Chinese Import Competition, Offshoring and Servitization*

Grace Gu† Samreen Malik‡ Dario Pozzoli§ & Vera Rocha¶

July 12, 2021

Abstract

This paper examines how domestic firms adapt to increased import competition from China, a topic of great relevance because of its implications for domestic growth and labor market outcomes. Using a Danish employer-employee matched dataset covering a large sample of manufacturing firms over the 1995-2007 period, we find that Chinese import competition significantly increases manufacturing firms' expansion of their business activities in the service industry (partial servitization). The probability of offshoring production activities abroad and of exiting the market are also positively affected by import competition. Import competition, however, does not induce firms to cease all of their involvement in production by switching completely and permanently out of the manufacturing sector (complete servitization). These findings are confirmed using various robustness tests as well as an analogous analysis of a Portuguese employer-employee matched dataset.

Key words: Foreign Competition, Offshoring, Servitization.

JEL code: F12, F14, O31.

*We are extremely grateful to Stephen Miller and to the seminar participants at University California Santa Cruz, Copenhagen Business School and the WEAI 2020 conference for the helpful comments and suggestions. We thank the data manager at Copenhagen Business School for granting access to the Danish registry data. Funding provided by the Danish Council for Independent Research in Social Sciences, Grant no. DFF-8019-00019B, is gratefully acknowledged. The usual disclaimer applies.

†Email: grace.gu@ucsc.edu. University of California Santa Cruz.

‡Email: samreen.malik@nyu.edu. New York University AD.

§Email: dp.eco@cbs.dk. Copenhagen Business School.

¶Email: vr.ino@cbs.dk. Copenhagen Business School.

1 Introduction

The surge of Chinese exports, encouraged by the country's transition to a market-oriented economy and rapid integration into the world economy, has been identified as a potential factor that could alter the course of the manufacturing sector, especially within the EU. Indeed, the recent decline of the manufacturing sector in high-income countries is documented in many papers (e.g., Bernard et al., 2017), and this trend has coincided with the rise of import competition from China. Against this backdrop, it is inevitable that manufacturing firms must adapt to survive and to avail themselves of the new opportunities offered by globalization.

There are numerous ways in which firms can respond. While some manufacturing firms may decide to exit the market in response to increased import competition because they find it unprofitable to continue production (exit, henceforth),[1] others may adjust by offshoring some or most of their production activities to low-wage countries to cut their labor costs (offshoring, henceforth).[2] Alternatively, some firms may consider switching partly into service activities to shift away from the production of tradable goods (servitization, henceforth). This includes two cases. In the first case, the firm becomes involved in activities that support its primary manufacturing function, such as wholesale, consulting or R&D activities (partial servitization, henceforth). In the second case, the firm fully switches into service activities (complete servitization, henceforth).[3]

Understanding how firms respond to import competition using one of the described meth-

[1] Melitz's (2003) model predicts that less productive firms are likely to exit production, and numerous studies, such as Bloom et al. (2016); Utar and Ruiz (2013), document that import competition from low-cost economies is associated with higher firm exit in industrialized countries.

[2] Grossman and Rossi-Hansberg's (2008) model of the global production process predicts that the reduced cost of some tradable tasks abroad would lead firms to choose to offshore tasks that have a limited cost of monitoring and coordinating workers abroad. A recent study on Denmark provides supporting evidence that foreign import competition is indeed positively associated with Danish firms' likelihood of offshoring to the new EU member countries (Bernard et al., 2020). Bernard et al. (2020) finds that trade induces Danish firms to offshore production and change their employment composition towards a much higher share of technology and research-related workers.

[3] In Breinlich et al.'s (2018) model, when there is rivalry between the goods a firm currently produces and the potential services it could offer, it implies that only specific firms with the accumulated expertise can fully transition from one output to the other. As a result, complete servitization may be a rare, although possible, phenomenon. Alternatively, if a firm's goods and services outputs are complements, the firm may choose to partially servitize in a related industry to include regular service to the product as a way to distinguish the domestic good from the imported good.

ods of adjustment is of key interest to policy makers and academics alike because each type of strategic adjustment may have important implications for domestic output, growth and unemployment. On the one hand, offshoring and exiting production altogether can lead to a reduction in manufacturing output coupled with an immediate loss of manufacturing jobs (Tybout et al., 1991; Tybout and Westbrook, 1995). On the other hand, servitization can give rise to the expansion of the service sector, new employment and the reallocation of labor. Despite these differential and significant implications for the domestic economy, we know relatively little about whether and how firms adjust to Chinese import competition.

In this paper, we first develop a simple theoretical multicountry framework to guide our empirical analysis. In our setup, each country has a continuum of firms that are heterogeneous in their productivity. Firms decide whether to offshore, servitize or exit the market in response to import competition while facing product-specific costs (goods or services) and location-specific costs (produced domestically or abroad). We characterize a productivity threshold for profit-maximizing firms and hypothesize that when a trade competition shock hits the economy less productive and non-exporting firms are likely to exit the market, whereas exporting firms and firms with high productivity are more likely to venture into servitization and offshoring.

We then test these hypotheses empirically by employing a matched employer-employee database for Denmark that covers a sample of manufacturing firms from 1995 to 2007. These data are well suited for our analysis for two reasons. First, the data measure the 4-digit industry affiliation of each establishment belonging to the same firm, which allows us to identify measures of both partial and complete servitization by exploiting detailed information at the plant level, similar to Bernard et al. (2017). Second, the data include detailed trade information, which allows us to measure offshoring at the firm level. This represents a significant improvement over the industry-level measures of offshoring that are common in the literature, since offshoring tends to be highly firm-specific (Hummels et al., 2014a).

We then extend our analysis to Portugal to explore whether the patterns we observe in Denmark can be generalized to another small open economy. Portugal, like Denmark, is highly exposed to Chinese import competition (OECD, 2013a,b) but differs from the Danish

context in many respects. For example, Portugal is characterized by a less flexible labor market and a more regulated product market than Denmark.

Our results show that import competition only positively affects Danish firms' probability of offshoring, partial servitization and exit. However, it does not impact the probability of complete servitization, of joint servitization with offshoring, or of switching to another manufacturing industry. Furthermore, we also find that most cases of partial servitization are instances of related servitization in which the industry of the service establishment is related to the core manufacturing activity of the firm. We then find that while both high- and low-productivity firms have a higher likelihood of partially servitizing in response to import competition, it is more likely for high-productivity firms.

Insofar as the evidence of service sector expansion in response to rising import competition is concerned, our results are in line with Bloom et al. (2019). However, we find no evidence of firms venturing into servitization and offshoring simultaneously, although Bloom et al. (2019) suggest that large US firms respond to Chinese competition by not only offshoring manufacturing employment but also simultaneously creating complementary jobs in U.S. research, design, management, and wholesale activities.[4]

By exploiting information on workforce composition and workers' characteristics, we show that there is an increase in the share and the number of workers employed in service establishments that can be attributed to both the within-firm reallocation of workers and new hirings. Firms that partially servitize their businesses in response to import competition achieve an increase in the workforce involved in the service industry, mainly by expanding the number of service establishments. Finally, the fact that we find similar results for Portugal suggests that the firms' adjustment in response to import competition is not limited to the Danish economy but is also evident in an economy that has starkly different institutions than Denmark.

Our empirical results confirm our theoretical hypotheses but are also in line with predictions from various other models studying firms' response to import competition. For instance, Crozet and Trionfetti (2013)'s framework predicts partial servitization of firms,

[4]Our sample mainly comprises of small firms. This may explain why we do not find any significant effect of import competition on the probability of joint servitization and offshoring. Small firms, may in fact, find it too costly to engage in both offshoring and servitization at the same time.

Grossman and Rossi-Hansberg (2008)'s model generates offshoring of tradable tasks by high-productivity firms and Melitz (2003)'s theory predicts the exit of low-productivity firms. Our empirical results confirm all these predictions and contribute to the literature by illustrating a firm's choice of offshoring, servitization (complete, partial and related) or exiting in response to an increase in Chinese import competition.

Apart from studying how firms adapt to import competition, two additional contributions of our work are worth highlighting. First, our work focuses on theoretically and empirically understanding a less explored channel of servitization, for which we provide a whole host of different measures by exploiting rich and detailed administrative data. This is a timely topic given the recent growth in the servitization trend among firms, which has been documented in many OECD countries (see Lodefalk (2017) for a comprehensive literature review), but the servitization implications of import competition have not been studied widely, with the only exception being Breinlich et al. (2018) and Greenland et al. (2020). Second, we extend our analysis with worker-level information to further understand whether the servitization channel leads to the reallocation of workers into the service sector.

In the next section, we present our theoretical framework. We then present our data and summary statistics in Section 3. Our empirical strategy is explained in Section 4, and our results are presented in Section 5. Finally we conclude in Section 6. Figures and tables are given at the end of the paper.

2 Theoretical Intuition

We propose a multicountry partial equilibrium model to demonstrate the mechanisms through which import competition (or trade liberalization in general) from a low-wage country (such as China) affects firms' servitization and offshoring decisions.

There are N countries, and each country has two sectors: manufacturing and service. Each sector supplies a differentiated product under monopolistic competition: each firm is a monopoly for the variety of goods (and services if any) that it produces, and it ignores the impact of their pricing choices on aggregate quantities. Only goods can be freely traded, and services cannot be traded across borders.

2.1 Demand

For each country, we assume that preferences for both the good and service varieties are given by the constant elasticity of substitution (CES) utility function. The utilities for the bundles of both goods and services are further aggregated using an additional CES function. The utility for country j's consumers can be written as:

$$U_j = [(1-a)C_{jm}^{\frac{\sigma-1}{\sigma}} + aC_{js}^{\frac{\sigma-1}{\sigma}}]^{\frac{\sigma}{\sigma-1}}$$
$$where\ C_{jm} = (\sum_{n=1}^{N} \int_{i_{nm} \in I_{nm}} x_{inm}^{\frac{\sigma_m-1}{\sigma_m}} di_{nm})^{\frac{\sigma_m}{\sigma_m-1}}$$
$$and\ C_{js} = (\int_{i_{js} \in I_{js}} x_{ijs}^{\frac{\sigma_s-1}{\sigma_s}} di_{js})^{\frac{\sigma_s}{\sigma_s-1}}$$

The elasticity of substitution between goods and services is $0 < \sigma < 1$, implying that goods and services are imperfect complements. $\sigma_m > 1$ and $\sigma_s > 1$ are the elasticities of substitution for the varieties within goods and within services, respectively, i.e., varieties within goods or services are imperfect substitutes. The share parameter a is between 0 and 1.

Consumers choose a demand for differentiated goods that maximizes their utility subject to their budget constraint. In this typical Dixit-Stiglitz framework, country j's demand functions for a single good (service) variety i from country n (including country j itself) are, respectively:

$$x_{inm} = E_{jm} P_{jm}^{\sigma_m - 1} p_{inm}^{-\sigma_m} \tag{1}$$
$$x_{ijs} = E_{js} P_{js}^{\sigma_s - 1} p_{ijs}^{-\sigma_s} \tag{2}$$

where country j's expenditures on goods and on services are, respectively:

$$E_{jm} = (1-a)^{\sigma} (\frac{P_{jm}}{P_j})^{1-\sigma} E_j \tag{3}$$
$$E_{js} = a^{\sigma} (\frac{P_{js}}{P_j})^{1-\sigma} E_j \tag{4}$$

Finally, country j's price index for goods, services and both can be written as:

$$P_{jm} = (\sum_{n=1}^{N} \int_{i_{nm} \in I_{nm}} p_{inm}^{1-\sigma_m} di_{nm})^{\frac{1}{1-\sigma_m}} \tag{5}$$

$$P_{js} = (\int_{i_{js} \in I_{js}} p_{ijs}^{1-\sigma_s} di_{js})^{\frac{1}{1-\sigma_s}} \tag{6}$$

$$P_j = [(1-a)^{\sigma} P_{jm}^{1-\sigma} + a^{\sigma} P_{js}^{1-\sigma}]^{\frac{1}{1-\sigma}} \tag{7}$$

2.2 Production

Each country has a continuum of firms that are heterogeneous in their productivity $z_i \in [0, 1]$. We assume that they all start as goods manufacturers and that each produces a single variety of differentiated goods domestically. Some firms may also choose to produce a single variety of differentiated service products with the same z_i or to produce their manufacturing products abroad, i.e., offshore.

We assume that labor is the only factor of production in the economy. Labor is supplied elastically in all countries and can freely move between manufacturing and service jobs within a country. Free mobility implies that wage rates are equalized across jobs in a country but not across countries.

Let us now consider a firm i; its production functions for goods and services (if any) are:

$$x_{im} = z_i m_i$$

$$x_{is} = z_i s_i$$

where m and s are the labor employed to produce goods and services, respectively.

All firms incur a positive fixed cost $f > 0$ when they produce goods domestically. An additional positive fixed cost, $f_s > 0$, is paid by firms when they also produce services. These fixed costs capture, among others, office rental costs and equipment purchases. A third positive fixed cost, $f_o > 0$, is paid when firms offshore goods production to a foreign country stemming from information frictions, language barriers, and institutional obstacles.

An operating firm i in home country j that only produces goods domestically and sells

everywhere maximizes the following profit:

$$\pi_i = \max_{p_{inm}} \sum_{n=1}^{N} (p_{inm} x_{inm} - w_j \frac{\tau_{in} x_{inm}}{z_i}) - f$$

where w_j is the domestic wage and $\tau_{in} >= 1$ is the iceberg trade costs that firm i in home country j pays in terms of labor costs to trade with country n. For $n = j$, $\tau_{ij} = 1$, i.e., domestic trade does not register any iceberg costs. For $n \neq j$, $\tau_{ij} > 1$

The firm chooses p_{inm} to maximize its profit. Given the demand function (1) and the above setup, from the first-order condition, the optimal pricing for firm i selling goods from home country j to country n is:

$$p^*_{inm} = \frac{\sigma_m}{\sigma_m - 1} \frac{w_j \tau_{in}}{z_i} \tag{8}$$

The optimal profits of firm i in home country j are:

$$\pi^*_i = \frac{1}{\sigma_m} (\frac{\sigma_m - 1}{\sigma_m} \frac{z_i}{w_j})^{\sigma_m - 1} \sum_{n=1}^{N} [E_{nm} (\frac{P_{nm}}{\tau_{in}})^{\sigma_m - 1}] - f$$

From the condition $\pi^*_i > 0$, we derive the productivity threshold z^* for firms' entry into domestic goods production:

$$z^* = \left\{ \frac{f \sigma_m (\frac{w_j \sigma_m}{\sigma_m - 1})^{\sigma_m - 1}}{\sum_{n=1}^{N} [E_{nm} (\frac{P_{nm}}{\tau_{in}})^{\sigma_m - 1}]} \right\}^{\frac{1}{\sigma_m - 1}} \tag{9}$$

It is also easy to see that in the special case in which an operating firm i in home country j produces goods domestically and only sells them domestically, the firm's productivity threshold z^* is:

$$z^* = \left\{ \frac{f \sigma_m (\frac{w_j \sigma_m}{\sigma_m - 1})^{\sigma_m - 1}}{E_{jm} P_{jm}^{\sigma_m - 1}} \right\}^{\frac{1}{\sigma_m - 1}} \tag{10}$$

Next, we will discuss firms' decision to servitize and offshore. For simplicity, in the model, we assume firms' offshoring and servitization decisions are separate and mutually exclusive.

Although we do not explicitly model the reason, one possible explanation could be financing constraint of simultaneously paying both f_s and f_o. In fact, from the data, we find that only a few very large firms (less than 2 percent in our sample) both servitize and offshore at the same time.

2.2.1 Servitization

If firm i in home country j produces both goods and services domestically, it maximizes the following profit:

$$\pi_{is} = \max_{p_{inm}, p_{ijs}} \sum_{n=1}^{N} (p_{inm} x_{inm} - w_j \frac{\tau_{in} x_{inm}}{z_i}) + p_{ijs} x_{ijs} - w_j \frac{x_{ijs}}{z_i} - f - f_s$$

The optimal pricing for firm i selling services in home country j is:

$$p^*_{ijs} = \frac{\sigma_s}{\sigma_s - 1} \frac{w_j}{z_i} \tag{11}$$

From the condition $\pi^*_{is} - \pi^*_i > 0$, we derive the productivity threshold z^*_s for firms' entry into domestic service production:

$$z^*_s = \left\{ \frac{f_s \sigma_s (\frac{w_j \sigma_s}{\sigma_s - 1})^{\sigma_s - 1}}{E_{js} P_{js}^{\sigma_s - 1}} \right\}^{\frac{1}{\sigma_s - 1}} \tag{12}$$

Note that the above condition holds regardless of whether the firm exports goods.

2.2.2 Offshoring

Next we consider the firm's offshoring decision. We assume that the firms that consider the offshoring option are also exporting firms, and non-exporting firms do not consider the offshoring option. This assumption is consistent with our empirical measure for offshoring, which is defined as exporting and importing products in the same 4-digit product code, as in Hummels et al. (2014b). Hence, all offshoring firms are also exporters in our empirical section.

If firm i in home country j offshores its goods production to foreign country k, where

$w_k < w_j$, it maximizes the following profit:

$$\pi_{io} = \max_{p_{inm}} (\sum_{n=1}^{N} p_{inm} x_{inm} - w_k \frac{\tau_{in} x_{inm}}{z_i}) - f - f_o$$

The optimal pricing for firm i, which offshores goods production to country k and sells goods from home country j to country n is:

$$p^*_{inm} = \frac{\sigma_m}{\sigma_m - 1} \frac{w_k \tau_{in}}{z_i} \tag{13}$$

The optimal profits of firm i is:

$$\pi^*_{io} = \frac{1}{\sigma_m} (\frac{\sigma_m - 1}{\sigma_m} \frac{z_i}{w_k})^{\sigma_m - 1} \sum_{n=1}^{N} [E_{nm} (\frac{P_{nm}}{\tau_{in}})^{\sigma_m - 1}] - f - f_o$$

From the condition $\pi^*_{io} - \pi^*_i > 0$, we derive the productivity threshold z^*_o in terms of the firm's offshoring decision:

$$z^*_o = \left\{ \frac{f_o \sigma_m (\frac{w_j w_k \sigma_m}{\sigma_m - 1})^{\sigma_m - 1}}{\sum_{n=1}^{N} [E_{nm} (\frac{P_{nm}}{\tau_{in}})^{\sigma_m - 1}] (w_j^{\sigma_m - 1} - w_k^{\sigma_m - 1})} \right\}^{\frac{1}{\sigma_m - 1}} \tag{14}$$

Note that we have not determined the order of magnitude among z^*, z^*_s, and z^*_o, as it depends on multiple factors, including the fixed costs. Since firms always start off as goods producers in this model, we assume that $z^* < z^*_s$ and $z^* < z^*_o$. However, we do not make any assumption of order between z^*_s and z^*_o, as servitization and offshoring are modeled as separate decisions. This approach is not inconsistent with the data, as we later show in Tables 1 and 2 that a very small share of firms both servitize and offshore and that those firms that do either operation have similar productivities (measured by sales per worker).

2.3 Trade Liberalization

We now use this partial equilibrium framework to derive some comparative statics, given the decline in iceberg trade costs τ for all firms in all countries that come with trade liberalization. Such trade liberalization thus also implies an increase in import competition from foreign

countries.

For exporting manufacturing firm i in country j, a decline in τ_{in} leads to a fall in the goods price index (P_{nm}). Overall, however, $(\frac{P_{nm}}{\tau_{in}})^{\sigma_m - 1}$ increases because $\sigma_m > 1$ and τ_{in} can only affect part of country n's aggregate goods price index P_{nm}, not all of its components, and thus P_{nm} does not decrease as much as τ_{in}. Intuitively, the profits of exporting manufacturing firms suffer from an aggregate goods price reduction (lower demand) due to trade liberalization, but they also benefit from lower iceberg costs in international trade when they export goods to other countries, and the benefit is larger than the cost. Thus, according to conditions (5), (8), (9), and $\sigma_m > 1$, the productivity threshold z^* will decrease with trade liberalization. That is, the entry productivity criteria for exporting manufacturers are lowered, and there will be more firms that only produce goods domestically and export globally. If we further see a decrease in E_{nm} according to equation (3), then the above effect on z_* will be dampened.

However, the productivity threshold z^* will rise for non-exporting manufacturers, according to equation (10), as P_{jm} falls. These firms suffer from lower demand without the benefit of lower international trade costs. That is, it now requires higher productivity to be a domestic manufacturer that does not export. This implies that, facing trade liberalization, some non-exporting manufacturing firms will exit the market. If we further see a decrease in E_{jm} according to equation (3), then the above effect on z_* will be strengthened.

Now considering firms' choice to servitize, according to equations (7), (4), and (12), the aggregate price index P_j will fall and the expenditure on services E_{js} will rise, since $0 < \sigma < 1$ assuming all else is equal, and thus the productivity threshold z_s^* will decline for firms. More firms will start to produce services for the domestic market.

In terms of offshoring, according to equations (6), (13), and (14), the productivity threshold z_o^* will decrease for firms as $(\frac{P_{nm}}{\tau_{in}})^{\sigma_m - 1}$ increases. More firms will start to offshore their manufacturing overseas. To summarize, we have the following propositions.

Proposition 1:

Low-productivity non-exporting firms are more likely to exit the market in response to import competition (trade liberalization) shocks than other firms.

Proposition 2:

In response to import competition (trade liberalization) shocks, more firms will engage in servitization. This is especially true for high-productivity firms.

Proposition 3:

In response to import competition (trade liberalization) shocks, more firms will engage in offshoring. This is especially true for high-productivity firms.

3 Data

We collect firm- and worker-level information from three database registers from the Danish official statistical institute (Denmark Statistics: the "Integrated Database for Labor Market Research" (*IDA*), the "Accounting Statistics Registers" (*FirmStat*) and the "Foreign Trade Statistics Register" (*Udenrigshandelsstatistikken*). From the population of all firms, we retain only private firms that are included in the first two databases over the period from 1995 to 2007[5] and that mainly operate within the manufacturing industry.[6] Moreover, we drop firms with fewer than 2 employees.[7] Next, we provide further details on how we process the data in each database.

The *IDA* is a longitudinal employer-employee register containing information on, for example, the place of work, education and labor market status of each individual aged 15-74 between 1980 and 2007. The information is updated once a year in week 48. Apart from deaths and permanent migration, there is no attrition in the data. From this register, we keep only individuals who are employed full time every year from 1995 to 2007. The individual information in the *IDA* is used to measure a number of workforce characteristics at the firm level, such as employees' education.

Our second database is the Firm Statistics Register (FirmStat henceforth), which covers the universe of private-sector firms over the years 1995-2007. It provides the annual value of

[5]We focus on the period before 2008 to avoid having the impact of the global financial crisis confound that of import competition.

[6]As we clarify below, our final sample also includes manufacturing firms that switched to the service industry either partially or completely at some point over the sample period.

[7]The size criteria reduce the inclusion of self-employed individuals.

firm productivity[8] and the 4-digit level classification of the Danish Industrial Activities.[9]

The third dataset is drawn from the *Foreign Trade Statistics Register* and is available from 1993 to 2007.[10] It contains information on import (and export) sales and the number of imported (and exported) products at the firm level for the same period as *FirmStat*. The trade data measured at the firm level are used to construct our offshoring measure. From these data, we also construct our measure of import competition at the industry level. This measure is based on import sales by product at the 4-digit level classification of the Danish Industrial Activities. More specifically, we map international import data at the 6-digit product level to the 4-digit industry level by merging the *Foreign Trade Statistics Register* with *FirmStat*, where we observe the industry code for each firm. To construct our instruments, as explained in the next section, we aggregate these flows at the 4-digit level and merge them with the U.N. COMTRADE data.[11]

3.1 Descriptive Statistics

The first panel in Table 1 reports the descriptive statistics of the main dependent variables used in the empirical analysis. We first examine the effect of import competition on servitization, industry switching and exit. We then estimate the impact of import competition on the firm-level intensive and extensive margins of offshoring.

The first row of Table 1 reports the average probability of partial servitization, which is 7 percent. Similar to Bernard et al. (2017), we define partial servitization as a dummy variable equal to 1 if the manufacturing firm has no establishments in the service industry at time $t-1$ and at least one establishment in the service industry at time t.[12] We refine

[8] Firm productivity is calculated as turnover per employee on a logarithmic scale (i.e., labor productivity). We deflate all monetary values using the World Bank's GDP deflator with 2005 as the base year.

[9] For multi-establishment companies, we are able to identify the 4-digit industry affiliation of each establishment belonging to the same firm. This information allows us to measure the transition to the service industry by exploiting detailed information on the main activity at the plant level, as explained in the next section.

[10] We use 1993 as a pre-sample year in the construction of our instrumental variables, as explained in the next section. The sample period used in all regressions runs from 1995 to 2007.

[11] The first 6 digits of the Combined Nomenclature in the *Foreign Trade Statistics Register* are the same as the product classification in the COMTRADE data, i.e., the HS classification. However, we use 4-digit level aggregation to considerably improve consistency over time.

[12] Note that the IDA database collects information on the industry for each establishment affiliated with the same firm and does not report any financial item (such as sales) at the establishment level. We therefore

this main definition of servitization as follows. First, we calculate two variables for partial servitization that take into account whether one of the firm's establishments at time t is in a service industry related to the main industry of the manufacturing firm at time $t-1$ using two measures of industry relatedness. The first classifies manufacturing and service industries as related if their core businesses are intuitively connected based on a textual inspection of their descriptions.[13] The second measure treats two industries as connected if the share of inter-industry labor flows between them is above the average for the whole economy, calculated by considering all possible pairs of industries in a given year. The main assumption of this approach is that if two industries are connected through labor mobility, they share similar human capital requirements and skills, and therefore, their core businesses are treated as related (Neffke et al., 2017). The average rates of related partial servitization are 4.3 and 4.5 percent according to the first definition and second definition, respectively.

We then consider two additional refinements of our definition of partial servitization in the next two rows. The first rules out the servitized firm offshoring in the same year, while the second captures those cases of partial servitization that are combined with offshoring in a given year t. The sample averages for these two additional definitions of servitization show that most cases of partial servitization do not occur in conjunction with offshoring. Finally, we consider a definition of complete servitization. This is a dummy variable equal to 1 if the firm in question has no establishments in the service industry at time $t-1$ and no establishment in the manufacturing industry at time t. The sample average of this variable is 2.5 percent. Therefore, partial servitization occurs much more frequently than a complete switch out of manufacturing.

To corroborate the main analysis performed on servitization, we also examine the impact of import competition on the share of workers employed in the service establishments of a given firm. This share is approximately 17 percent on average. We also consider the

base our measures of servitization only on the industry information for each establishment belonging to the same firm. This means that we can identify partial servitization only for multi-establishment firms (i.e., for approximately 35 percent of the sample).

[13]For example, all of the 3-digit industries under the manufacture of food products are classified as related to the following service industries: wholesale of food, beverages and tobacco; wholesale of sugar and chocolate and sugar confectionery; wholesale of coffee, tea, cocoa and spices; retail sale of food, beverages and tobacco in specialized stores; retail sale via stalls and markets. A complete mapping of manufacturing industries into their related service industries is reported in Table A-0 in the online appendix.

firm's probability of switching industry within the manufacturing sector. Only 1 percent of observations report such a change. Finally, for completeness, we consider the firm's exit as a strategy to cope with import competition. The average exit rate is approximately 2 percent. Note that all these definitions described so far imply that we are able to reliably identify servitization, industry switching and exit from 1996 through 2007.

Using data from the Foreign Trade Statistics Register, we also calculate a firm-level measure of offshoring. As in Feenstra and Hanson (1999) and Hummels et al. (2014b), we construct a "narrow offshoring" measure that is defined as the summation of those firm imports in the same HS4 category as its exports.[14] The last three rows in the upper panel of Table 1 show that approximately 20 percent of manufacturing firms engage in offshoring, according to our narrow measure. The large majority of offshoring firms do not simultaneously engage in partial servitization. When we examine the intensive margin of offshoring in the second row, we find that the average value of offshoring is approximately 9 million Danish krone.

[Insert Table 1 about here]

The remainder of Table 1 shows the descriptive statistics of the independent variables used in our regression models at the firm level, including firm productivity and size, among others. As we explain more extensively in the next section, the central explanatory variable of the empirical analysis is import competition from China, which is measured as the log of the weighted sum of Chinese imports of all HS products by the EU-15 and the US. Descriptive statistics are presented in the second panel of Table 1. Similar to Hummels et al. (2014b), the instrument of our import competition variable, reported in the second row, is calculated from COMTRADE and is based on the shocks to Chinese export demand originating in 4 high-income countries, i.e., Australia, Canada, Japan, and New Zealand.

In addition, we calculate an alternative import competition measure by using import values not from China but from new EU members, i.e., Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, the Slovak Republic, Slovenia, Cyprus, and Malta, which joined the EU in 2004, and Bulgaria and Romania, which joined in 2007 (Dauth et al., 2014). The

[14] Given the richness of the data, for multiproduct firms, we are able to sum imports across all of the HS4 products that the firm also exports.

corresponding instrument is calculated as the total export values from these new EU member countries to the 4 high-income countries. Note that to avoid our measures of import competition at the industry level being mechanically related to our firm-level (especially offshoring) outcomes, we always calculate import competition by subtracting out the product-specific import and export values of a given firm.

When we calculate the main descriptive statistics of the independent variables separately for the sample of firms that engage in either servitization, offshoring or both, we find that all these types of firms are generally more productive, larger in size and more likely to apply for at least a patent compared to the average firm of the main sample (see Table 2). They also operate in industries characterized by more intense import competition from China, and they feature a larger share of skilled workers. This is especially true for firms that combine offshoring with partial servitization. However, this group represents a very small fraction of firms.

[Insert Table 2 about here]

Figure 1 shows the basic time-series variation in the share of firms that offshore production abroad (top left panel), the share of firms that partially servitize according to the main definition reported in Table 1 (top right panel), the share of firms that engage in both partial servitization and offshoring (bottom left panel) and the import competition variable (bottom right panel) over the sample period. There is a clear positive trend in all variables. The offshoring (partial servitization) rate increased from approximately 14 (2) percent in the late 1990s to approximately 22 (6) percent in 2007. As we mention above, the combination of partial servitization with offshoring is not a very widespread strategy, and despite its positive trend, it consistently remains below 2 percent over the sample period. Over the same period, our import competition variable at the industry level increases on average from approximately 19 to approximately 21, an increase of 200 percent.

[Insert Figure 1 about here]

Figure 2 presents evidence on the share of firms that partially servitize according to our main definition by the top five (3-digit) industries of origin and the top five (3-digit) industries

of destination. We find that the furniture, printing and machining industries feature the highest servitization rate (approximately 10 percent of all switchers are concentrated in these industries), followed by the manufacture of other general-purpose machinery and other textiles. The most popular destination industries for partially servitized firms are wholesale trade and other service industries that relate to the main products of the manufacturing industries of origin. For example, the wholesale of household goods relates to the manufacture of furniture, and the wholesale of machinery relates to the manufacture of machinery. This finding is in line with our earlier statement that most cases of partial servitization are captured by our measures of related servitization described above and reported in Table 1.

[Insert Figures 2 about here]

We conclude this section by presenting the five (3-digit) manufacturing industries with the highest share of offshoring firms for Denmark in Figure 3. Offshoring is most common for the manufacturing of fabricated metals, where 80 percent of firms offshore, followed by textiles, electronics, chemicals and other transport equipment.

[Insert Figures 3 about here]

4 Empirical models

4.1 Explorative analysis

Our empirical strategy consists first of a descriptive analysis in which we establish whether import competition from China is correlated with a whole host of different firm strategies to cope with increased competition. This is done by estimating a multinomial logit model in which the dependent variable is one of the following mutually exclusive choices: 1) the firm has no establishment in a service industry at time t-1 and at least one at time t but at the same time does not offshore; 2) the firm has no establishment in a service industry at time t-1 and at least one at time t and at the same time offshores; 3) if the firm offshores at time t and engages in no servitization according to definition (1) at time t; 4) if the firm has no

service establishments at time t-1 and no manufacturing establishment at time t; 5) if the firm exits the market; and 6) if none of the above conditions are fulfilled.

The results of this explorative analysis are reported in Table 4. Controlling for industry, municipality and year fixed effects and a number of firm-level characteristics such as productivity and size, we find that import competition is indeed positively correlated with partial servitization and offshoring as separate strategies but not as a combined option, probably because a very small share of firms engage in such a strategy. The probability of exiting the market is also positively associated with increases in import competition, whereas the probability of complete servitization, i.e., of exiting the manufacturing industry to switch to the service industry does not seem to be affected by import competition.

To corroborate the finding that partial servitization does not often combine with offshoring in our sample, we also estimate bivariate probit models in which we simultaneously estimate the probability of partial or complete servitization and the probability of offshoring as a function of import competition using the same specification as the multinomial logit model. The results are reported in Table 5 and confirm that import competition correlates with either the probability of partial servitization or of offshoring but does not associate with the probability of complete servitization.

Furthermore, the coefficients estimated for the correlation between the unobserved determinants for servitization and offshoring decisions are never statistically significant. This finding suggests that the processes of servitization and offshoring are not jointly determined. In the next section, we therefore proceed with an empirical strategy that estimates the causal impact of import competition on either servitization or offshoring as separate outcome variables.

To corroborate that partial servitization and offshoring are not interdependent strategies, we also estimate two bivariate probit models. In the first model, we simultaneously estimate the probability of partial servitization and offshoring as a function of import competition, and in the second model, we estimate the probability of complete servitization and offshoring as a function of import competition. For both of these models, we use the same specification as that of the multinomial logit model. The results are reported in Table 5, where columns (1) and (2) correspond to the first model and columns (3) and (4) correspond to the second

model. The results confirm that import competition correlates with either the probability of partial servitization or of offshoring but is not associated with the probability of complete servitization. Furthermore, the coefficients estimated for the correlation between the unobserved determinants of servitization measures and offshoring decisions are never statistically significant. This finding suggests that the processes of servitization and offshoring are not jointly determined. Having established the lack of interdependence between the two strategies, we proceed with an empirical strategy that estimates the causal impact of import competition on either servitization or offshoring as separate outcome variables.

4.2 Empirical strategy

Our estimation strategy examines the impact of Chinese import competition on firms' servitization and offshoring decisions. For all these outcomes, we estimate the following linear probability model:

$$Outcome_{ijt} = \alpha_0 + \beta_1 Imp^{CH}_{jt-1} + X'_{ijt-1}\gamma_1 + \delta_i + \delta_j + \delta_m + \delta_t + \epsilon_{ijt} \tag{15}$$

where the dependent variable, $Outcome_{ijt}$, captures the decision to engage in one of the strategies described above (such as partial servitization) of firm i in 4-digit industry j in year t.[15]

Our main independent variable, Imp^{CH}_{jt-1}, measures the level of Chinese import competition and is calculated as follows:

$$Imp^{CH}_{jt-1} = log(\sum_{p=1}^{P} \frac{exports_{jp1995}}{exports_{j1995}} Imp^{CH-EU15-US}_{pt-1}) \tag{16}$$

[15] All of the outcome variables are treated as state variables in the analysis reported in this paper. For example, partial servitization is a dummy variable equal to 1 not only in the transition year but also in the subsequent years if the firm in question maintains at least one service establishment in the subsequent years. However, the results obtained by modeling the outcome variables as transition variables, i.e., as dummy variables equal to 1 only in correspondence with the transition year, are very similar to those already reported in the paper.

where $Imp_{pt-1}^{CH-EU15-US}$ is the total purchases of product p from China at time $t-1$ by the EU-15 countries (including Denmark) and the US.[16] We include imports from other EU-15 countries (other than Denmark) and the US to capture the effect that the rise in Chinese exports has on Danish firms through intensifying competition not only in the domestic market but also in the foreign markets to which Danish firms export and, therefore, compete with Chinese products.[17] The weights, $\frac{exports_{jp1995}}{exports_{j1995}}$, are export shares, which are time invariant (i.e., 1995) and industry specific.[18] The variable $export_{jp1995}$ represents Danish industry j's export value of product p to the world market in year 1995, whereas $export_{j1995}$ denotes Danish industry j's total exports to the world market in that year.[19] Import competition and the other independent variables are lagged to account for companies' inability to immediately respond to changing economic conditions, among other factors.

The vector X_{ijmt-1} includes a sector-by-year Herfindahl index (to control for the degree of domestic competition) and a set of firm characteristics that could influence our firm-level outcomes, such as firm productivity, adoption of robots, size and share of high-skill workers. The inclusion of productivity in our specification controls for the potential "productivity effect" associated with obtaining access to cheaper or better foreign inputs, which may influence offshoring and servitization decisions. A recent study on Denmark (Humlum, 2019) shows that the adoption of industrial robots induces manufacturing firms to reorganize production around R&D activities. To control for this channel, which may confound the impact of import competition, we include a dummy variable equal to 1 if the firm imports robots.[20] All these additional control variables at the firm level allow us to focus more carefully on the effects of import competition. Furthermore, we incorporate firm fixed effects

[16] As an alternative definition, we calculate our import competition variable using import values from new EU members (Dauth et al., 2014).

[17] Danish export sales to the other EU-15 countries and the US represent more than 70 percent of total exports over the sample period (OECD, 2015).

[18] We use time-invariant (base-year) industry-specific export shares as weights to reduce endogeneity issues.

[19] As mentioned in the previous section, we always subtract the focal firm's trade outcomes when calculating the import competition variables at the industry level. Specifically, we exclude the product-specific export values of the focal firm in the calculation of the export shares in the base year (1995). This addresses the concern that the export shares at the industry level may be driven by the export values of those firms that are large in size and are already active at the beginning of the sample period. We also exclude the current import values of the specific firm from China in the calculation of the total imports from China directed to Denmark and the other countries in the EU-15 group.

[20] Similar to Humlum (2019), we construct robot adoption on the basis of information on imported robots.

(γ_i), two-digit sector (γ_j), municipality (γ_m) and year fixed effects (γ_t).

One possible threat to the identification and estimation of the coefficient of β_1 is that Chinese import competition is likely to be endogenous in regression (4.2), as unobserved productivity shocks may be associated with both firms' outcomes and imports. To obtain an unbiased estimate of this parameter, we instrument Imp^{CH}_{jt-1} with exogenous shocks to the Chinese export demand in a 2SLS estimation. Similar to Hummels et al. (2014b), the instrumental variable Imp^{IV}_{jt-1} is calculated as follows:

$$Imp^{IV}_{jt-1} = log(\sum_{p=1}^{P} \frac{exp_{jp\_1993}}{exp_{j\_1993}} Imp^{CH-HI}_{pt}) \tag{17}$$

where Imp^{CH-hi}_{pt} is 4 high-income countries' total purchases of product p from China at time t, weighted by the base year (1993) Danish export shares, which are constant, industry specific and calculated two years before our sample period starts. Similar to Autor et al. (2013), we consider the following high-income countries: Australia, Canada, Japan, and New Zealand.

While our instrument is centered on the base year of Danish export shares and therefore not subject to the same contemporaneous forces that affect firm outcomes, we require our instrument to be independent from any expectations in future trends of the same outcomes. We test such restrictions by regressing the change in our instrument from 1995 to 1998 on the change in the firms' outcomes (offshoring and servitization) at the 4-digit industry level in the pre-sample period, i.e., 1993-1995. Column 1 of Table 3 shows that we cannot reject the hypothesis of no correlation between our instrument and the pre-trend growth in the main outcome variables used in the empirical analysis at the firm level. This result is robust to using alternative periods to calculate the growth rate of our instrumental variable (see columns 2-3 of Table 3).

[Insert Table 3 about here]

5 Results

In this section, we present the causal effects of import competition. First, we examine whether the increase in Chinese competition affects Danish firms' servitization, industry switching and exit. Second, we focus on whether competition influences firms' probability of offshoring. Finally, we extend the analysis to Portugal to assess whether similar effects occur in another context that is characterized by different institutional and labor settings.

5.1 Import Competition and Servitization

We now examine the impact of import competition on manufacturing firms' servitization. For the first four columns of Table 6, the dependent variable is a dummy equal to 1 if the manufacturing firm has no establishments in the service industry at time $t-1$ and at least one establishment in the service industry at time t. In columns 1 and 2, we find a positive and statistically significant correlation between Chinese import competition and partial servitization in a probit and a linear probability model, respectively.[21] Having established that our results are robust to an alternative specification based on the probit model, we now proceed with additional estimations using our preferred linear probability specification. Column 3 extends the specification with firm fixed effects and shows that a 100 percent increase in import competition in the 4-digit manufacturing industry is associated with a 1.5 percent increase in the probability of partial servitization.

In column 4, we turn to our instrumental variable approach to address endogeneity concerns. The first-stage coefficient on the instrument is significant and positive, as expected (see the bottom panel of column 4), and the first-stage F-statistic on the instrument is above 17.[22] The second-stage IV results show that Chinese import competition has a positive

[21] Following the existing literature (Damm and Dustmann, 2014; Miguel et al., 2004), we prefer the flexibility of the linear probability model, especially since our analysis is based on employing an instrumental variable for import competition, which is more challenging in a probit specification. The linear probability model is unbiased and consistent as long as few of the predicted probabilities lie outside the unit interval (Horrace and Oaxaca, 2006). Moreover, Angrist and Pischke (2010) deem the linear probability model a preferable approach, especially when the nature of the nonlinear model is unknown.

[22] Note that the rule of thumb of 10 is meant only for special cases, such as the case of no cross-sectional or time-series correlation in the error term. For more complex autocovariance structures, Olea and Pflueger (2013) suggest an F-statistic threshold of 17 instead. Even considering this higher rule of thumb, we do not

and significant impact on firms' partial servitization, whereby doubling import competition from China increases the probability of partial servitization by approximately 3 percent. Moreover, the import competition coefficient in the IV specification (column 4) is larger in magnitude than the analogous OLS coefficient (column 3). This result is consistent with the following endogeneity concern. An unobserved positive productivity shock at the industry level may induce more firms in that industry to partially servitize and simultaneously to be less exposed to import competition from abroad. As a result, there is a spurious negative bias in the OLS coefficient reported in column 3. Our instrumental variable approach addresses this issue, and thus, in column 4, the causal impact of Chinese import competition on partial servitization is of a larger magnitude. These partial servitization results are consistent with Proposition 2 of our theory section.

Similar results are obtained by using our alternative definitions of partial servitization in columns 5 and 6 based on measures of cross-industry relatedness. These findings show that most of the partial servitization triggered by Chinese import competition is a related type of servitization, in which the service industry of at least one of the firms' establishments is connected to the core manufacturing business of that company.

When we examine complete servitization in column 7 of Table 6, we estimate an insignificant effect on our import competition variable. Very similar results are reported in Table A-3 of the online appendix where we both use longer lags and try a nonlinear specification: import competition does not have a significant impact on the probability of complete servitization even in these alternate specifications. We also do not find any significant impact on the probability that the firm engages in partial servitization combined with offshoring (column 8).[23] For completeness, we also look at the probability of switching manufacturing industries. Similar to complete servitization and servitization combined with offshoring, the probability of switching manufacturing industries is not affected by import competition. Note that only a negligible share of companies engaged in such a strategy (1 percent). How-

face a weak instrument problem in any of our specifications.

[23]Similar results, available upon request from the authors, are obtained when we examine the probability of offshoring (partial servitization) for the first time at time t and of engaging in partial servitization (offshoring) one, two or three years later. The corresponding share of firms that offshore (partially servitize) for the first time in a given year and servitize (offshore) later in the sample period is less than 2 (1) percent. This result shows that neither offshoring nor partial servitization is a stepping stone strategy for the other in our sample.

ever, although import competition does not affect the probability of switching manufacturing industries, it does affect the probability that the firm exits the market (column 10). Furthermore, consistent with Proposition 1 of our model, we find in column 11 that the positive effect of import competition on a firm's exit is mainly relevant for firms that do not export before exiting the market. All these results confirm the explorative analysis discussed in the previous section that import competition affects only partial servitization and exit by firms but not the probability of complete servitization or of a joint practice of servitization with offshoring.

We then conclude the analysis of the probability of partial servitization by adding two refinements in columns 12 and 13 of Table 6. First, we augment the main specification with an interaction term between import competition and a dummy that is equal to 1 if the firm's average productivity is above the 75th percentile of the within-industry productivity distribution. Consistent with Proposition 2 of our theoretical intuition, the servitization response of high-productivity firms to import competition is stronger than that of the other firms in the sample (column 12). Second, we redefine the import competition variable by focusing on Danish imports from new EU member countries.[24] EU-15 countries, including Denmark, experienced an unprecedented increase in trade with these new EU members over the course of the sample period (Dauth et al., 2014). The results show that import competition as calculated in this alternative definition still has a significant positive impact on partial servitization (column 13).

[Insert Table 6 about here]

Overall, this section suggests that partial servitization is a relevant response to increased import competition from China. Next, we corroborate the importance of partial servitization for manufacturing firms in Denmark by examining whether import competition affects the share of workers employed in service establishments within a given manufacturing company. Column 1 of Table 7 shows that, indeed, an increase in Chinese import competition by 100

[24]The new EU countries include the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, the Slovak Republic, Slovenia, Cyprus, and Malta, which joined the EU in 2004, and Bulgaria and Romania, which joined in 2007. The corresponding instrumental variable is calculated as the total export values from new EU member countries to high-income countries.

percent triggers an increase in the share of workers employed in service establishments by 0.005, i.e., by approximately 3 percent. In column 2, we recalculate the share of service workers by including in the numerator only the stock of workers who reallocated from a manufacturing to a service establishment within the same firm. The impact of import competition is approximately 40 percent of the impact reported in column 1. When we consider the share of service workers obtained by only including new hirings from other firms in the numerator of the share variable, we find that the impact of import competition is approximately 50 percent of the overall effect of import competition on the share of service workers. Therefore, import competition induces firms to increase the share of service workers by either reallocating current workers from manufacturing to service establishments belonging to the same firm or by hiring new workers from other firms.[25]

To rule out the possibility that the share of service workers increases because the firm reduces its size, we also report the effects of import competition on both the log of the total number of workers employed in service establishments (column 4) and the log of the total number of employees (column 5). Import competition increases both outcomes; however, the impact on the total number of service workers is larger. Finally, the estimated coefficient reported in column 6 of table 7 shows that the increase in the share of service workers within a given firm is mainly achieved by creating new establishments in the service industry rather than by merely increasing the size of existing establishments. A 100 percent rise in import competition from China increases the number of service establishments by approximately 2 percent.

The second panel of Table 7 shows that the results provided for the main sample are mainly driven by firms that engage in partial servitization. Doubling import competition from China implies an increase of 3 percent in the share of workers employed in service establishments. Both within-firm reallocation of workers and new hirings explain the increase in the share and the number of workers employed in service establishments. Firms that partially servitize their businesses in response to import competition achieve an increase in

[25]These findings are confirmed by a worker-level analysis reported in Table A-4 of the online appendix in which we show that import competition from China indeed increases current workers' probability of being reallocated from a manufacturing to a service establishment within the same firm. We also find that import competition has a positive impact on workers' probability of moving from one firm to another and being employed in a service establishment within the new firm.

the workforce involved in the service industry by expanding the number of service establishments: doubling import competition triggers a 3 percent increase in the number of service establishments.

[Insert Table 7 about here]

5.2 Import Competition and Offshoring

We now estimate the impact of Chinese import competition on the extensive margin of offshoring with the linear probability equation (4.2) after controlling for firm characteristics and municipality, sector and year fixed effects. In this relatively straightforward specification reported in column 2 of Table 8, we see that Chinese import competition is positively related to the probability that a manufacturing firm will offshore production abroad. The import competition coefficient of 0.017 implies that a 100 percent increase in import competition at time $t-1$ is associated with a 9 percent increase in the extensive margin of offshoring at time t. Column 1 reports the estimated marginal effect from a probit specification. Reassuringly, we find that the import competition coefficients in the linear probability model (column 2) and the probit model (column 1) are both positive and statistically significant.

In column 3, we add firm fixed effects to the main specification, whereas in column 4, we turn to our instrumental variable approach. The first-stage result shows that the instrument has a significant positive impact on import competition (see bottom panel of Table 8). The first-stage F-statistic is well above 17, indicating a strong first stage. The second-stage result shows that exogenous Chinese import competition significantly increases the likelihood of offshoring, and it now carries a causal interpretation. Specifically, a 100 percent increase in import competition leads to a 0.016 percentage point increase in the probability that a manufacturing firm will offshore, which corresponds to an approximately 7 percent increase. The IV coefficient is larger than the non-instrumented coefficient reported in column 4, which indicates that our identification strategy has a spurious negative bias in the OLS coefficient reported in column 2. Our instrumental variable approach addresses this issue, and thus, in column 3, the causal impact of Chinese import competition on offshoring is of a larger magnitude.

In column 5, we refine our measure of offshoring by excluding partial servitization. The estimated coefficient of our import competition variable shows that most of the effect on offshoring is explained by cases in which offshoring is not combined with partial servitization. In column 6 of Table 8, we then redefine the import competition variable by focusing on Danish imports from new EU member countries. The results show that import competition as calculated in this alternative definition still has a significant positive impact on the extensive margin of offshoring, although it is smaller in magnitude to our baseline specification.

Consistent with Proposition 3 in our theory section, we also find in column 7 that high-productivity firms respond to import competition more strongly in terms of the likelihood of offshoring compared to the other firms in the sample. Finally, we estimate the impact of Chinese import competition on the intensive margin of offshoring. Column 8 of Table 8 uses the logarithm of offshoring volumes as the dependent variable, conditional on the firm offshoring at all. We find that a 100 percent increase in import competition increases the intensive margin of offshoring by 8 percent.

[Insert Table 8 about here]

Overall, the results reported in Tables 6 and 8 provide compelling evidence that offshoring and partial servitization are predominant and separate reactions of Danish companies to foreign import competition. An exogenous increase in import competition from China increases the likelihood of Danish firms either offshoring production activities abroad or partially servitizing their business by expanding the workforce in their service establishments. It does not, however, increase their probability of switching permanently out of manufacturing (complete servitization) or of switching from one manufacturing industry to another. Finally, similar to Bloom et al. (2016), our analysis also shows that import competition increases exit rates, especially if we focus on the group of non-trading firms.

5.3 The Case of Portugal

Thus far, the empirical analysis has documented the effects of import competition on the propensity of firms in Denmark to either offshore or servitize. In this section, we extend our investigation to Portugal to assess the generalizability of our findings reported in the

previous section. We believe that comparing Denmark to Portugal offers useful insights for the following reasons. First, both countries are small, highly trade-oriented and have similar exposure to Chinese import competition over the sample period considered in the empirical analysis (see Figure 4 below).

Second, these economies are characterized by different institutional frameworks, such as different labor and product market institutions. On the one hand, Denmark has an extremely flexible labor market, which reduces the frictions hindering labor reallocation across firms within and across industries. In contrast, Portugal is characterized by one of the most rigid labor markets in the world (Botero et al., 2004). Furthermore, at the beginning of the 2000s, Denmark (Portugal) ranked as among the OECD countries with the most liberal (restrictive) product market regulation(OECD, 2000). Of course, the two economies differ in many other respects, but the purpose of this comparison aims only to provide suggestive evidence of whether our findings for Denmark are driven by the country's idiosyncratic features or instead reflect a general economic pattern among economies in the EU that are exposed to the China shock.

We replicate the same empirical analysis described in the previous section for Denmark using "Quadros de Pessoal" *(QP)*, the matched employer-employee dataset for Portugal. The *QP* dataset is comparable to the IDA dataset for Denmark in its structure and content (Buhai et al., 2014). It is an annual, mandatory employment survey administered by the Portuguese Ministry of Employment and covers all firms (with at least one wage earner) and their establishments and employees. The analysis of the Portuguese case is based on all active firms that were ever in manufacturing and had more than 1 employee over the 1995–2007 period.[26] Individual-level data files are used to measure workforce characteristics (such as the share of high-skill workers) and firm characteristics (such as labor productivity). They are comparable to those used for Denmark. Trade information at the firm level is obtained from Statistics Portugal and merged with the QP dataset.

Following the Danish case, we construct the relevant instruments for Chinese import competition by industry based on information from the U.N. COMTRADE database at the

[26]The year 2001 is missing, as no data were collected at the worker level by the Portuguese Ministry of Employment in this year.

product level.[27] The link between 3-digit industries, the relevant 4-digit products exported, and the destination countries is provided by Statistics Portugal.

Figure 4 shows basic time-series variation in the share of firms that offshore (top left panel), the share of firms that partially servitize (top right panel), the share of firms that do both (bottom left panel) and the import competition variable (bottom right panel) over the sample period for the manufacturing industry in Portugal. There is a positive trend for all variables, although it is less pronounced than that observed in the Danish context. However, similar to the Danish case, we observe again that the combination of partial servitization with offshoring is very rare among Portuguese firms. We also find that the food and textile industries feature the highest servitization rates, followed by the furniture and chemicals industries. The most popular destination industries are the wholesale and retail trade industries (see Figure A-1 in the online appendix). When we look at the distribution of offshoring by industry, we find that the wood industry stands out with the largest shares of firms that offshore (see Figure A-2 in the online appendix). Similar to the Danish sample, firms that engage in either partial servitization or offshoring are, on average, more productive, more innovative, more skill intensive and larger in size than the average firm in the sample (see Table A-1 in the online appendix).

[Insert Figures 4 about here]

The main results for Portugal are presented in Tables 9, 10 and 11. The multinomial logit model in Table 9 shows that Chinese import competition is positively correlated with partial servitization and offshoring as separate choices but not as a combined strategy. The firms' probability of switching completely out of manufacturing is not affected by import competition, whereas Portuguese firms seem to be more likely to exit the market as soon as import competition increases. The bivariate probit models confirm that the processes of servitization and offshoring are not jointly determined, as the correlation coefficients between

[27] The Portuguese Classification of Economic Activities (CAE, comparable to NACE) underwent several changes over the period considered. To perform the empirical analysis over the same period covered by the Danish data (1995–2007), we standardize all industry classifications according to the earlier versions of NACE rev. 1.1, which is more aggregated than later versions (NACE rev. 2). This corresponds to approximately 80 (3-digit) industries every year.

the unobservables in the servitization and offshoring equations reported in Table 10 are never statistically significant.

To tease out causality, we proceed with our IV models in which we estimate the probability of each strategy as a separate outcome in a linear framework. In columns 1-4 of Table 11, we examine partial servitization. Similar to Denmark and consistent with Proposition 2 of the theoretical intuition, a 100 percent increase in import competition from China triggers a four percent increase in the probability that the firm partially servitizes. We obtain very similar results when we use our two definitions of related servitization. This again shows that most partial servitizations are cases of related servitizations, in which one of the firm's establishments is in a service industry related to the core manufacturing business of that firm. These results on partial servitization are confirmed by looking at the share of service workers employed in a given manufacturing firm: increasing import competition by 100 percent implies a 0.003 increase in this share, which corresponds to a 2 percent increase (column 8).

Columns 4 and 7 also indicate that for Portuguese firms, offshoring is a firm's response to import competition only if not combined with partial servitization, especially for high-productivity companies, in line with Proposition 3. Finally, whereas import competition does not affect the probability that firms leave the manufacturing sector and switch to the service sector (column 5), it does increase the firms' probability of completely shutting down their businesses (column 6).[28] Doubling import competition from China implies a 19 percent increase in the probability of exit by closedown. This last effect is almost four times as large as that estimated using the sample of Danish firms, and it is consistent with the hypothesis that Portuguese firms faced extremely stringent labor and product market regulations over the sample period, making it difficult for many to optimally adjust to import competition shocks (Branstetter et al., 2019).

[Insert Tables 9, 10 and 11 about here]

The similarity in firms' responses to import competition documented in this cross-country

[28] When we augment the specification for the exit regression including the interaction between the import competition variable and a "trading firm" dummy, the coefficient estimated on this interaction is dropped because a low share of firms engage in trade activities before exiting the market in the Portuguese sample.

comparison suggests the following result. Manufacturing firms operating in small open economies (such as Denmark and Portugal) react to foreign competition from low-wage countries mainly by exiting, offshoring production or partially servitizing their businesses and not by switching completely and permanently out of manufacturing.

6 Conclusions

This paper examines the impact of import competition on a number of firm-level margins of adjustment: servitization, offshoring and market exit. We utilize a detailed employer-employee matched dataset covering a large sample of Danish and Portuguese firms in the manufacturing industry from 1995 to 2007. Our results provide new insights into firms' strategies for coping with foreign competition.

First, we find that an exogenous increase in import competition leads to a significant increase in firm-level partial servitization and offshoring. This result indicates that import competition from low-wage countries, such as China, increases the need for firms to either relocate production activities abroad or to reallocate some of their business activities towards service establishments. We do not find any evidence that firms use these two strategies in combination. Second, firms do not seem to respond to increased import competition by switching completely and permanently out of manufacturing (i.e., complete servitization), but some do exit the market completely by shutting down their businesses. Third, the above results are consistent across Denmark and Portugal.

Policy makers should be aware of the strategies most commonly undertaken by firms in the face of foreign import competition to better assist in worker reallocation during the transition. In both the Danish and Portuguese cases, the main effect of Chinese import competition is to induce manufacturing firms to either offshore production or partially servitize their business activities.

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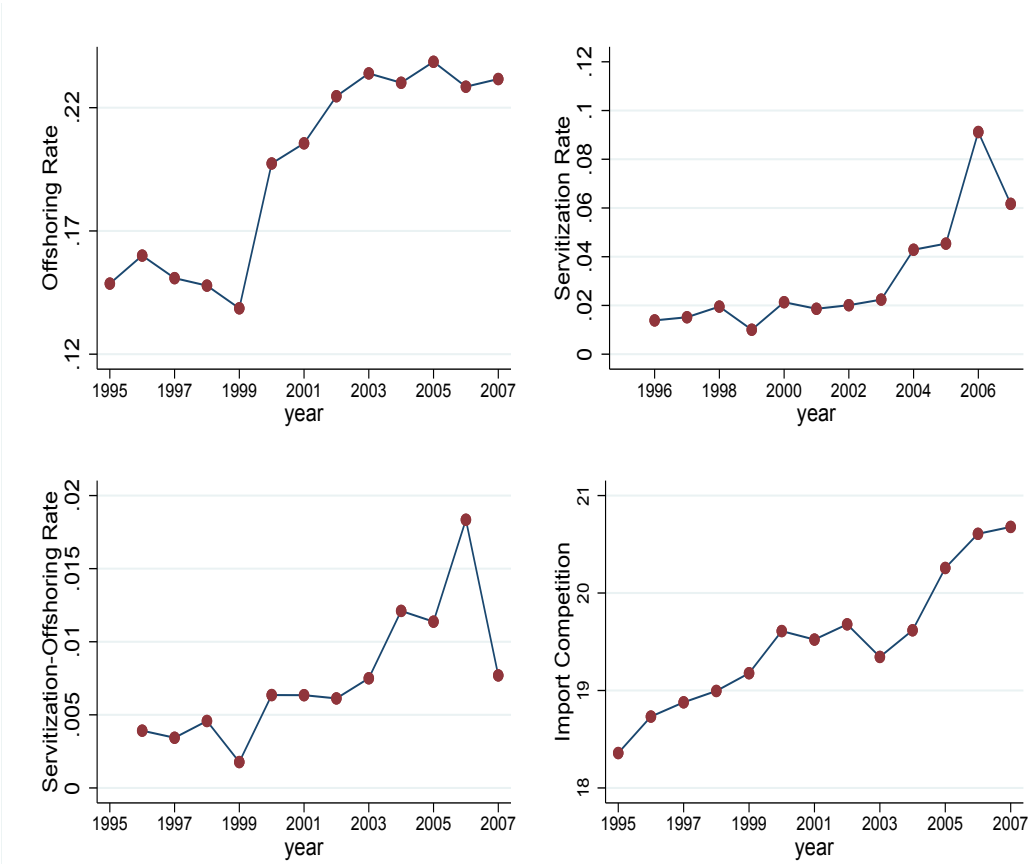
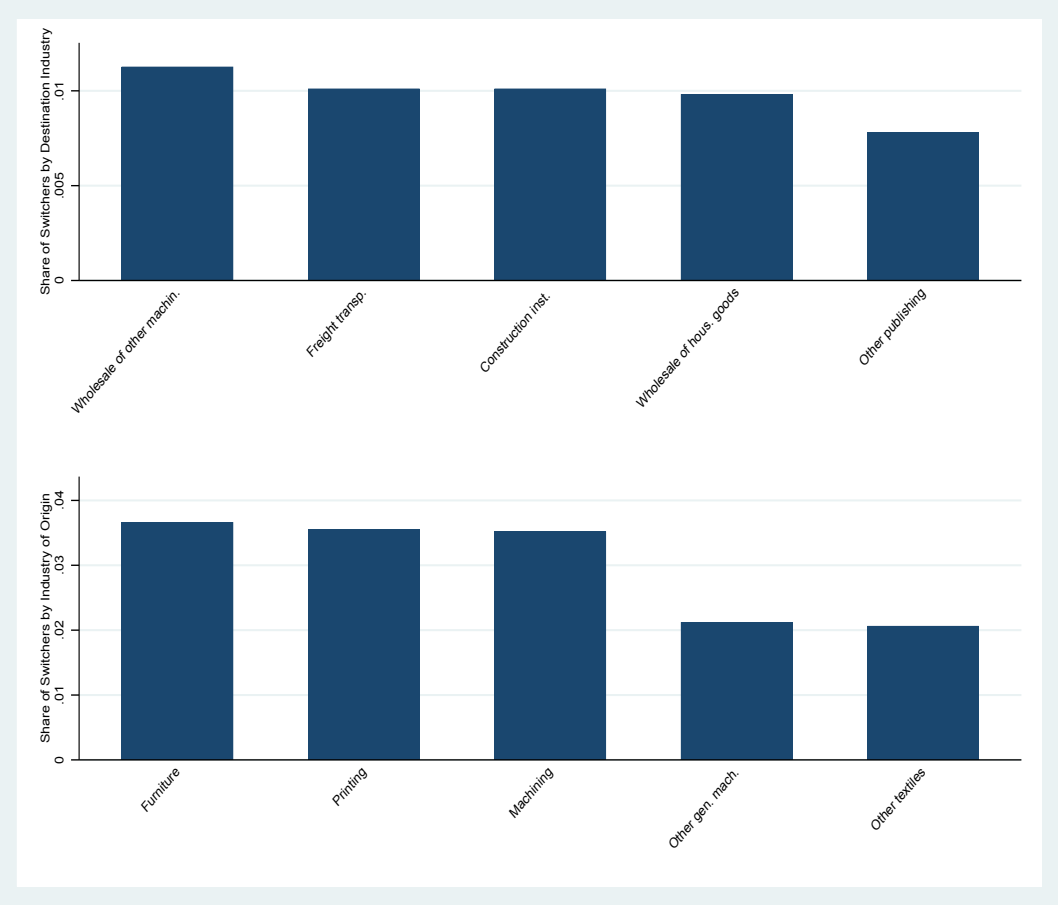
Figure 1: Import Competition, Servitization, Offshoring: Time Series Variation (Denmark)



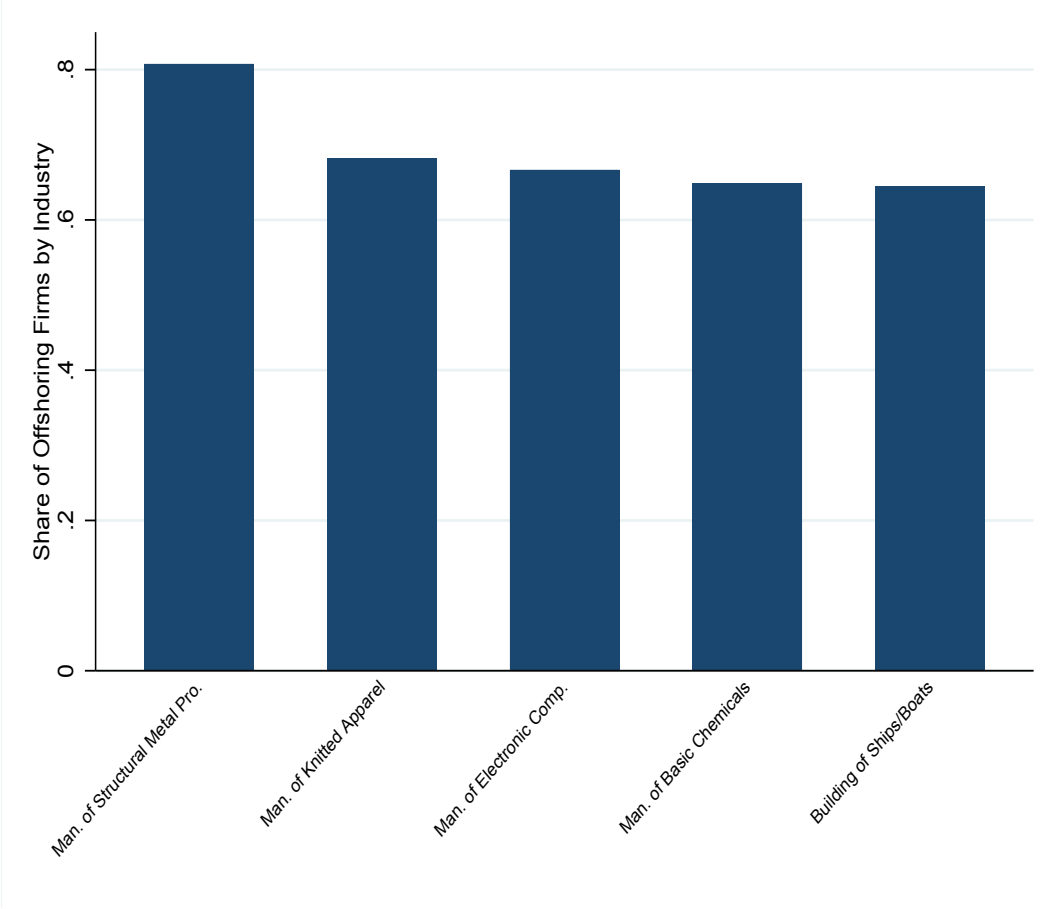
Notes: The offshoring rate is the year-specific share of firms that engage in offshoring activities. The servitization rate is the year-specific share of firms that engage in partial servitization according to definition (1) reported in Table 1. The servitization-offshoring rate is the year-specific share of firms that engage in both partial servitization and offshoring. Import competition is the year-specific average log of the weighted sum of Chinese import values of all HS products.

Figure 2: Servitization by Industry of Destination and of Origin (Denmark)



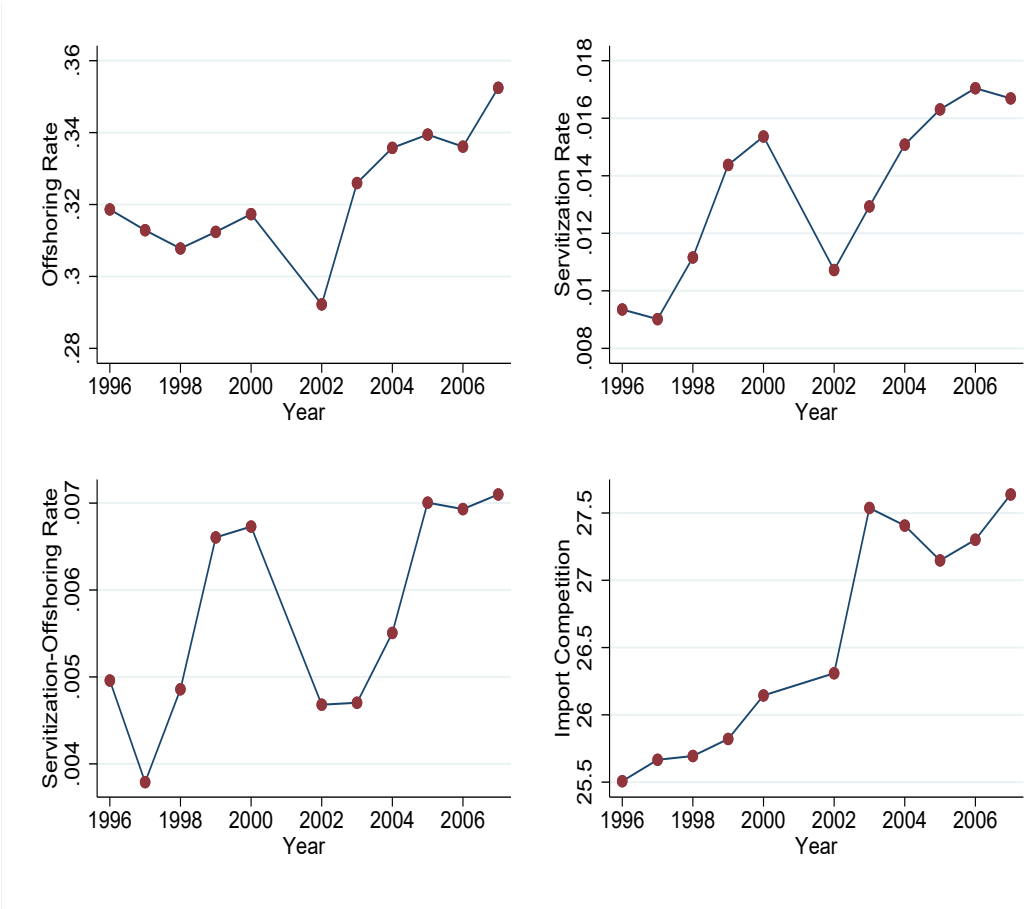
Notes: In the top panel, we report the share of firms that partially servitize according to the main definition reported in Table 1 by the industry of destination (average, 1995-2007) in order: 1) Wholesale of agricultural machinery, equipment and supplies; 2) Freight transport by road and removal services; 3) Electrical, plumbing and other construction installation activities; 4) Wholesale of household goods; 5) Publishing of books, periodicals and other publishing activities. In the bottom panel, we report the share of firms that servitize according to definition (1) by the industry of origin (average, 1995-2007): 1) Manufacture of furniture; 2) Printing and service activities related to printing; 3) Treatment and coating of metals and machining; 4) Manufacture of other general-purpose machinery; 5) Manufacture of other textiles.

Figure 3: Offshoring by Industry (Denmark)



Notes: Share of offshoring firms within each manufacturing industry (1995-2007): 1) Manufacture of structural metal products; 2) Manufacture of knitted apparel; 3) Manufacture of electronic components; 4) Manufacture of basic chemicals; 5) Building of ships and boats.

Figure 4: Import Competition, Servitization, Offshoring: Time Series Variation (Portugal)



Notes: The share of offshoring firms is the year-specific share of firms that engage in offshoring activities. The share of firms servitizing is the year-specific share of firms that engage in servitization according to definition (1). The servitization-offshoring rate is the year-specific share of firms that engage in both partial servitization and offshoring. Import competition is the year-specific average log of the weighted sum of Chinese import values of all HS products.

Table 1: Descriptive Statistics

Variables	Definition	Mean	SD
Outcome variables			
service Partial Servitization	1, if the firm has no service establ. at time t-1 and at least one at time t	0.069[a]	0.253
Related Partial Servitization (1)	1, if the firm has no service establ. at time t-1 and at least one in a related (def.1) service industry at time t	0.043[a]	0.134
Related Partial Servitization (2)	1, if the firm has no service establ. at time t-1 and at least one in a related (def.2) service industry at time t	0.045[a]	0.161
Partial Servitization without Offshoring	1, if the firm is partially servitized and does not offshore at time t	0.051[a]	0.234
Partial Servitization with Offshoring	1, if the firm is partially servitized and offshores at time t	0.018[a]	0.167
Complete Servitization	1, if the firm has no service establ. at time t-1 and no manuf. establishment at time t	0.025[a]	0.077
Switch Manufacturing	1, if the firm changes manufacturing industries at time t	0.010[a]	0.089
Exit	1, if the firm exits the market at time t	0.021	0.102
Offshoring (1)	1, if the firm offshores at time t	0.198	0.397
Offshoring without partial servitization	1, if the firm offshores and does not engage in partial servitization at time t	0.180[a]	0.395
Offshoring (2)	log of offshoring values, conditional on offshoring at time t	15.908[b]	3.440
Import competition variables			
Import Competition	log of the weighted sum of all HS products by value imported from China by the EU-15 and the USA	19.485	1.867
Import competition instrument	log of the weighted sum of all HS products by value imported from China by 4 high-income countries	18.618	1.622
Import Competition (alternate def.)	log of the weighted sum of all HS products by value imported from new EU members by the EU-15 and the USA	19.617	1.261
Import Competition Instrument (alternate def.)	log of the weighted sum of all HS products by value imported from new EU members by 4 high-income countries	16.520	1.543
Firm variables			
Workers Serv.	share of workers employed in service establ.	0.166	0.440
Productivity	log of sales per worker	13.500	0.602
Profits	log of profits per worker	12.707	0.492
Size	log of total number of workers	2.635	1.258
Multi	1, if the firm is a multi-establishment company	0.345	0.465
Tech	1, if the firm applies for a patent in the sample period	0.014	0.116
Robot Adoption	1, if firm adopts industrial robots	0.001	0.035
Exports	log of export (merchandise) sales	6.051	7.315
Imports	log of import (merchandise) purchases	5.836	7.208
High-skill Workers	share of workers with tertiary education	0.063	0.126
N		90,482	
Number of firms		11,019	

Notes: All descriptive statistics are calculated as averages over the 1995-2007 period. Firm variables are in real Danish kroner (using 2005 as the base year). In "Related Partial Servitization (1)", we classify manufacturing and service industries as related if their core businesses are intuitively connected based on a textual inspection of their descriptions. In "Related Partial Servitization (2)", we treat manufacturing and service industries as connected if the share of interindustry labor flows between them is above the average for the whole economy, calculated by considering all possible pairs of industries in a given year. (a) A variable is calculated for the sample period between 1996 and 2007. (b) The intensive margin of offshoring is available conditional on offshoring, i.e., for the sample of firms that offshore.

Table 2: Descriptive Statistics by Firm Type

Definition	**Offshoring Sample**	**Partial Servitization Sample**	**Partial Servitization with Off. Sample**	**Complete Servitization Sample**
log of the weighted sum of all HS products by value imported from China by the EU-15 and the USA	19.741 (1.923)	19.881 (2.026)	19.508 (1.966)	19.178 (2.294)
log of the weighted sum of all HS products imported from China by 4 high-income countries	18.931 (1.624)	19.148 (1.636)	18.718 (1.603)	18.395 (2.087)
share of workers employed in service establ.	0.261 (0.402)	0.577 (0.398)	0.575 (0.368)	0.601 (0.378)
log of sales per worker	13.843 (0.553)	13.752 (0.591)	13.859 (0.546)	13.652 (0.615)
log of total number of workers	3.844 (1.288)	3.702 (1.497)	4.106 (1.276)	3.799 (1.792)
1, the firm is a multi-establishment company	0.483 (0.499)	0.467 (0.498)	0.620 (0.485)	0.635 (0.481)
1, if the firm applies for a patent in the sample period	0.048 (0.214)	0.032 (0.177)	0.054 (0.181)	0.023 (0.197)
1, if firm adopts industrial robots	0.004 (0.063)	0.005 (0.071)	0.005 (0.055)	0.001 (0.097)
log of export (merchandise) sales	15.070 (4.180)	9.544 (7.992)	12.768 (5.974)	9.967 (8.409)
log of import (merchandise) purchases	15.118 (3.383)	9.261 (7.764)	12.961 (5.454)	10.528 (8.051)
share of workers with a tertiary education	0.103 (0.117)	0.067 (0.109)	0.115 (0.121)	0.078 (0.119)
	33,931	18,170	6,228	2,609

Notes: All descriptive statistics are calculated as averages over the 1995-2007 period. Firm variables are in real Danish kroner (using 2005 as the base year). "Offshoring Sample" includes all firms that offshore at least once over the sample period. "Partial Servitization Sample" includes all firms that partially "servitize" at least once over the sample period. "Partial Servitization with Off. Sample" includes all firms that partially "servitize" and offshore at the same time at least once over the sample period. "Complete Servitization Sample" includes all firms that engage in complete servitization at least once over the sample period

Table 3: Pre-trend Tests

	Instrumental variable growth rates		
	1998-1995 (1)	2000-1995 (2)	2007-1995 (3)
Offshoring_{1995}-Offshoring_{1993}	0.79863	1.00767	1.00189
	(0.56811)	(0.92399)	(1.00333)
R-sq	0.02482	0.02522	0.02443
N	417	417	417
$\text{Servitization}_{1995}$-$\text{Servitization}_{1990}$	0.54393	0.48513	0.45807
	(0.44079)	(0.52507)	(0.51809)
R-sq	0.00104	0.00104	0.00006
N	417	417	417

Notes: The dependent variable is the growth rate of the instrumental variable. Robust standard errors are in parentheses. Significance levels: ***1%, **5%, *10%.

Table 4: Import Competition, Servitization, Offshoring and Firm Exit: Multinomial Logit Results

	(1)	(2)	(3)	(4)	(5)
	Partial Servitization without Off.	**Partial Servitization with Off.**	**Offshoring without Partial Serv.**	**Complete Servitization**	**Exit**
Import Competition$_{t-1}$	0.00212***	0.00005	0.01109***	-0.00098	0.00076**
	(0.00023)	(0.00014)	(0.00276)	(0.00067)	(0.00035)
Firm Fixed Effects	no	no	no	no	no
Municipality Fixed Effects	yes	yes	yes	yes	yes
Sector Fixed Effects	yes	yes	yes	yes	yes
Year Fixed Effects	yes	yes	yes	yes	yes
Control Variables	yes	yes	yes	yes	yes
Mean Y	0.051	0.018	0.180	0.025	0.021
Pseudo R-sq			0.455		
N			90,482		

Notes: The dependent variable is a categorical variable equal to 1 if the firm has no service establishments at time t-1 and at least one while not offshoring at time t; 2 if the firm has no service establishment at time t-1 and at least one while also offshoring at time t; 3 if the firm offshores at time t and experiences no servitization according to definition (1) at time t; 4 if the firm has no service establ. at time t-1 and no manuf. establishment at time t; 5 if the firm exits the market and 6 if none of the above conditions are fulfilled. The coefficients reported in the table are the calculated marginal effects on the probability for each category included in the categorical dependent variable. Import Competition$_{t-1}$ (alternate def.) is the log of the weighted sum of all HS products by value imported from China (new EU) by the EU-15 and the US at time $t-1$. The instrumental variable is the log of the weighted sum of all HS products by value imported from China (or new EU for the alternate def.) by the following high-income countries: Australia, Canada, Japan and New Zealand. Control variables include firm characteristics (the lagged value of firm size, robot adoption, exports, imports, share of high-skill workers, log of sales per employee and a multi-establishment dummy) and a sector-by-year Herfindahl index. Significance levels: ***1%, **5%, *10%.

Table 5: Import Competition, Servitization and Offshoring: Bivariate Probit Model Results

	Model I		**Model II**	
	(1)	**(2)**	**(3)**	**(4)**
	Partial Servitization	**Offshoring**	**Complete Servitization**	**Offshoring**
Import Competition$_{t-1}$	0.00125**	0.00698***	-0.00103	0.00443***
	(0.00061)	(0.00218)	(0.00115)	(0.00085)
Firm Fixed Effects	no	no	no	no
Municipality Fixed Effects	yes	yes	yes	yes
Sector Fixed Effects	yes	yes	yes	yes
Year Fixed Effects	yes	yes	yes	yes
Control Variables	yes	yes	yes	yes
Mean Y	0.069	0.198	0.025	0.198
Correlation Unobservables	0.015 (0.014)		-0.041 (0.038)	
Log likelihood	-37648.71		-21308.56	
N	90,482		90,482	

Notes: In column 1, the dependent variable is a binary variable equal to 1 if the firm has no service establishment at time t-1 and at least one at time t. In columns 2 and 4, the dependent variable is equal to 1 if the firm offshores at time t. In column 3, the dependent variable is equal to 1 if the firm has no service establ. at time t-1 and no manuf. establ. at time t. Import Competition$_{t-1}$ (alternate def.) is the log of the weighted sum of all HS products by value imported from China (new EU) by the EU-15 and the US at time $t-1$. The instrumental variable is the log of the weighted sum of all HS products by value for imports from China (or new EU for the alternate def.) by the following high-income countries: Australia, Canada, Japan and New Zealand. Control variables include firm characteristics (the lagged value of firm size, robot adoption, share of high-skill workers, log of sales per employee and a multi-establishment dummy) and a sector-by-year Herfindahl index. Significance levels: ***1%, **5%, *10%.

Table 6: Import Competition, Servitization, Industry Switching and Firm Exit

Dep. Var. :	**Partial Servitization**	**Partial Servitization**	**Partial Servitization**	**Partial Servitization**	**Related Partial Servitization (1)**	**Related Partial Servitization (2)**	
				Total Sample			
	Probit (1)	**OLS (2)**	**OLS (3)**	**IV (4)**	**IV (5)**	**IV (6)**	
Import Competition$_{t-1}$	0.00081***	0.00087***	0.00109**	0.00198**	0.00176**	0.00153**	
	(0.00020)	(0.00031)	(0.00044)	(0.00085)	(0.00082)	(0.00077)	
Firm Fixed Effects	no	no	yes	yes	yes	yes	
Municipality Fixed Effects	yes	yes	yes	yes	yes	yes	
Sector Fixed Effects	yes	yes	yes	yes	yes	yes	
Year Fixed Effects	yes	yes	yes	yes	yes	yes	
Control Variables	yes	yes	yes	yes	yes	yes	
Mean Y	0.069	0.069	0.069	0.069	0.043	0.045	
First Stage F-stat on Instruments	.	.	.	64.09	64.09	64.09	
First Stage- Import Competition IV Coeff.	.	.	.	0.489*** (0.061)	0.489*** (0.061)	0.489*** (0.061)	
Pseudo R-sq/R-sq	0.174	0.095	0.348	0.346	0.361	0.34044	
N	90,482	90,482	90,482	90,482	90,482	90,482	

Dep. Var. :	**Complete Servitization**	**Partial Servitization with Offshoring**	**Switch Manufacturing**	**Exit**	**Exit**	**Partial Servitization**	**Partial Servitization**
			All Sample			**All Sample**	**All Sample**
	IV (7)	**IV (8)**	**IV (9)**	**IV (10)**	**IV (11)**	**IV (12)**	**IV (13)**
Import Competition$_{t-1}$	0.00562	0.00174	-0.00148*	0.00104**	0.00491*	0.00106**	
	(0.00438)	(0.00166)	(0.00076)	(0.00044)	(0.00270)	(0.00049)	
Import Competition$_{t-1}$* Trading Firm					-0.00597***		
					(0.00160)		
Import Competition$_{t-1}$* High Productivity						0.00188*	
						(0.00102)	
Import Competition (alternate def.)$_{t-1}$							0.00145**
							(0.00072)
Firm Fixed Effects	yes	yes	yes	yes	yes	yes	yes
Municipality Fixed Effects	yes	yes	yes	yes	yes	yes	yes
Sector Fixed Effects	yes	yes	yes	yes	yes	yes	yes
Year Fixed Effects	yes	yes	yes	yes	yes	yes	yes
Control Variables	yes	yes	yes	yes	yes	yes	yes
Mean Y	0.018	0.025	0.010	0.021	0.021	0.069	0.069
First Stage F-stat on Instruments	64.09	64.09	64.09	64.09	62.07; 331.80	62.07; 331.80	60.74
First Stage- Import Competition IV Coeff.	0.489*** (0.061)	0.489*** (0.061)	0.489*** (0.061)	0.489*** (0.061)	0.461*** (0.083); 0.541*** (0.056)	0.461*** (0.083); 0.541*** (0.056)	0.446*** (0.031)
Pseudo R-sq/R-sq	0.372	0.348	0.299	0.257	0.257	0.347	0.347
N	90,482	90,482	90,482	90,482	18,728	90,482	90,482

Notes: In columns 1, 2, 3, 4, 12 and 13, the dependent variable is a binary variable equal to 1 if the firm has no service establishment at time t-1 and at least one at time t. In column 5(6), the dependent variable is equal to 1 if the firm has no service establishment at time t-1 and at least one in a def.1 (def.2)-related service industry at time t. In column 7, the dependent variable is equal to 1 if the firm permanently switches out of manufacturing. In column 8, the dependent variable is equal to 1 if the firm has no service establishment at time t-1 and at least one while also offshoring at time t. In column 9 (10,11), the dependent variable is equal to 1 if the firm switches manufacturing industries (exits the market) at time t. The "Trading Firm" variable is a dummy equal to 1 if the firm exports before its exit (if it exits the market). The "High Productivity" variable is a dummy equal to 1 if the firm's average productivity is above the 75th percentile of the within-industry productivity distribution. Import Competition$_{t-1}$ (alternate def.) is the log of the weighted sum of all HS products by value imported from China (new EU) by the EU-15 and the US at time $t-1$. The instrumental variable is the log of the weighted sum of all HS products by value imported from China (or new EU for the alternate def.) by the following high-income countries: Australia, Canada, Japan and New Zealand. Control variables include firm characteristics (the lagged value of firm size, exports, imports, robot adoption, share of high-skill workers, log of sales per employee and a multi-establishment dummy) and a sector-by-year Herfindahl index. In column 1, the reported coefficient is the marginal effect. Robust standard errors clustered at the industry-year level are in parentheses. Significance levels: ***1%, **5%, *10%.

Table 7: Import Competition and Service Workers

Dep. Var.:	**Workers Serv.**	**Workers Serv. (Within)**	**Workers Serv. (Between)**	**Workers Serv. (Count)**	**Size**	**Service Establishments**
			All sample			
	IV (1)	**IV (2)**	**IV (3)**	**IV (4)**	**IV (5)**	**IV (6)**
Import Competition$_{t-1}$	0.00462**	0.00015*	0.00170*	0.02507*	0.01801**	0.01895**
	(0.00204)	(0.00009)	(0.00101)	(0.01499)	(0.00745)	(0.09347)
Firm Fixed Effects	yes	yes	yes	yes	yes	yes
Municipality Fixed Effects	yes	yes	yes	yes	yes	yes
Sector Fixed Effects	yes	yes	yes	yes	yes	yes
Year Fixed Effects	yes	yes	yes	yes	yes	yes
Control Variables	yes	yes	yes	yes	yes	yes
Mean Y	0.166	0.014	0.130	0.966	2.635	0.651
First Stage F-stat on Instruments	64.09	64.09	64.09	64.09	64.09	64.09
First Stage- Import Competition IV Coeff.	0.489*** (0.061)	0.489*** (0.061)	0.489*** (0.061)	0.489*** (0.061)	0.489*** (0.061)	0.489*** (0.061)
R-sq	0.828	0.368	0.720	0.718	0.731	0.731
N	90,482	90,482	90,482	90,482	90,482	90,482
Dep. Var.:	**Workers Serv.**	**Workers Serv. (Within)**	**Workers Serv. (Between)**	**Workers Serv. (Count)**	**Size**	**Service Establishments**
			Partial Servitization Sample			
	IV (7)	**IV (8)**	**IV (9)**	**IV (10)**	**IV (11)**	**IV (12)**
Import Competition$_{t-1}$	0.01818**	0.00046*	0.00951*	0.02835*	0.02153***	0.02961**
	(0.00902)	(0.00025)	(0.00540)	(0.01562)	(0.00777)	(0.01494)
Firm Fixed Effects	yes	yes	yes	yes	yes	yes
Municipality Fixed Effects	yes	yes	yes	yes	yes	yes
Sector Fixed Effects	yes	yes	yes	yes	yes	yes
Year Fixed Effects	yes	yes	yes	yes	yes	yes
Control Variables	yes	yes	yes	yes	yes	yes
Mean Y	0.577	0.045	0.489	0.489	0.489	0.969
First Stage F-stat on Instruments	70.33	70.33	70.33	70.33	70.33	70.33
First Stage- Import Competition IV Coeff.	0.486*** (0.057)	0.486*** (0.057)	0.486*** (0.057)	0.486*** (0.057)	0.486*** (0.057)	0.486*** (0.057)
R-sq	0.665	0.379	0.855	0.855	0.855	0.855
N	18,170	18,170	18,170	18,170	18,170	18,170

Notes: In columns 1 and 7, the dependent variable is the share of workers employed in service establishments within the same firm at time t. In columns 2 and 8, the dependent variable is the same share calculated by using only the stock of workers who switched to a service establishment with the same firm at time t. In columns 3 and 9, the dependent variable is the same share calculated by using only the stock of newly hired workers employed in service establishments with the same firm at time t. In columns 4 and 10, the dependent variable is the log of the number of workers employed in service establishments within the same firm at time t. In columns 5 and 11, the dependent variable is the log of the total number of workers employed at the same firm at time t. In columns 6 and 12, the dependent variable is the log of the total number of service establishments within the same firm at time t. "Partial Servitization Sample" includes all firms that partially "servitize" at least once over the sample period. Import Competition$_{t-1}$ (alternate def.) is the log of the weighted sum of all HS products by value imported from China (new EU) by the EU-15 and the US at time $t-1$. The instrumental variable is the log of the weighted sum of all HS products by value imported from China (or new EU for the alternate def.) by the following high-income countries: Australia, Canada, Japan and New Zealand. Control variables include firm characteristics (the lagged value of firm's size, exports, imports, robot adoption, share of high-skill workers, log of sales per employee and a multi-establishment dummy) and a sector-by-year Herfindahl index. In column 1, the reported coefficient is the marginal effect. Robust standard errors clustered at the industry-year level are in parentheses. Significance levels: ***1%, **5%, *10%.

Table 8: Import Competition and Offshoring

Dep. Var.:	**Offshoring (1)**	**Offshoring (1)**	**Offshoring (1)**	**Offshoring (1)**	**Offshoring without Partial Servitization**	**Offshoring (1)**	**Offshoring (1)**	**Offshoring (2)**
					All Sample			**Offshoring Firms**
	Probit	**OLS**	**OLS**	**IV**	**IV**	**IV**	**IV**	**IV**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Import Competition$_{t-1}$	0.08319***	0.01732***	0.00219**	0.01560**	0.01464***		0.00993*	0.08633*
	(0.00440)	(0.00080)	(0.00094)	(0.00619)	(0.00491)		(0.00555)	(0.05250)
Import Competition$_{t-1}$*High Productivity							0.03851*	
							(0.02259)	
Import Competition (alternate def.)$_{t-1}$						0.00872**		
						(0.00439)		
Firm Fixed Effects	no	no	yes	yes	yes	yes	yes	yes
Municipality Fixed Effects	yes	yes	yes	yes	yes	yes	yes	yes
Sector Fixed Effects	yes	yes	yes	yes	yes	yes	yes	yes
Year Fixed Effects	yes	yes	yes	yes	yes	yes	yes	yes
Control Variables	yes	yes	yes	yes	yes	yes	yes	yes
Mean Y	0.198	0.198	0.198	0.198	0.180	0.180	0.180	15.908
First Stage F-stat on Instruments	.	.	.	64.09	64.09	60.74	62.07; 331.80	64.48
First Stage- Import Competition IV Coeff.	.	.	.	0.489*** (0.061)	0.489*** (0.061)	0.446*** (0.031)	0.461*** (0.083); 0.541*** (0.056)	0.563*** (0.069)
Pseudo R-sq/R-sq	0.413	0.383	0.742	0.740	0.665	0.741	0.756	0.795
N	90,482	90,482	90,482	90,482	90,482	90,482	90,482	20,021

Notes: In columns 1,2,3,4,6 and 7, the dependent variable is a binary variable equal to 1 if the firm offshores at time t. In column 5, the dependent variable is equal to 1 if the firm offshores and experiences no servitization (1) at time t. The dependent variable in column 8 is the log of offshoring values, conditional on offshoring. The "High Productivity" variable is a dummy equal to 1 if the firm's average productivity is above the 75th percentile of the within-industry productivity distribution. Import Competition$_{t-1}$ (alternate def.) is the log of the weighted sum of all HS products by value imported from China (new EU) by the EU-15 and the US at time $t-1$. The instrumental variable is the log of the weighted sum of all HS products by value imported from China (or the new EU for the alternate def.) by the following high-income countries: Australia, Canada, Japan and New Zealand. Control variables include firm characteristics (the lagged value of firm size, exports, imports, robot adoption, share of high-skill workers, log of sales per employee and a multi-establishment dummy) and a sector-by-year Herfindahl index. In column 1, the reported coefficient is the marginal effect. Robust standard errors clustered at the industry-year level are in parentheses. Significance levels: ***1%, **5%, *10%.

Table 9: Import Competition, Servitization, Offshoring and Firm Exit: Multinomial Logit Results for Portugal

	(1)	(2)	(3)	(4)	(5)
	Partial Servitization without Off.	**Partial Servitization with Off.**	**Offshoring without Partial Serv.**	**Complete Servitization**	**Exit**
Import Competition$_{t-1}$	0.00109**	0.000056	0.03245***	-0.00088	0.00496***
	(0.00054)	(0.00041)	(0.00055)	(0.00059)	(0.00062)
Firm Fixed Effects	no	no	no	no	no
Municipality Fixed Effects	yes	yes	yes	yes	yes
Sector Fixed Effects	yes	yes	yes	yes	yes
Year Fixed Effects	yes	yes	yes	yes	yes
Control Variables	yes	yes	yes	yes	yes
Mean Y	0.021	0.014	0.358	0.011	0.037
Pseudo R-sq			0.350		
N			68,317		

Notes: The dependent variable is a categorical variable equal to 1 if the firm has no service establishment at time t-1 and at least one while not offshoring at time t; 2 if the firm has no establishment in service at time t-1 and at least one while also offshoring at time t; 3 if the firm offshores at time t and experiences no servitization according to definition (1) at time t; 4 if the firm has no service establ. at time t-1 and no manuf. establishment at time t; 5 if the firm exits the market and 6 if none of the above conditions are fulfilled. The coefficients reported in the table are the calculated marginal effects on the probability for each category included in the categorical dependent variable. Import Competition$_{t-1}$ (alternate def.) is the log of the weighted sum of all HS products by value imported from China (new EU) import by EU-15 and the US at time $t-1$. The instrumental variable is the log of the weighted sum of all HS products by value imported from China (or new EU for the alternate def.) by the following high-income countries: Australia, Canada, Japan and New Zealand. Control variables include firm characteristics (the lagged value of firm size, robot adoption, exports, imports, share of high-skill workers, log of sales per employee and a multi-establishment dummy) and a sector-by-year Herfindahl index. Significance levels: ***1%, **5%, *10%.

Table 10: Import Competition, Servitization and Offshoring: Bivariate Probit Model Results (Portugal)

	Model I		**Model II**	
	(1)	**(2)**	**(3)**	**(4)**
	Partial Servitization	**Offshoring**	**Complete Servitization**	**Offshoring**
Import Competition$_{t-1}$	0.00078*	0.03955*	-0.00056	0.04369**
	(0.00041)	(0.02107)	(0.00043)	(0.02231)
Firm Fixed Effects	no	no	no	no
Municipality Fixed Effects	yes	yes	yes	yes
Sector Fixed Effects	yes	yes	yes	yes
Year Fixed Effects	yes	yes	yes	yes
Control Variables	yes	yes	yes	yes
Mean Y	0.035	0.372	0.025	0.372
Correlation Unobservables	0.008 (0.028)		0.026 (0.022)	
Log likelihood	-28301.16		-30035.98	
N	68,317		68,317	

Notes: In column 1, the dependent variable is a binary variable equal to 1 if the firm has no service establishment at time t-1 and at least one at time t. In columns 2 and 4, the dependent variable is equal to 1 if the firm offshores at time t. In column 3, the dependent variable is equal to 1 if the firm has no service establ. at time t-1 and no manuf. establishment at time t. Import Competition$_{t-1}$ (alternate def.) is the log of the weighted sum of all HS products by value imported from China (new EU) by the EU-15 and the US at time $t-1$. The instrumental variable is the log of the weighted sum of all HS products by value imported from China (or new EU for the alternate def.) by the following high-income countries: Australia, Canada, Japan and New Zealand. Control variables include firm characteristics (the lagged value of firm size, robot adoption, share of high-skill workers, log of sales per employee and a multi-establishment dummy) and a sector-by-year Herfindahl index. Significance levels: ***1%, **5%, *10%.

Table 11: Import Competition, Offshoring and Servitization: Results for Portugal

Dep. Var.:	**Partial Servitization**	**Related Partial Servitization (1)**	**Related Partial Servitization (2)**	**Partial Servitization with Offshoring**
	IV (1)	**IV (2)**	**IV (3)**	**IV (4)**
Import Competition$_{t-1}$	0.00128*	0.00059*	0.00064**	-0.00069
	(0.00068)	(0.00031)	(0.00032)	(0.00076)
Firm Fixed Effects	yes	yes	yes	yes
Municipality Fixed Effects	yes	yes	yes	yes
Sector Fixed Effects	yes	yes	yes	yes
Year Fixed Effects	yes	yes	yes	yes
Control Variables	yes	yes	yes	yes
Mean Y	0.035	0.019	0.022	0.014
First Stage F-stat on Instruments	694.2	694.2	694.2	694.2
First Stage- Import Competition IV Coeff.	0.678*** (0.025)	0.678*** (0.025)	0.678*** (0.025)	0.678*** (0.025)
R-sq	0.251	0.253	0.253	0.243
N	68,317	68,317	68317	68,317
Dep. Var.:	**Complete Servitization**	**Exit**	**Offshoring**	**Workers Serv.**
	IV (5)	**IV (6)**	**IV (7)**	**IV (8)**
Import Competition$_{t-1}$	-0.00124	0.00708***	0.01509*	0.00310*
	(0.00080)	(0.00179)	(0.00851)	(0.00190)
Import Competition$_{t-1}$* High Productivity			0.03611*	
			(0.02008)	
Firm Fixed Effects	yes	yes	yes	yes
Municipality Fixed Effects	yes	yes	yes	yes
Sector Fixed Effects	yes	yes	yes	yes
Year Fixed Effects	yes	yes	yes	yes
Control Variables	yes	yes	yes	yes
Mean Y	0.011	0.037	0.372	0.165
First Stage F-stat on Instruments	694.2	694.2	782.85; 147.88	694.2
First Stage- Import Competition IV Coeff.	0.678*** (0.025)	0.678*** (0.025)	0.983*** (0.020); 0.765*** (0.022)	0.678*** (0.025)
R-sq	0.244	0.266	0.434	0.253
N	68,317	68,317	68,317	68,317

Notes: In column 1, the dependent variable is a binary variable equal to 1 if the firm has no service establishment at time t-1 and at least one while also not offshoring at time t. In column 2(3), the dependent variable is equal to 1, if the firm has no service establishment at time t-1 and at least one in a def.1 (def.2) related service industry at time t. In column 4, the dependent variable is equal to 1 if the firm has no service establishment at time t-1 and at least one while also offshoring at time t. In column 5, the dependent variable is equal to 1 if the firm permanently switches out of manufacturing. In column 6 (7), the dependent variable is equal to 1 the firm exits the market (offshores) at time t. In column 8, the dependent variable is the share of workers employed in service establishments within the same firm at time t. Import Competition$_{t-1}$ (alternate def.) is the log of the weighted sum of all HS products by value imported from China (new EU) by EU-15 and the US at time $t-1$. The instrumental variable is the log of the weighted sum of all HS products by value imported from China (or new EU for the alternate def.) by the following high-income countries: Australia, Canada, Japan and New Zealand. The "High Productivity" variable is a dummy equal to 1 if the firm's average productivity is above the 75th percentile of the within-industry productivity distribution. Control variables include firm characteristics (the lagged value of firm size, exports, imports, robot adoption, share of high-skill workers, a multi-establishment dummy and log of sales per employee) and a sector-by-year Herfindahl index. In column 1, the reported coefficient is the marginal effect. Robust standard errors clustered at the industry-year level are in parentheses. Significance levels: ***1%, **5%, *10%.