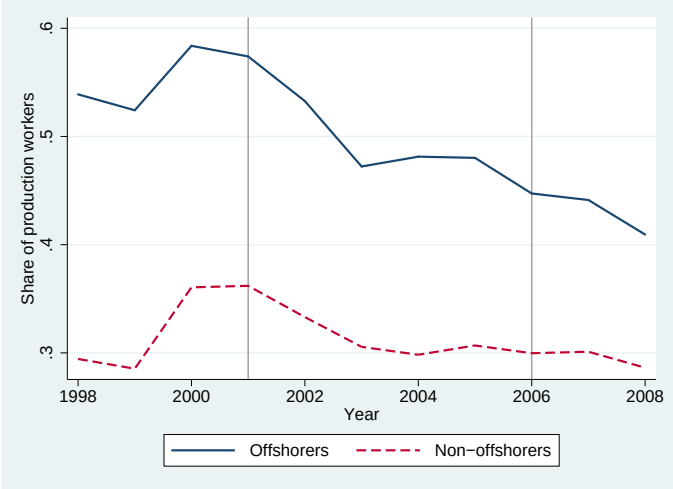
production worker shares, both types of firms display very similar trends between 2001 and 2008.

These patterns suggest that the disproportionate increase in offshoring firms' share of technology workers is not solely driven by their of firing production workers. In fact, the data show that the increase in offshorers' technology worker shares is not just a function of decreasing firm size. Offshorers had a net *positive* change in their aggregate level of technology workers from 2001 to 2008, even as their total employment declined.

2.5 Margins of worker adjustment

Offshoring firms are reallocating their activities away from those performed by production workers towards those performed by technology workers. These changes may mask a large amount of churning of workers inside the firm. Figure 7 shows that the shares of technology workers in firm hires and separations are both higher and increasing from 1998 to 2008 for offshoring firms. In figure 7a, we show that offshoring firms are increasing their hiring of technology workers relative to overall hires during the period, while non-offshoring firms have relatively constant hiring shares of technology workers. Similarly, Figure 7b shows that

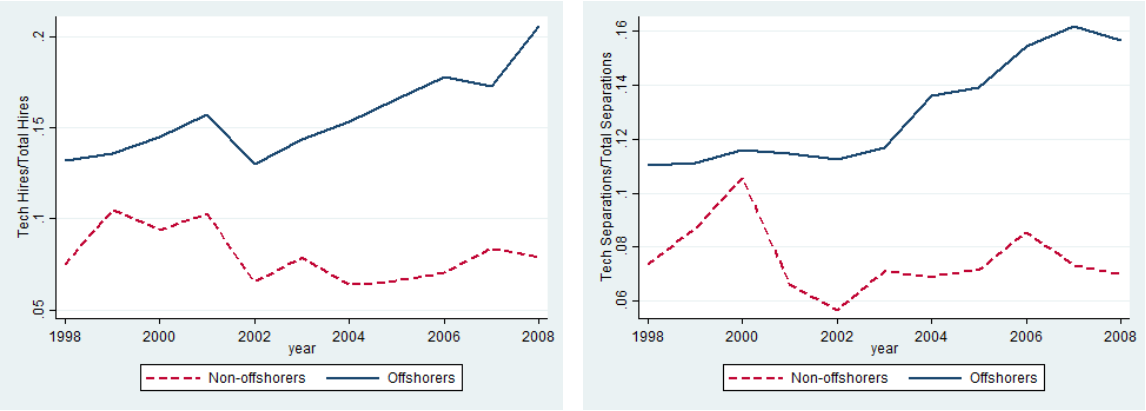
Figure 6: Share of production workers by firm's offshoring status



Notes: Figure plots the share of line 2 production workers over total employment for firms in the offshoring survey. Offshoring firms are those that relocated their core activity to a foreign country between 2001 and 2006.

separations at offshorers are disproportionately in technology workers, and that prevalence is rising during the period. For non-offshorers, the share of tech workers in separations is lower and constant.

Figure 7: Tech worker shares of hires and separations by offshore status

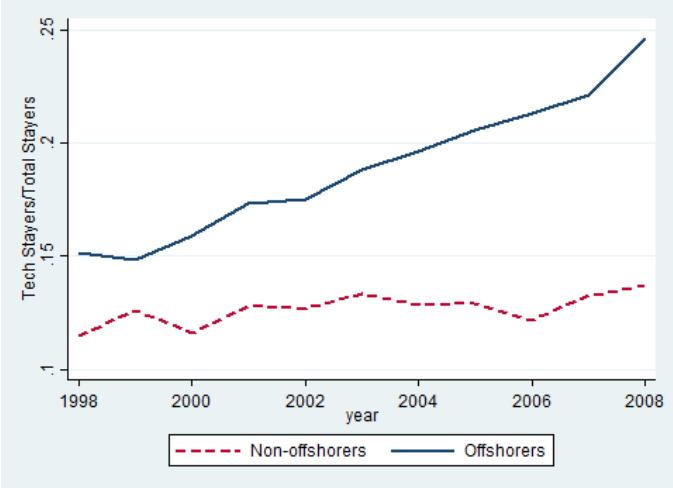


(a) Share of tech worker hires (b) Share of tech worker separations

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

We also examine the composition of workers employed at the same firm from year t to $t+1$.

Figure 8: Share of tech worker stayers by offshore status



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

Figure 8 shows that for workers that remain at the firm, the share of technology workers is higher and steadily rising at offshorers. This stands in sharp contrast to the pattern in non-offshorers, where the share of retained workers in technology occupations remains relatively constant over the period. Most interestingly, preliminary results indicate that approximately one third of the increase in the share of technology stayers over total stayers consists of workers who switched their occupation from a non-technology to a technology occupation *within* the firm.

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

3 Theoretical motivation and empirical approach

In this section, we first describe potential theoretical channels through which offshoring and innovation may be related. We then discuss several challenges to documenting a causal relationship between a firm's decision to relocate its core activity to a foreign country and its decision to reorganize domestic production towards R&D. Finally, we present an identification strategy to address these issues and to provide information on the various potential channels.

3.1 Theoretical channels for offshoring and innovation

One way in which offshoring may affect innovation is to allow for increased gains from specialization. A number of early papers focus on the possible efficiency gains from this type of fragmentation of production (e.g., Deardorff, 2001; Jones and Kierzkowski, 2001; Kohler, 2004). More recent work conceptualizes production as a combination of different tasks that can be performed in distinct geographic locations (Grossman and Rossi-Hansberg, 2008, 2012). In these papers, decreases in the costs to offshore certain tasks lead to productivity gains that imply offshoring sectors may expand their remaining domestic activities. A distinct but related link between offshoring and innovation can be found in the work of Rodríguez-Clare (2010). In that paper, increased offshoring lowers the production worker wage in high wage countries, thereby decreasing the opportunity cost for workers in those countries to engage in innovation-related activities. In our context, when Danish firms relocate activities in which they are relatively less productive (e.g., production work) to a foreign country, they may enjoy gains to specialization as they re-focus domestic resources on R&D-related activities.

Another channel through which offshoring and innovation may be related is the focus of work that considers a firm's decisions to trade with other countries and to invest in new research and technology. Melitz and Constantini (2008), Lileeva and Trefler (2010), and

Bustos (2011) present endogenous technology adoption models in which a trade shock may induce some firms to upgrade their technology so that they grow enough to pay the fixed cost to trade. In a related paper, Boler et al. (2015) develop a model in which there are strong complementarities between firms' sourcing decisions and their R&D investment. In their model, trade and technology are complementary activities because they both lead firms to become more profitable and thus cover associated fixed costs. Analogously in our work, if firms find offshoring more profitable, this may facilitate an increase in their innovative activities. One way to assess whether this channel drives our results is to see whether our estimates are affected by controlling for changes in firm sales over the offshoring period. If the impact of offshoring on innovation is due to a firm scale effect, we would not expect to find significant results once we control for changes in firm sales.

Offshoring and innovation may also be related if they are both a firm's optimal response to increased competitive pressure from abroad. Bloom et al. (2014) present a framework in which firms that face increased import competition reallocate "trapped" resources within the firm towards R&D activities. In that model, increased competition lowers the opportunity cost to innovate so that firms decrease production and shift workers into innovative activities. A key feature of their theoretical channel is the presence of labor market frictions that make it infeasible (or suboptimal) for the firm to fire workers in response to the increased competition. Import competition may also lead firms to innovate by reducing x-inefficiencies (Schmitz, 2005), or by changing managerial incentives (Schmidt, 1997; Aghion et al., 2005). It seems unlikely that Danish firms face these types of firing frictions, so that trapped factors probably do not drive our results. Import competition more generally, however, has clear potential implications for firm innovation. We therefore focus on empirical specifications in which we control for industry-level import penetration separately from a firm's decision to offshore.

Offshoring and innovation may also be related if firms' decisions to relocate overseas increase their access to new ideas or inputs. A number of papers document an important

role for imported intermediates in improving firm productivity (Amiti and Konings, 2007; Goldberg et al., 2010; Halpern et al., 2011), and for imports in spreading ideas across countries (Coe and Helpman, 1995; Acharya and Keller, 2009). These channels may be quite important for offshoring by developing countries to more developed countries, but are likely to be less important when considering Danish firms' offshoring decisions to low wage countries, such as China and EU12 countries. In addition, we focus on Danish firms' decision to offshore their main activity, which is potentially distinct from the decision to offshore IT and R&D activities.

3.2 Empirical approach

An important contribution of this paper is to show that offshoring leads firms to reallocate their domestic resources towards innovative activities. A primary concern with estimating this relationship is that a firm's decision to offshore may be part of a larger, long-term strategy to reorganize the firm. One might expect a downward bias on the estimated coefficient of the effect of offshoring on innovation if firms start offshoring as part of a bigger strategy to reduce costs. In this scenario, firms may seek to lower costs not just by relocating production offshore, but also by reducing domestic expenditure on higher wage occupations. Alternatively, one might expect an upward bias on the OLS estimates if firms offshore their main activities so that they can re-orient domestic resources towards innovation. To address these possibilities, we implement an instrumental variables (IV) strategy in which we identify firms that began offshoring due to factors external to both the firm and Denmark.

In particular, we exploit the significant productivity growth within offshore markets in years prior to firms' offshoring activity. Rapid performance gains in these countries increase the likelihood that Danish firms will want to offshore their main activity to take advantage of them. We use industry-level measures of productivity changes from 1996 to 2001 in the EU12 countries to construct exogenous shocks to potential savings from offshoring to that

region.[7] We assign a shock to each firm based on the firm's main NACE industry in 2001.

Our IV strategy identifies a firm's decision to begin offshoring to EU12 countries due to rising productivity in those countries in the years before offshoring. As is clear from the discussion on the potential theoretical channels through which offshoring and innovation may be related, it will be important to consider the role of changes in import competition in a firm's offshoring and employment decisions. In our first stage, we therefore estimate the probability that a firm will begin offshoring to EU12 countrires between 2001 to 2006 according to

$$Pr(\Delta Off_{iEU12}^{2001-2006} = 1 | \Delta X_i^{2001-2006}) = \beta_{EU12} \Delta Shock_{iEU12}^{1969-2001} + \beta_X \Delta X_i^{2001-2006}, \quad (1)$$

where $\Delta X_i^{2001-2006}$ includes the change in import penetration from the EU12 and the change in import penetration from China.[8] We include the latter since existing work on import competition finds that China's rapid export growth had significant negative labor market effects in the U.S.[9] Note that estimation of equation (1) is similar to a first differences approach since we exploit changes in foreign productivity to identify changes in a firm's offshoring decision.

4 Employment Allocation

Our instrumental variable strategy, outlined in section 3, identifies firms that began offshoring to EU12 countries as a result of improved regional productivity. The exclusion restriction requires that changes in EU12 productivity have no effect on Danish firms' in-

[7] We weight each industry-level productivity growth using the country's GDP in 2001, averaging productivity changes across all the countries for a particular industry.

[8] We measure regional import penetration as $Imports_{kR}/(Imports_k + Production_k)$. While the standard measure of import penetration would subtract total exports from the denominator to normalize by total domestic absorption, we do not do that here since this leads to negative import penetration measures in some instances. These negative values likely reflect inventories, trade in capital goods, and carry-along trade. See Bernard et al. (2012) for a description and analysis of the latter.

[9] For example, see Autor et al. (2013) and Autor et al. (2014).

novation decisions other than through their impact on a firm's decision to offshore to the EU12. Since increased import competition might violate the exclusion restriction (e.g., see Bloom et al., 2015), it is import to control for this channel.

4.1 First stage results

Table 8: First stage results for offshoring

Dep var is $\Delta Off_{i,EU12}^{2001-2006}$		
$\Delta_{j,EU12}^{1996-2001}$	0.200***	0.174***
	[0.048]	[0.051]
$\Delta ImpPen_{j,China}^{2001-2006}$		1.509***
		[0.584]
$\Delta ImpPen_{j,EU12}^{2001-2006}$		-0.144
		[0.531]
Constant	0.011	0.003
	[0.017]	[0.022]
Observations	1571	1571
Clusters	22	22
F-stat on excluded instruments	17.51	11.43

Standard errors in brackets, clustered by industry.
* p<0.10, ** p<0.05, *** p<0.01
The F-stat is the Kleibergen-Paap Wald F-statistic.

Table 8 presents first stage results for the offshoring outcome for the EU12. Changes in industry labor productivity in the region in the years before offshoring are positively and significantly correlated with the subsequent decision to offshore for the EU12. Interestingly Chinese imports enter with a positive and significant coefficient for the EU12 offshoring decision.

4.2 Second stage results

We can now present estimates of the impact of firm-level offshoring on innovation. To do so, we estimate

$$\Delta y_i^{2001-2008} = \beta_{Off} \Delta Off_{iEU12}^{2001-2006} + \varepsilon_i^{2001-2008}, \tag{2}$$

where $\Delta y_i^{2001-2008}$ is a change in a firm outcome from 2001 to 2008 and β_{Off} is the estimated coefficient on an indicator equal to one for firms that begin offshoring to EU12 countries between 2001 to 2006. We consider changes in firm outcomes from 2001 to 2008 since one would expect changes in a firm's mix of employees to take time to implement, and we do not know for any given firm the start year for the offshoring activity which itself might take time to finish. We report results throughout both with and without the inclusion of the import penetrations variables from the EU12 and China; however, we focus our discussion on those that include import penetration.

Table 9 presents OLS results for the IV sample for offshoring to the EU12. The offshoring variable is negative and significant for the total employment and technology worker growth rates, while the estimate for the share of technology workers in total employment is positive but statistically insignificant.

Table 10 reports the IV results for the same specifications. All the coefficients are now positive, and the share of technology workers and the growth rate of technology workers are positive and significant when controlling for import penetration. The differences between the OLS and IV results, and the importance of controlling for import penetration, suggest an important compositional issue in thinking about the effects and causes of offshoring. The effect of positive productivity growth in the EU12 countries induces firms to offshore and reorganize their domestic activities away from productions and towards innovation activities. The broader set of forces that induce offshoring to these markets include those that are associated with declining employment at home.

Table 9: OLS results for offshoring to EU12 and workforce changes

Dep Var is 2001-2008 change in :						
	log employment		Share tech		tech workers	
$\Delta Off_{i,EU12}^{2001-2006}$	-0.340***	-0.326***	0.008	0.010	-0.167*	-0.146*
	[0.102]	[0.102]	[0.007]	[0.006]	[0.093]	[0.084]
$\Delta ImpPen_{j,China}^{2001-2006}$		-2.597		-0.469		-4.811**
		[1.673]		[0.285]		[2.235]
$\Delta ImpPen_{j,EU12}^{2001-2006}$		1.680		-0.350*		-4.297**
		[1.307]		[0.203]		[1.580]
Constant	-0.016	-0.011	0.013**	0.026**	0.113**	0.254***
	[0.027]	[0.044]	[0.005]	[0.010]	[0.049]	[0.071]
Observations	1571	1571	1571	1571	1571	1571
R^2	0.017	0.022	0.001	0.010	0.002	0.010

Standard errors in brackets, clustered by industry. * p<0.10, ** p<0.05, *** p<0.01

Table 10: IV results for offshoring to EU12 and workforce changes

Dep Var is 2001-2008 change in :						
	log employment		Share tech		tech workers	
$\Delta Off_{i,EU12}^{2001-2006}$	0.484	0.851	0.067	0.188**	0.910	2.386**
	[0.411]	[0.574]	[0.075]	[0.092]	[0.899]	[1.013]
$\Delta ImpPen_{j,China}^{2001-2006}$		-5.160**		-0.857**		-10.322***
		[2.123]		[0.436]		[4.006]
$\Delta ImpPen_{j,EU12}^{2001-2006}$		1.360		-0.399		-4.985**
		[1.424]		[0.255]		[2.213]
Constant	-0.089**	-0.074	0.008	0.016	0.017	0.117
	[0.044]	[0.051]	[0.009]	[0.011]	[0.109]	[0.103]
Observations	1571	1571	1571	1571	1571	1571

Standard errors in brackets, clustered by industry. * p<0.10, ** p<0.05, *** p<0.01

4.3 Robustness

We now discuss the robustness of the results to the inclusion of a variety of controls. In appendix section A.2, we show that the results are robust to controlling for initial log firm sales, the growth rate of firm imports from 2001-2006, the change in log firm sales from 2001-2006, and pre-trends using the change in the dependent from 1996-2001.

Appendix table 13 shows that offshoring to the EU12 does not have a significant effect on firm size in any of these additional specifications. In contrast, increases in Chinese import penetration in a firm's output industry have a large, negative and significant coefficient in all specifications, except when controlling for changes in firm sales over the offshoring period. This is consistent with previous work that documents negative employment effects from import competition, and suggests that offshoring is correlated with a decline in average firm size not because offshoring itself causes firms to shrink, but because firms offshore in response to increased competitive pressure.

Tables 14 and 15 report similar specifications for the change in the share of technology workers and the growth rate of technology workers. The main results remain positive and significant in each case. Firms that offshore to EU12 countries increase their share and level of technology workers. Interestingly, changes in import penetration from China have negative and generally significant results in all these specifications as well.

A remaining concern with our empirical approach is that industry-level technology shocks may have led firms to hire more technology workers, and also lowered the coordination costs of offshoring (for example, as in Fort, forthcoming). If these technology shocks also led to productivity gains in EU12 countries, the exclusion restriction would be violated. We plan to address this possibility in future drafts by controlling directly for changes in firm-level technology.

5 Innovation

In this section, we provide descriptive evidence suggesting that the reallocation of workers towards technology-related occupations is related to innovative activities at the firm. We first show that offshoring is associated with relatively more new products. We also exploit R&D survey data, available for a subset of firms, to show that offshoring firms increase their R&D expenditures.

5.1 Offshoring and product development

To assess what offshoring firms may be doing differently, relative to non-offshorers, we compare changes in their product-level margins. To do so, we focus on the subset of manufacturing firms, since production data are available for this sector. Table 11 shows that in 2000, offshorers produce an average of 4.85 distinct products, compared to only 2.89 by non-offshorers. The difference is even larger by 2007, with offshoring firms producing 6.26 new products relative to only 3.05 for non-offshorers. The right panel shows that this disproportionate increase in new products by offshorers is driven by the fact that almost half of their products in 2007 are new, while less than one third of the products sold by non-offshorers are new introductions post 2000.

Table 11: Product switching by offshore status

	No. of Products		Product changes from 2000-2007		
	2000	2007	Continued	Dropped	Introduced
Non-offshorers	2.89	3.05	2.15	0.74	0.90
percent			*74.4%*	*25.6%*	*29.5%*
Offshorers	4.85	6.26	3.41	1.44	2.85
percent			*70.3%*	*29.7%*	*45.5%*
Total	3.22	3.60	2.36	0.86	1.24
percent			*73.3%*	*26.7%*	*34.4%*

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

The evidence in table 11 suggests that product development may be an important new

activity for offshorers. Since offshorers are more concentrated in certain industries, we also calculate within-industry statistics for product counts. Table 12 presents average product counts by offshore status, normalized by each firm's industry average. In both 2000 and 2007, non-offshorers produced fewer products than the average firm in their industry. In contrast, offshorers produced just over a quarter more products than their industry average in 2000, and almost 50 percent more by 2007. As in the raw count data, new products represent the most important margin of adjustment for these differences. While non-offshorers introduced only 0.81 percent of their industry average, offshoring firms introduced almost twice as many new products over the period.

Table 12: Product switching by offshore status, relative to firm's industry average

	No. of Products		Product changes from 2000-2007		
	2000	2007	Continued	Dropped	Introduced
Non-offshorers	0.94	0.90	0.95	0.91	0.81
Offshorers	1.28	1.46	1.22	1.46	1.94
Total	1.00	1.00	1.00	1.00	1.00

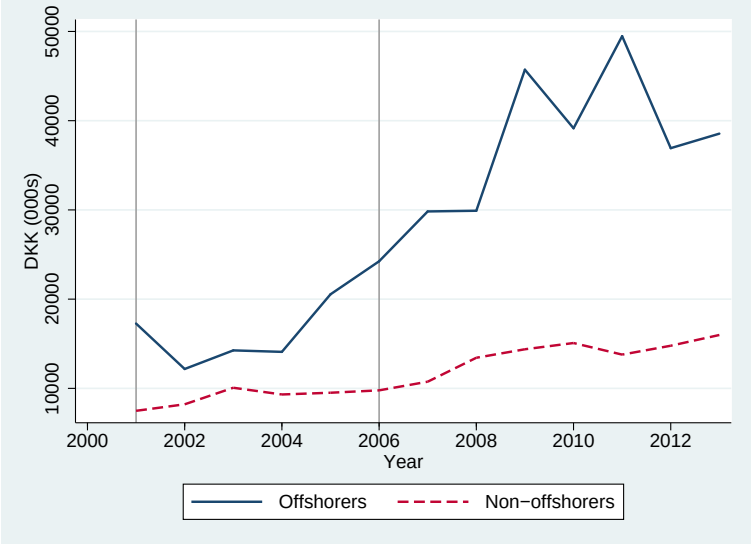
Notes: There are 1,220 firms (207 offshorers) with production data.

5.2 R&D Expenditure

We conclude this section with simple descriptive evidence on firms' R&D expenditures. Figure 9 plots average R&D expenditure in thousands of Danish Kroner by firms' offshore status. Beginning in 2004, there is a clear divergence in R&D spending trajectories, as offshoring firms significantly increase their expenditures, both in level terms and relative to non-offshorers. These results provide reassuring evidence that firms' shift in their workforce composition towards technology workers is indeed related to changes in their innovative efforts.

We further exploit the richness of the R&D survey information to shed light on which types of expenditures drive these changes. Figure 10 plots firms' average R&D expenditures

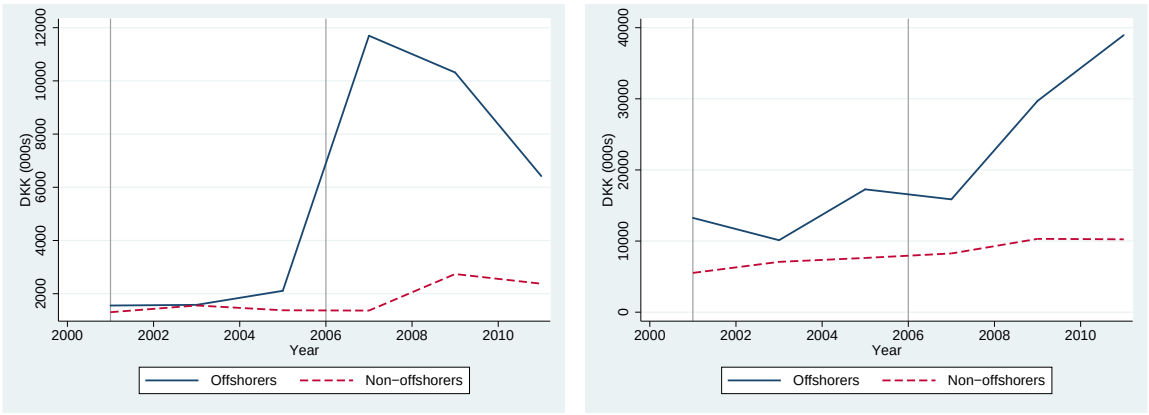
Figure 9: Average R&D expenditure



Notes: Figure plots average R&D expenditure for firms in the offshoring and R&D surveys. Offshoring firms are those that relocated their core activity to a foreign country between 2001 and 2006.

broken apart by product versus process R&D. The left panel shows that offshoring firms begin increasing their process innovation around 2004 and continue to do so through 2007. This suggests that offshoring entails changes in firms' physical production process which require additional research to implement. These changes appear to be short-lived however, as expenditure on process R&D falls sharply from 2007 through 2012. In contrast, the right panel of figure 10 shows that expenditure on product innovation increases somewhat during the initial offshoring years, and then grows significantly from 2007 to 2012. Product R&D by offshorers seems to replace their process innovation after 2007, and differs markedly from R&D expenditure by non-offshoring firms. This evidence supports the premise that offshoring allows firms to reallocate both workers and financial resources towards innovation, and highlights its potential to increase future growth with the advent of potentially more and better varieties of goods.

Figure 10: Average product and process R&D expenditure



(a) Process R&D (b) Product R&D

Notes: Figure plots average product and process R&D expenditure for firms in the offshoring and R&D surveys. Offshoring firms are those that relocated their core activity to a foreign country between 2001 and 2006.

6 Conclusion

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

The results in this paper point to important long-term implications of offshoring. We show that firms that relocate their main activities to a foreign country are more likely to shift their domestic resources into innovative activities. Since innovation is a major determinant of future performance, this shift has important potential implications for the long-term effects of offshoring on productivity and growth.

A Data appendix

A.1 Definition of core activity

The survey asks firms to identify their core activities. In doing so, they can choose the following general descriptions: regular manufacturing; subcontractors; factoryless goods producers; construction; regular services; design and R&D services; or other services.

A.2 Robustness specifications

This appendix section presents robustness tests for the main specifications presented in section 4.2.

Table 13: IV results for offshoring to EU12 and log firm employment

Dep Var is 2001-2008 log difference in firm i employment					
	(1)	(2)	(3)	(4)	(5)
$\Delta Off_{i,EU12}^{2001-2006}$	1.066	0.099	0.507	0.562	0.359
	[0.708]	[0.451]	[0.591]	[0.439]	[0.436]
$\Delta ImpPen_{j,China}^{2001-2006}$	-7.432***	-3.304*	-3.156	-4.752**	-3.962**
	[2.643]	[1.865]	[2.221]	[2.106]	[1.907]
$\Delta ImpPen_{j,EU12}^{2001-2006}$	0.552	0.547	0.827	0.999	-0.428
	[1.701]	[1.071]	[1.416]	[1.511]	[1.231]
$logSales_i^{2001}$	-0.172***				-0.050
	[0.040]				[0.031]
DHS $imports_i^{2001-2006}$		0.155***			0.009
		[0.031]			[0.016]
$\Delta logSales_i^{2001-2006}$			0.736***		0.744***
			[0.044]		[0.067]
$\Delta logEmp_i^{1996-2001}$				0.030	-0.015
				[0.054]	[0.048]
Constant	3.069***	-0.078**	-0.294***	-0.088**	0.656
	[0.690]	[0.040]	[0.048]	[0.040]	[0.551]
Observations	1570	1566	1564	1311	1306
First stage F-stat	9.58	10.40	9.61	16.05	10.90

Standard errors in brackets, clustered by industry. * p<0.10, ** p<0.05, *** p<0.01

DHS is Davis-Haltiwanger-Schuh growth rate in firm imports.

Table 14: IV results for offshoring to EU12 and firm tech worker share

Dep Var is 2001-2008 change in firm i tech worker share					
	(1)	(2)	(3)	(4)	(5)
$\Delta Off_{i,EU12}^{2001-2006}$	0.189**	0.190*	0.183*	0.148**	0.155*
	[0.094]	[0.098]	[0.095]	[0.074]	[0.085]
$\Delta ImpPen_{j,China}^{2001-2006}$	-0.906*	-0.866*	-0.865*	-0.706*	-0.746
	[0.470]	[0.457]	[0.454]	[0.417]	[0.469]
$\Delta ImpPen_{j,EU12}^{2001-2006}$	-0.427	-0.395	-0.410	-0.400	-0.405
	[0.260]	[0.248]	[0.255]	[0.266]	[0.274]
$logSales_i^{2001}$	-0.003				-0.002
	[0.003]				[0.004]
DHS $imports_i^{2001-2006}$		-0.001			-0.003
		[0.003]			[0.003]
$\Delta logSales_i^{2001-2006}$			0.000		0.002
			[0.007]		[0.007]
$\Delta techshare_i^{1996-2001}$				-0.085	-0.084
				[0.055]	[0.055]
Constant	0.071	0.016	0.017	0.015	0.058
	[0.059]	[0.012]	[0.013]	[0.012]	[0.080]
Observations	1570	1566	1564	1311	1306
R^2	-0.364	-0.371	-0.345	-0.228	-0.258
First stage F-stat	9.58	10.40	9.61	15.82	10.83

Standard errors in brackets, clustered by industry. * p<0.10, ** p<0.05, *** p<0.01
DHS is Davis-Haltiwanger-Schuh growth rate in firm imports.

Table 15: IV results for offshoring to EU12 and growth of tech workers

Dep Var is 2001-2008 DHS growth rate in tech workers at firm i					
	(1)	(2)	(3)	(4)	(5)
$\Delta Off_{i,EU12}^{2001-2006}$	2.550*	1.812*	2.224**	2.246***	2.174**
	[1.395]	[1.000]	[1.043]	[0.777]	[0.972]
$\Delta ImpPen_{j,China}^{2001-2006}$	-12.348***	-9.117**	-9.330**	-9.148**	-9.062**
	[4.711]	[4.035]	[3.937]	[3.901]	[4.524]
$\Delta ImpPen_{j,EU12}^{2001-2006}$	-5.780**	-5.376***	-5.217**	-5.995**	-6.865***
	[2.319]	[2.038]	[2.152]	[2.398]	[2.594]
$logSales_i^{2001}$	-0.149***				-0.049
	[0.053]				[0.045]
DHS $imports_i^{2001-2006}$		0.138***			0.000
		[0.037]			[0.041]
$\Delta logSales_i^{2001-2006}$			0.569***		0.617***
			[0.063]		[0.061]
DHS $techworkers_i^{1996-2001}$				-0.304***	-0.292***
				[0.039]	[0.039]
Constant	2.833***	0.101	-0.061	0.104	0.836
	[0.907]	[0.100]	[0.115]	[0.107]	[0.844]
Observations	1570	1566	1564	1311	1306
R^2	-0.526	-0.273	-0.332	-0.390	-0.267
First stage F-stat	9.58	10.40	9.61	14.83	10.24

Standard errors in brackets, clustered by industry. * p<0.10, ** p<0.05, *** p<0.01
DHS is Davis-Haltiwanger-Schuh growth rate.

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