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Author: Arnd Kölling | Antje Mertens

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Biographic note:

Arnd Kölling is Professor of Empirical Economics at the Department of Cooperative Studies at the Berlin School of Economics and Law.

Arnd Kölling ist Professor für Volkswirtschaftslehre, insbesondere empirische Wirtschaftsforschung am Fachbereich 2 „Duales Studium" der Hochschule für Wirtschaft und Recht.

Antje Mertens is Professor of Economics at the Department of Cooperative Studies at the Berlin School of Economics and Law.

Antje Mertens ist Professorin für Volkswirtschaftslehre am Fachbereich 2 „Duales Studium" der Hochschule für Wirtschaft und Recht

Arnd Kölling
Berlin School of Economics and Law
Alt-Friedrichsfelde 60
D-10315 Berlin
Arnd.Kölling@hwr-berlin.de
Phone: ++49 (0) 30 30877 2449

Antje Mertens
Berlin School of Economics and Law
Alt-Friedrichsfelde 60
D-10315 Berlin
Antje.Mertens@hwr-berlin.de
Phone: ++49 (0) 30 30877 2250

Abstract

The analysis deals with the influence of exporting on the demand for workers with different skill levels. Previous literature suggests that this includes two major topics. First, productivity of exporting firms may increase due to learning facts after entering international markets and/or be higher initially due to self-selection of firms into exporting. Second, exporting potentially leads to a change in the employment structure towards highly skilled workers. We applied a conditional difference-in-difference regression model of labor demand for three different skill levels to investigate this hypothesis. For this purpose, we use German establishment panel data that covers the period from 2000 to 2014. The outcome shows that not only self-selection into exports must be controlled for but also that changes in employment seem to be skill biased in manufacturing firms starting export activities. Nevertheless, there are no corresponding findings for firms that stop exporting or establishments in the service sector respectively.

***Key Words**: Export, labor demand, skills, treatment model.*

***JEL classification:** F14, J23, J24, C31*

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1. Introduction

Germany, as one of the major trading nations in the world, exports around 40% and imports around 35% of its GDP (Statistical Office Germany 2018). Given the importance of international trade for the German economy, we are likely to see not only German employment levels being influenced by the world economy but also the composition of the workforce being transformed. In fact, globalization and trade can also be seen as intermediating the effects of economic shocks on wages and employment (Lichter et al. 2017).

The influence of trade on labor demand is of special importance, as it is likely to affect remuneration differently and employment chances of different skill groups in the labor market. The recent literature on heterogeneous firms and trade (Melitz 2003) looks at this from an establishment perspective, which helps to identify the effects of exporting (and importing) on the composition of the workforce more directly than looking at aggregate figures. One important mechanism between trade and labor demand of individual firms is the potential influence of trade on technological change (Acemoglu 2003; Van Reenen 2011). If trade induces skill-biased technical change, as Acemoglu (2003) argued, then complementarities between technology and skill will increase the relative demand for skilled workers, putting potential downward pressure on unskilled workers wages and employment. This matches with the observation that exporting firms are often found to be different in terms of productivity, value added, and employment, though the question of whether this is just a selection of establishments that decide to sell in international markets or whether exporting firms develop differently is not fully clear.

To our knowledge there are so far only two German studies dealing with these important issues. Lichter et al. (2017) were interested in the effect of trade on labor demand elasticities and reported that own-wage demand elasticities significantly increase with a firm's export share. They also found, however, that the elasticities differ for white-collar and blue-collar workers in Germany with lower own-wage demand elasticities for white-collar workers than for blue-collar workers. This suggests that skill groups will be affected differently by international trade. Also, Dauth et al. (2018) findings point in this direction. They studied the impact of trade exposure on German workers' employment trajectories and found that skilled workers benefit the most from export opportunities. On the other hand, low-skilled workers bear most of the burden stemming from import shocks.

Our paper supplements this literature by studying directly the effects of exporting on the labor demand of firms for different skill groups, separately for establishments in manufacturing and services. Our work adds to the previous literature in several ways. To our knowledge, we are the first to apply difference-in-difference models to this question (eliminating unobserved heterogeneity on the firm level) and treatment effects controlling for selectivity of firms into exporting. We use radius matching based on calculations of propensity scores to control for selectivity. For our purposes, we prefer this method over instrumental variables (IV) as it uses less strict assumptions and allows us to better exploit our data.

In the following Chapter 2, we will review the theoretical and empirical literature connected to our research question and derive our hypotheses. The methodology and data are discussed in detail in Chapters 3 and 4. We use data from the IAB Establishment Panel between 2007 and 2014 augmented by information from the Establishment Historic Panel. In this data set, we are able to distinguish between establishments starting or stopping exporting (though we do not have information on imports or offshoring decisions) and estimate the effect of changing exporting behavior on the employment of different skill types within establishments. The results are presented in Chapter 4. Finally, Chapter 5 concludes.

2. Literature overview

Research on the labor market effects of trade has, to a large extent, been influenced by the Heckscher-Ohlin (H-O) and Specific Factors models, which predict changing relative wages across skill groups, occupations, or industries (Helpman et al. 2017). Based on these models, the debate in the 1990s focused on the effects of trade with lower developed countries and the effect on wages and unskilled worker employment in industrialized countries (see Freeman and Ravenga 1999). In Europe, Wood (1995) argued that trade had a huge effect, but the most common position was that the shift against unskilled workers was caused primarily by technological change (see e.g. Autor et al. 1998; Berman et al. 1994; Desjonqueres et al. 1999; Machin and Van Reenen 1998; Wood 2018).[1] The most recent developments in trade theory and analysis have shifted the focus by considering the export decisions among heterogeneous firms and the influence of exporting on firms' performance (see Bernard and Jensen 1995; Melitz 2003; Melitz and Redding 2014). In the following, we will first discuss the question of self-selection into exports followed by an overview of the influence of trade on the skill composition of the workforce.

2.1 Selectivity of exporting firms versus productivity gains due to exporting

One of the most stable empirical findings in this literature is that exporting and non-exporting firms differ, with exporters being larger, more capital intensive, and showing better performance like higher levels of productivity or higher wages on average compared to non-exporters in the same industry (compare e.g., Bernard and Jensen 1995, 1999 who pioneered this literature). These findings could be due to (i) superior firms becoming exporters or (ii) the fact that exporting is advantageous and improves firms' performance. Theoretically, it is easy to argue that superior firms become exporters: Starting to export usually causes fixed entry costs (sunk costs) not linked to export volume. Before becoming an exporter, a firm needs to do market research, learn about foreign regulations, and maybe even set up new distribution channels and potentially adjust products to foreign standards. These sunk costs will be easier to recover for larger, high-productivity firms, and therefore their likelihood to start exporting will be higher. Bernard and Jensen (1999), Cleridas et al. (1998), and Roberts and Tybout (1997) originally used such a fixed export cost to explain self-selection into exporting, while Melitz (2003) theoretically applied the approach in a general equilibrium framework. By the same argument, firms will stop exporting if they become less productive, resulting in a negative return from trade. However, sunk costs might stop them from doing so immediately, leading to lagged exits following negative productivity changes (Girma et al. 2004). Argument (ii) that firms' performance will improve if they start exporting has been linked to potential learning effects and higher competition in export markets. If such learning effects exist, exporters will become even more efficient as they gain experience in exporting. Moreover, firms can take better advantage of economies of scale in differentiated international product markets. Theoretical models dealing with firm heterogeneity with differentiated product markets predict that trade liberalization leads to reallocation in product markets (Melitz and Redding 2014). Essentially, firms will be affected unevenly by trade liberalization: High-productivity firms will start exporting and will expand, low-productivity firms will exit the product market altogether, and intermediate-productivity domestic firms will contract.

By now, there is a considerable amount of evidence showing self-selection into export markets for better performing firms. In their early studies, Bernard and Jensen (1995, 1999) showed evidence for the United States that supported the self-selection story. Early international literature shows that indeed self-selection is important for many countries, for example, Chile (Pavcnik 2002), Taiwan and Korea (Aw et al. 2000), Colombia, Mexico, and Morocco (Clerides et al. 1998), and Spain (Delgado et al. 2002). Later studies have supported that view (for overviews see Bernard et al. 2007 and Wagner 2011).

However, the evidence on learning effects and productivity gains is less clear. Aw et al. (2000) found some productivity improvements following the entry into export markets for Taiwanese firms but not for

[1] Many studies have analyzed price changes and their effect on the workforce skill composition, or they have compiled factor content analyses estimating job loss through product imports "incorporating" unskilled labor. Some studies have, contrary to the H-O story, found rising wage differentials in developing countries (Robbins 1996). Helpman (2017) briefly summarized the problems with using Heckscher-Ohlin type models: 'In contrast to the predictions of those theories, empirical studies find increased wage inequality in both developed and developing countries, growing residual wage dispersion among workers with similar observed characteristics, and increased wage dispersion across plants and firms within sectors. In part due to this disconnect, previous studies have concluded that the contribution of trade to growing wage inequality is modest at best'.

South Korea. Also, Clerides et al. (1998) did not find that export-led development benefits from productivity improvements after entry into export markets in Colombia, Mexico, and Morocco, but they did find evidence for self-selection into export markets. For Germany, studies by Bernard and Wagner (1997, 2001) and Wagner (2002) found a similar pattern for the single German state of Lower Saxony, stating that 'success leads to exporting, rather than the reverse'. They reported that most productive advantages are present several years before entry into exporting such that higher employment, output, and productivity growth rates for new exporters can be explained by this ex-ante difference. Using a matching approach, Wagner (2002) found positive causal effects of starting to export on plant performance as measured by employment, wages, and, to a limited extent, on productivity. Using a similar method but a different data set (Mannheim Innovation Panel), Arnold and Hussinger (2005) analyzed a representative sample of German manufacturing firms finding that productivity increases prior to taking up exports, but that when controlling for selection into exporting, there are no significant effects of exporting on the productivity level or growth rate. Many other studies on Germany have followed using a variety of data sets and methods with mixed results (see Wagner 2011 for an overview).

Many of these empirical studies have also shown that exporters pay higher wages than firms just selling to the domestic market due to their higher productivity (Burstein and Vogel 2017; Schank et al. 2007 provided a synopsis of 21 studies) thereby increasing wage inequality among otherwise homogeneous workers. Theoretically, wage inequality between exporting and non-exporting firms can be explained in competitive labor markets with heterogeneous workers when there is assortative matching between worker skill and firm productivity (e.g., Sampson 2014; Verhoogen 2008). Other theoretical models used to explain wage differentials include labor market imperfections (Davidson et al. 2008; Helpman et al 2010a) and firm human resource practices (Helpman et al. 2017). Though many studies report an exporter wage premium, controlling for employee characteristics is important, as Schank et al. (2007) showed for Germany. They found that the average wage paid by exporters is 36.6 percent higher than by non-exporters, but controlling for observable and unobservable employee characteristics reduces this exporter wage premium to just 2.2 percent.

2.2 Potential effects of exporting on labor demand and skill composition

Much of the literature that deals with the labor demand effects of international trade has estimated labor demand elasticities. Starting off from the well-known fact that the own wage elasticity of labor demand—as a derived demand—increases in absolute terms with the price elasticity of product demand (Hamermesh 2003), effects of trade will be highly likely. Firms trading in international markets will face higher elasticities of product demand and therefore exhibit higher labor demand elasticities in absolute terms if faced with increased competition in a globalized world (Rodrick 1997). Empirical studies have shown that indeed demand elasticities in absolute terms decrease with per capita income so that firms in high-productivity countries will be faced with higher elasticities when trading (Markusen 2013; Simonovska 2013). Thus, the common presumption is that as exporters are faced with overall higher volatility in product demand, with volatility increasing in the export share (Vannoorenberghe 2012), leading to more volatile employment for exporters. Kurz and Senses (2016) showed that 'a higher share of exports, fewer numbers of export destinations, and export destinations that are further away, and with lower average incomes are associated with higher levels of volatility for exporters. However, they found that employment for exporters was less volatile than that of firms selling only domestically overall. The reason behind this finding could be the ability of exporters to absorb demand shocks in one country, diversifying their activities in other countries. Higuchi et al. (2016) analyzed in a similar manner the relationship between employment growth and foreign exposure for Japan and got similar results. Moreover, they showed that in manufacturing, the effect of exports on employment volatility varies by the share of intra-firm exports to total sales, while in wholesale and retail trade exports do not have significant effects on employment volatility at all. Some have also estimated demand elasticities directly. Slaughter (2001), however, found only very mixed evidence that trade played a role in the increasing variability of demand elasticities in the United States. Krishna et al. (2012) and Fajnzylber and Maloney (2005), in their study, found no connection between elasticities and international trade for Turkey and Latin America. On the other hand, there is evidence that in India (Hasan et al. 2007) and South Korea (Mitra and Shin 2012) trade has led to increasing labor demand elasticities. For Germany Lichter et al. (2017) studied labor demand elasticities for different skill groups. They found that exporting increases the own wage elasticities for all skill groups, with a significant difference between the median exporter (-0.93) and the median non-exporter (-0.53).

We now turn to the studies that analyze the direct effects of trade on the skill composition of the workforce. One mechanism between trade and the demand for skilled workers may arise from the interaction between trade and technical change (for an overview see e.g., Van Reenen 2011). Acemoglu (2003) argued that trade endogenously induces skill-biased technical change, which can, in turn, explain increases in the relative demand for skilled workers.[2] The mechanism behind this is that trade affects innovation incentives through its effect on product prices, as "International trade increases the relative price of skill-intensive goods, and the higher relative price of skill-intensive goods encourages further skill-biased technical change" (Acemoglu, p. 217). The technical change will increase workers' productivity, so product prices will not increase as predicted by standard H-O models. Complementarity between new technologies and high-skilled workers will lead to increasing demand for highly skilled workers (Krusell 2000). Similar effects can be found in developing and lower-developed countries as they open up to trade; the usage of new foreign technology increases skill demand. Moreover, trade can induce shifts to more skill-intensive sectors as the composition of production changes in the direction of more high-quality products (Verhoogen 2008). Some studies have empirically tested for such a link, and some have found evidence that a reduction of trade barriers leads to technology upgrades (see e.g., Bustos 2011 for Argentinian firms; Gallego 2012 for Chile; Meschi et al. 2016 for Turkey; and Bloom et al. 2016 for Europe), and lower prices for machinery and equipment lead to increasing skill differentials and skill demand (see e.g., Caselli 2014 for Mexico; Haile et al. 2017; Harrigan and Reshef 2015 for Chile; and Anderson (2005) for an overview of earlier studies). Several studies have shown that the skill wage premium and demand for skill increases (and/or gets less volatile) when firms export (see e.g., Hahn and Choi 2017 for Korea; Charfeddine and Mrabet 2015 and Ben Salha 2013 for Tunesia; Bas et al. 2017 for France; and Fieler et al. 2018 for Columbia). Fajnzylber and Fernandez (2009) found an increased skill demand in Brazil but not in China. The skill premium also increases in the distance between the trading partners, which can be explained by a combination of high-quality goods being relatively skilled intensive with the effect that goods shipped over longer distances are of higher quality (Bekkers et al. 2016). The only German study in this tradition by Dauth et al. (2018) argued that trade has indeed increased the demand for skilled workers in Germany in industries with greater trade exposure. In effect, they analyzed job and industrial mobility as a reaction to import and export shocks in Germany. Workers in industries most exposed to exports were found to experience earnings gains, many after changing their employer within the original industry. So, the highest-skilled workers re-allocate after trade shocks to exploit opportunities generated by exporting firms.

2.3 Hypotheses

First of all, there is ample evidence that firms self-select into exports. Establishments with a higher value added (Hypothesis 1a) and those with higher productivity/higher share of skilled workers (Hypothesis 1b) will be more likely to export. Likewise, establishments with these characteristics will be less likely to stop exporting. We will control for this selection using propensity score matching on a sample of German manufacturing and service firms (see in this context e.g., Wagner 2002; Arnold and Hussinger 2005; Vogel and Wagner 2009; Schank et al. 2010) as described below in Section 3.

Secondly, our literature discussion has shown that the reduction of trade barriers may induce technological change through innovation incentives (Acemoglu 2003). As firms start to export, they will upgrade workers' skill level due to the complementarity between new technologies and high-skilled workers. A shift to more skill-intensive sectors caused by compositional changes in the direction of high-quality products by exporting firms will have the same effect (Melitz and Redding 2014). (Hypothesis 2). Especially, we hypothesize that we will see the demand for skilled workers firms staring to export increasing (Hypothesis 2a) and the demand for unskilled workers to decrease (Hypothesis 2b). Moreover, according to the literature (see Lichter et al. 2017 for Germany) we expect wage elasticities to be negative for all skill groups (Hypothesis 3). Finally, we suppose that as productivity and the adoption of new technologies differ significantly between the manufacturing and the services sector, we will find the demand for skills to be less affected in services (Hypothesis 4).

[2] For a discussion on the influence of technological change on skill demand see e.g., Acemoglu and Autor (2011), Atkinson (2008), Autor et al. (1998, 2003), Katz and Murphy (1992), and Machin and Van Reenen (1998).

3. Empirical Model

This study was designed to analyze the effects of export on labor demand for heterogeneous skill levels. In this context, we are looking for an empirical model that fits the need of this target. We did not adopt a model that is based on a cost or production function because of the strong assumptions about market structures and individual behavior that are used to derive a labor demand model (Hamermesh 1993, p. 33). Instead, a treatment model for panel data was applied to the analysis (Wooldridge 2010, p. 969) because it will estimate causal effects without using restrictive assumptions about cost or production functions. In addition, it is possible to extend the model to multiple and non-binary treatments (Wooldridge 2010, p. 961).

The fundamental problem of a treatment analysis is that it cannot measure the causal effect of a treatment on the untreated, since it is not possible to be treated and non-treated at the same time. As such, we cannot observe how an exporting firm would behave if it did not export. This fundamental evaluation problem is frequently solved using the Roy-Rubin model or the model of potential outcomes (cf. Roy 1951, Rubin 1974). When empirically studying a treatment effect, it is usually assumed that taking into consideration certain observable variables X_{it}, participants and non-participants would have developed in the same way if the treatment had not been applied. This assumption is frequently referred to as the conditional independence assumption (CIA) of unconfoundedness (Wooldridge 2010):

$$(1) \qquad E(Z_{it}(0)|\ d_{it} = 1, X_{it}) = E(Z_{it}(0)|\ d_{it} = 0, X_{it}),$$

where '$Z_{it}(0)$' is the outcome for firm 'i' in period 't' if the entity is not treated, i.e., did not export in that particular period; 'd' is the indicator of treatment ($d_{it} = 1$) or non-treatment ($d_{it} = 0$); and 'X_{it}' is the vector of observed covariates under consideration. In addition to the selectivity of treatment, unobserved heterogeneities c_i can also influence the effect of the treatment. This leads to a reformulation of equation (1):

$$(1a) \qquad E(Z_{it}(0)|\ d_{it} = 1, X_{it}, c_i) = E(Z_{it}(0)|\ d_{it} = 0, X_{it}, c_i).$$

As the difference in the outcome is defined as the treatment effect τ, we can also assume:

$$(2) \qquad E(Z_{it}(1)|\ d_{it} = 1, X_{it}, c_i) = E(Z_{it}(0)|\ d_{it} = 0, X_{it}, c_i) + \tau.$$

The observed value of Z_{it} is then given by:

$$(3) \qquad Z_{it} = \begin{cases} Z_{it}(0) \text{ if } d = 0 \\ Z_{it}(1) \text{ if } d = 1 \end{cases}$$

or

$$(4) \qquad Z_{it} = (1 - d_{it})\cdot Z_{it}(0) + d_{it}\cdot Z_{it}(1) = Z_{it}(0) + d_{it}\cdot(Z_{it}(1) - Z_{it}(0)).$$

Replacing Z_{it} by its expected values, assuming a linear model for $Z_{it}(0) = \alpha_0 + \alpha_1\cdot t + \beta_i\cdot X_{it} + c_i$ and using the relationship in equation (2), equation (4) becomes:

$$(5) \qquad E(Z_{it}|\ d_{it}, x_{it}, c_i) = \alpha_0 + \alpha_1\cdot t + \beta_i\cdot X_{it} + c_i + \tau\cdot d_{it}.$$

This causal model is an extension of the standard difference-in-differences model to linear panel data. Moreover, it is possible to use more than one treatment variable (Autor 2003). If one assumes that the treatment effects are constant and independent of heterogeneity among the firms' c_i, then this model is easily estimated with fixed effects considering heteroscedasticity and serial correlation (Wooldridge 2010). In the subsequent analysis, we argue that the observation of exporting firms is biased through the variable's endogeneity. In this case, weighting the regressions by the propensity score of observing a treated entity could correct for this selectivity (Hirano and Imbens 2001; Freedman and Berk 2008). If one likes to use a fixed-effects model in this case, one has to assume that the weights are constant for all observations of a particular establishment. This assumption is very unlikely because the variables that influence the decision to export or not, are not fixed and change over the observed time. Therefore, we decided to estimate a model in first differences. This approach loses some of the efficiency of the estimates, but it still eliminates the unobserved heterogeneity c_i and respectively results in consistent parameter estimates (Wooldridge 2010) and allows time-varying weights for individual firms i. Equation (5) is then given by:

(6) $(\Delta Z_{it}| \Delta d_{it}, \Delta X_{it}) = \alpha_1 + \beta_i \cdot \Delta X_{it} + \tau \cdot \Delta d_{it}.$

The constant α_0 and the firm-specific effects c_i are eliminated from the equation, while the time effect α_1 becomes the new constant. In the following, we assume that the probability to observe a firm that starts respectively ends exporting (p^s_{it} and p^e_{it}) based on other observables Y_{it}:

(7a) $p^s_{it}(Y_{it}) = p(\Delta d_{it} = 1|Y_{it}),$

(7b) $p^e_{it}(Y_{it}) = p(\Delta d_{it} = -1|Y_{it}).$

with $0 < p(Y) < 1$ for both treated and untreated observations. The latter condition satisfies the overlap assumption (Wooldridge 2010, p. 911). If we ignore equations (7a) and (7b), then the outcome of the regressions could be biased through selectivity. One way to overcome this problem is to derive weights for the regression based on a matching procedure. The matching of treated and untreated firms follows the propensity score, that is, estimations of p^s_{it} and p^e_{it} on the observed Y_{it}. In our analysis, we used radius matching. Therefore, we conducted two probit regressions to estimate the propensity score and compare the result of firms that start (finish) exporting with the results of the establishments in the control group of firms that remain non-exporting (exporting) entities. If the estimation is located within a defined distance (caliper) of 0.001 from the determined propensity score of the participating unit, then the control group data must be weighted with the factor w_{jt} depending on the number of control group establishments in the defined radius. Firms that start or end their export activities receive a weight equal 1 ($w_{it} = 1$ if $\Delta d_{it} \neq 0$). Equation (6) then becomes:

(8) $E(\Delta Z_{it}| \Delta d_{it}, \Delta X_{it}, p_{it}) = w_{it} \cdot (\alpha_1 + \beta_i \cdot \Delta X_{it} + \tau \cdot \Delta d_{it}).$

The treatment d_{it} is also in first differences, indicating firms that change their export activities to start (Δd_{it}=1) or end (Δd_{it}=-1) exporting. If we allow for different effects e_{jit} for both cases, it leads to the following expression for τ:

(9a) $e_{1it} = \begin{cases} 0 \text{ if } \Delta d_{it} \neq 1 \\ 1 \text{ if } \Delta d_{it} = 1 \end{cases}$

(9b) $e_{2it} = \begin{cases} 0 \text{ if } \Delta d_{it} \neq -1 \\ 1 \text{ if } \Delta d_{it} = -1 \end{cases}$

And therefore, the treatment effect τ is given by:

(10) $\tau = \delta_1 e_{1it} + \delta_2 e_{2it} = \sum_j \delta_j e_{jit}$

An alternative way to identify endogeneity in this context would be the use of instrumental variables (IV) (Dauth et al. 2014) and Lichter et al. 2017). As IV requires stronger assumptions and conditions when the model is estimated (Wooldridge 2010), we prefer a propensity score over IV methods. Nevertheless, we also conducted regressions using the lag of the variables of interest as instrumental variables. Compared with the propensity score method, the results do not contradict the subsequent analysis and are available from the authors upon request.

Because the outcome variable ΔZ_{it} is defined as the first difference in the logarithms of the firms' employment of different qualifications (ΔlnL_i), the empirical model becomes:

$$(11) \qquad \Delta lnL_i = w_{it} \cdot (\alpha_1 + \beta_i \cdot \Delta X_{it} + \sum_j \delta_j e_{jit} + \mu_{it}),$$

with μ_{it} as the error term ($\mu_{it} \sim N(0, \sigma^2)$. As the ΔlnL_i are approximately equal to the growth rates of L_i, it is possible to use estimates of δ_j c.p. as changes in the growth rate according to changes in the export behavior, i.e., the semi-elasticities. In the following, we will also allow for treatment effects that appear over a longer time period and estimate (11) with lagged treatment variables e_{jit-1}:

$$(11a) \qquad \Delta lnL_i = w_{it} \cdot (\alpha_1 + \beta_i \cdot \Delta X_{it} + \sum_j \delta_j e_{jit-1} + \mu_{it})$$

Please note that equations (11) and (11a) are defined in first differences Therefore, we assume that firms continuing to export or to not export show no additional effect on changes in labor demand. Nevertheless, we also estimated separate models for both kinds of treatments without significant changes in the main results. The results are available from the authors. Before equation (11a) is used to estimate the effect of export on labor demand, we will first introduce the data used in our estimations.

4. Data and Descriptive Evidence

The subsequent analysis needs data that allows to continuously analyze exporting and employment behavior of German establishments. Therefore, we use data from the IAB Establishment Panel to conduct the following investigation. The Institute for Employment Research of the German Federal Labor Agency has conducted the IAB Establishment Panel since 1993 in the western part of Germany and since 1996 in the former eastern part of Germany. The population of the IAB Establishment Panel includes all German establishments with at least one employee covered by social insurance contributions. The survey is then a stratified random sample of 17 industries, 10 employment size classes, and 16 regions (the Bundesländer) as particular strata of the total population (Fischer et al. 2008, 2009). The data in the regressions is restricted to the period from 2000, as some of the variables used in the regressions had not been collected before that year, to 2014, the last year available. The survey shows a very high response rate of over 70% to 80% for establishments that have participated more than once. The data is unbalanced, however, as new establishments have replaced panel mortality through exits and non-response. In total, there are about 16,000 observations each year available for our investigation (Fischer et al. 2008, 2009).

The IAB Establishment panel contains information about the share of export of firms' total turnover. Therefore, if the share is zero, then d_{it} is 0, and if the share is greater than zero, d_{it} becomes 1. As described above, the treatment variables are defined as firms that start ($\Delta d_{it}=1$) and respectively finish ($\Delta d_{it}=-1$) exporting activities. As our focus is on the effect of exports on firms' employment, we wanted to exclude those entities that export at odd times and did not always belong to the group of exporters or non-exporters. Because of the rather short time series, we defined firms that start to export as establishments that did not export in t-2 but export in t-1 and continuously export in t (see Table 1). Therefore, firms have to export at least two consecutive years before being recognized as exporting entities. These firms were compared with establishments that did not export in all three periods. Moreover, entities that finish exporting are establishments that have a positive export share in t-2 but not in t-1 and t. The controls are defined as firms that have a continuously positive export from t-2 to t. Consequently, all other covariates in the regressions are defined as first differences between t-2 and t ($\Delta X_{it} = X_{it} - X_{it-2}$).

Table 1: Lag structures

Definitions group of firms			
	t-2	t-1	t
Start exporting	no export	export	export
Control group export starting	no export	no export	no export
Stop exporting	Export	no export	no export
Control group export ending	export	export	export
Difference and lag structures			
Dependent variable: employment by skill group	first differences (t-2)-t		
Export variables	lag of first difference (t-3)-t-1		
All other covariates	first differences (t-2)-t		

However, we argue that the observations of the treatment variables are biased and that this is the source of selectivity. In fact, the first impression of this assumption is given when we look at some descriptive statistics. The subsequent tables 2 and 3 contain changes of value added and employment for firms with altering export status. Compared to establishments that did not export, firms that started exporting in t-1 have a much better development on average as measured by its value added. This can be observed both after the start of the export activities and well before. While the non-exporters experienced a decrease of value added in all periods, the exporting firms always had increases in value added, with the highest peak of +5.9% on average right before the establishments started to export. The opposite was true for firms that stop exporting. Almost all values calculated are negative, with the largest decrease immediately after exiting the international market. Table 3 contains the changes in employment for exporting and non-exporting establishments. Again, we find a negative development in firms that stop exporting or do not export. The employment in those firms decreased up to 3.6%. Entities that start to export experienced a remarkable increase in employment just before. All other values are much lower and almost zero, in some cases just below but close to zero. This first impression from our descriptive statistics supports the hypothesis that exporting and non-exporting firms differ, making it necessary to control for this selectivity in the data through a matching procedure.

Table 2: Relative Changes in Value Added

	All establishments	Establishments that…			
		did not export	started exporting	always exported	stopped exporting
t-3 to t-1 (obs.)	-0.029 (54555)	-0.033 (35708)	0.024 (763)	0.019 (10069)	-0.006 (792)
t-2 to t (obs.)	-0.022 (64265)	-0.031 (43583)	0.059 (1002)	0.018 (12065)	0.014 (991)
t-1 to t+1 (obs.)	-0.018 (76723)	-0.031 (53386)	0.046 (1324)	0.009 (14674)	-0.051 (1292)
t to t+2 (obs.)	-0.018 (75427)	-0.037 (43994)	0.011 (1124)	0.010 (11782)	-0.038 (1082)
t+1 to t+3 (obs.)	-0.018 (76723)	-0.036 (36678)	0.036 (955)	0.010 (9640)	-0.011 (892)

IAB-Establishment Panel 1996 - 2014

Table 3: Relative Changes in Employment

	All establishments	Establishments that…			
		did not export	started exporting	always exported	stopped exporting
t-3 to t-1 (obs.)	-0.026 (97868)	-0.024 (53294)	0.013 (1105)	0.009 (12765)	-0.002 (1112)
t-2 to t (obs.)	-0.024 (116094)	-0.025 (65332)	0.041 (1388)	0.008 (15358)	-0.019 (1460)
t-1 to t+1 (obs.)	-0.023 (141461)	-0.030 (81348)	0.010 (1900)	0.003 (18787)	-0.030 (1906)
t to t+2 (obs.)	-0.022 (138443)	-0.034 (64907)	-0.004 (1541)	-0.001 (14891)	-0.036 (1543)
t+1 to t+3 (obs.)	-0.023 (141461)	-0.035 (52850)	0.001 (1252)	-0.003 (12083)	-0.007 (1246)

IAB-Establishment Panel 1996 - 2014

Our sample further provides detailed information about the number of workers in three different qualification levels and their respective daily remuneration from the Establishment Historical Panel (Eberle and Schmucker 2017) for the firms observed. Low-skilled employees are defined as individuals with a lower secondary, intermediate secondary, or upper secondary school completion certificate but no vocational qualifications. Medium-skilled employees are individuals with a lower secondary, intermediate secondary, or upper secondary school completion certificate and vocational qualification. The group of high-skilled employees of an establishment are those who have a university degree (including universities of applied sciences "*Fachhochschule*"). We know from the data whether workers work full-time or part-time, but the exact number of working hours was not supplied. In order to calculate the number of employees for the respective qualifications, part-time workers were assigned a value of 0.5. The employment information was used to calculate the dependent variables for our regressions, that is, the first differences in the logarithms of the number of employees with a particular skill level. As mentioned before, the time between the differences is two years from t-2 to t.

With respect to daily remuneration, the Establishment Historical Panel offers information about the mean and the median of full-time employees for each particular skill group. For our analysis, the median of wages was used, as it is less affected by coincidental inferences and censoring. The variable includes special payments, such as holiday pay or 13th monthly salary, but only contains values up to the upper earnings limit for statutory pension insurance contributions. This means that about 10% of the data is censored and the earnings means are biased. To remedy this censoring problem, the data provider regularly imputed the information on daily wages according to the procedure of Card, Heining, and Kline (2015) before the medians were calculated. Another problem that can occur with wage data concerns the calculation of daily remuneration. Opposite to hourly wages, the value could rise or fall because of altered overtime wages and special payments. In this case, changes in remuneration do not necessarily reflect changes in labor costs, i.e., hourly wages. Unfortunately, because of the official nature of the data as being information from the social security system, it is not possible to identify hourly wages, and we have to assume that the payment of overtime wages and special payments do not affect the outcome of the estimations. Tables A.1 to A.3 contain the changes in employment for the different skill levels according to the export status. In general, the outcome confirms the results of table 3 with the constraint that the positive effect of exporting increases with the skill level.

Further covariates included are structural aspects of the establishments and other variables known to influence labor demand (Groshen 1991). In detail, the IAB Establishment Panel contains information about firms' turnover in the year prior to the interview. Because we used turnover in our investigation, establishments that did not report turnover, including banks, insurance companies, and public administrations, were excluded from the database. However, we did not use turnover directly. Instead, we used the logarithm of value added where intermediate materials were excluded from turnover. Other variables used are the shares of part-time workers, female workers, temporary employees, and employees subject to the social insurance scheme; dummies for coverage by a collective agreement and the firms' profitability; the state of machinery; and years. Profitability and state of machinery are based on self-reporting by the establishments on a range from one (very low and outdated) to five (very high and up-to-date). As described in the methodological section above, the regressions contain these variables in first differences with a time span of two years.

Our propensity score estimates are estimated in levels and use lagged values of the logarithm of productivity, the shares of low- and high-skilled, the year of founding (21 dummies), industry (40), company level (two), ownership (four), and federal states (15) as additional regressors, while the variables that indicate the remuneration of the different skills were omitted. Finally, all nominal values of variables in the treatment model and the propensity score estimation were discounted by the producer price index. We did not use further lags to identify exporting firms because of a large loss of observations for higher lag structures. Table A.5 contains the descriptive statistics of the variables used in this analysis. The next section contains the results of the propensity score estimates and the empirical model regressions.

5. Regression Outcomes

This section contains the results of our difference-in-difference models from equation (11a). Taking into account the probable selectivity bias from observing exporting firms, we used a matching approach based on propensity score estimations. For this, we estimated pooled probit regressions from which we derived the probability to observe an establishment that exports. The variables modeling the selection process for the propensity score estimation had to be chosen considering various aspects. Under ideal conditions, regressors simultaneously affect participation and determine the effect of exports on employment. At the same time, the regressors should not be influenced by participation in exporting or its announcement and should satisfy the conditional independence assumption (CIA) and the parallel trend assumption conditions (Caliendo and Kopeining 2008; Black and Smith 2004). Here, we used the log of value added and the log of productivity as continuous regressors, respectively. In addition, the regressions contain the shares of low- and high-skilled workers as well as the share of part-time employees (cf. Wagner 2011). To avoid problems with causality, lagged values of these variables were used as additional regressors. Moreover, dummies for the founding year, company level, ownership structure, state of machinery, industry, time, federal states, and collective agreements act as additional covariates. In total, more than 70 variables were used in the propensity score regressions. Table 4 contains the results of the pooled probit regressions.

Table 4: Propensity Score Estimates of Establishments Starting or Ending Export Radius Matching, Caliper 0.001)

	Start export		End export	
	(a) manufacturing	(b) services	(c) manufacturing	(d) services
log. value added (lagged)	0.204** (0.039)	0.084* (0.038)	-0.166** (0.036)	-0.105 (0.079)
log. productivity (lagged)	-0.107 (0.068)	-0.008 (0.073)	-0.051 (0.067)	0.024 (0.152)
share of part-time workers (lagged)	-0.841* (0.397)	-0.875** (0.273)	0.141 (0.430)	-0.429 (0.663)
share of low skilled workers (lagged)	1.775** (0.523)	-0.501 (0.700)	0.875 (0.503)	-0.525 (1.264)
share of highly skilled workers (lagged)	2.351** (0.506)	1.326** (0.317)	-2.198** (0.584)	-0.409 (0.620)
covered by collective agreement (yes = 1 / lagged)	-0.105 (0.102)	-0.121 (0.117)	0.148 (0.104)	0.235 (0.185)
Additional variables (lagged)	year of founding (21 dummies), state of machinery (two), industry (forty), year (14), company level (two), ownership (four), federal states (15) and a constant.			

LR-Test χ^2 (df.)	406.75** (78)	173.39** (75)	226.15** (78)	133.02** (74)
Log likelihood	-698.48	-417.09	-386.8	-236.33
Pseudo R^2	0.2255	0.1721	0.1516	0.2196
Obs. (no. of exporting firms)	3552 (249)	4132 (109)	5907 (163)	895 (95)

Source: IAB Establishment Panel 2000 - 2014. Note: Standard errors in parentheses. ** and * denote significance at the .01 and .05 levels, respectively.

As expected, firms that start international trade in manufacturing and services show a higher value added (Hypothesis 1a) but also larger shares of high-skilled workers (Hypothesis 1b). We were surprised to find that manufacturing firms starting exporting tend to have high ratios of low skilled works, as well. With respect to highly skilled workers, the opposite effect occurs when manufacturing firms decide to stop exporting goods. Similar to manufacturing, establishments in the service sector employ a larger share of highly skilled workers when they start to export. Against our expectations though, the parameter for productivity is insignificant in all estimations. This may be due to the relatively high correlation between productivity and the share of highly skilled workers. Overall, the likelihood ratio tests of joint statistical relevance of all covariates, including the vast number of dummy variables, show highly significant values. Moreover, the Pseudo R^2 is quite large for a pooled probit estimation on firm data. The quality of the matching procedure determines whether the CIA and the overlapping assumption conditions hold. Here, we applied a radius matching with a maximum difference of propensity scores of 0.001.

The results of some tests on matching quality can be found in Table A.5. Pseudo R^2 from estimations of the propensity score on all the variables on matched samples with a dependent variable that indicates whether the unit changes export behavior. The likelihood ratio test of the joint insignificance of all regressors indicates that these are statistically not different from zero in all cases. Moreover, the standardized bias is the difference of the sample means in the treated and non-treated sub-samples as a percentage of the square root of the average of the sample variances in the treated and non-treated groups, following the method by Rosenbaum and Rubin (1985). With the exemption of the matched samples for firms that end exporting in the service sector, the calculated means and medians are rather low. Therefore, we must be careful when analyzing the outcome for firms in the service sector. We, therefore, assume in the following that the propensity score estimations lead to reliable regression outcomes.

From our propensity score estimations, we calculated weights for the subsequent regressions that are based on radius matching with a caliper of 0.001. As these weights are created from regression outcomes, we have to take into account the distribution of the estimated values when we calculate the standard errors of our treatment model. Therefore, we calculated the bootstrapped standard errors with 1,000 repetitions of the estimation process. We used the first differences of the three employment variables to estimate particular ordinary least squares (OLS) equations for each skill level. This is equal to a system of seemingly unrelated regressions (SUR), because all equations use the same covariates (Wooldridge 2010, p. 169). The subsequent results are based on estimations of equation (11a) for manufacturing and services, separately. The outcome of the models with unlagged treatment variables are presented in the appendix (tables A.6 and A.7). Other specifications without weighting or for split subsamples for firms starting or finishing export are available in the supplement.

Table 5 Conditional Difference-in-Differences Regressions for Different Skill Levels in Manufacturing (First Differences between t and t-2, Lagged Export Variable, Weighted)

	(a) Low skilled	(b) Medium skilled	(c) High skilled
Δ of log. wages of low skilled	-0.271** (0.049)	-0.002 (0.021)	0.121** (0.033)
Δ of log. wages of medium skilled	0.149 (0.170)	-0.435** (0.115)	-0.457** (0.110)
Δ of log. wages of high skilled	0.108 (0.062)	0.024 (0.024)	-0.506** (0.057)
Δ of log. value added	-0.029 (0.027)	0.077** (0.011)	0.080** (0.016)
Establishments start exporting (lagged, yes = 1)	-0.181** (0.067)	0.052* (0.026)	0.128* (0.059)
Establishments stop exporting (lagged, yes = 1)	-0.157 (0.116)	0.020 (0.035)	-0.043 (0.081)
Δ of share of part-time employees	-0.001 (0.158)	0.181** (0.069)	-0.489** (0.146)
Δ of share of fixed-term employees	0.537** (0.184)	0.513** (0.083)	-0.074 (0.115)
Δ of share of employees subject to social insurance contributions	0.294 (0.386)	-0.736** (0.125)	-0.132 (0.248)
Δ of share of female employees	-0.234 (0.184)	-0.420** (0.075)	-0.016 (0.124)
Δ in union coverage	-0.060 (0.040)	0.025 (0.013)	0.071** (0.026)
Wald test χ^2(df.)	306.74** (22)	596.45** (22)	429.44** (22)
R^2	0.1095	0.2589	0.2264
Obs.	2,322	2,322	2,322

Source: IAB Establishment Panel 2000 - 2014.

Note: Bootstrapped standard errors in parentheses (1000 repetitions). ** and * denote significance at the .01 and .05 levels, respectively. The regressions contain the first differences of reported profitability (two dummies), of reported state of machinery (two), yearly dummies (four) and a constant as additional variables.

Table 5 contains the results of the treatment model for firms in the manufacturing sector. We start off discussing the parameter estimates on wages and our other control variables before we turn to our main variables of interest, the change in export behavior. The parameter estimates of the particular wages for each skill level are significant and, as expected, negative (Hypothesis 3). As stated earlier in the paper, the parameter estimates are approximately equal to the elasticities. The estimated values of the parameters are rather low compared to earlier studies that have estimated own-wage elasticities for Germany, such as Addison et al. (2008). However, as Lichter, Peichl, and Siegloch (2015) showed in their meta-analysis, there is a broad range of results for these parameters, and the outcome presented here is not unique. We did not expect that the own-wage elasticity for low-skilled employees would be the lowest in absolute terms. A possible explanation for this could be a larger market power for employers on the market for unskilled workers. If some parts of this particular labor market have monopsonistic structures, then an increase of remuneration does not necessarily lead to a reduction of labor. It is reasonable to assume that this is the case in Germany, as the introduction of a common minimum wage in 2015 had no significant effect on labor demand for low-skilled full-time workers in total (Caliendo et al. 2017). Moreover, the estimates give some support to the notion that medium-skilled and high-skilled workers are complements, while an increase in the wages for low skilled workers leads to substitution effects which increase the demand for high-skilled workers: The significant estimates indicate that the demand for high-skilled workers depends positively on the wages of the low-skilled and negatively on the wages for medium-skilled. However, this conclusion is not confirmed in all estimates, as most of the cross-wage elasticities are insignificant.

Our regressions additionally control for typical firm-specific variables (Groshen 1991) and year dummies. We found that the amount of medium- and high-skilled workers in the firm increased with value added. The changes in the composition of the workforce are significantly linked to changes in demand for different skill groups. Especially, an increase in part-time employment goes hand in hand with decreasing demand for the skilled and increasing demand for medium-skilled workers. Similarly, more fixed-term employment goes hand-in-hand with higher demand for unskilled and medium skilled workers. Table 6 shows the results of the same regressions for service sector firms. Overall, we have considerably fewer significances here. The parameters for the own-wage variables and value added, however, point in the same direction as in manufacturing. In line with our hypothesis 4, we find exporting to be of less relevance in the service sector.

With respect to our main variable of interest—the dummies indicating the starting or ending of exporting—we found different results for manufacturing and services. To make sure that causality did not pose a problem, we included lags of the treatment variable, that is, we looked for changes in employment that occurred after the decision to start or finish exporting. First, we found that the composition of the firms' workforce in manufacturing seems to change when an establishment starts to export. The estimated parameters for all skill levels are significant. As the parameters are approximately equal to the semi-elasticities of the dummy variable, our results indicate a reduction of the low-skilled workers of about -18.1%, while the number of medium- and high-skilled increase by 5.2% and 12.8%, respectively, if the firm starts exporting.

Table 6: Conditional Difference-in-Differences Regressions for Different Skill Levels in Services (First Differences between t and t-2, Lagged Export Variable, Weighted)

	(a) Low skilled	(b) Medium skilled	(c) High skilled
∆ of log. wages of low skilled	-0.150** (0.046)	-0.064** (0.018)	-0.068* (0.030)
∆ of log. wages of medium skilled	0.197 (0.141)	-0.598** (0.136)	-0.145 (0.114)
∆ of log. wages of high skilled	-0.058 (0.081)	-0.095** (0.033)	-0.181* (0.076)
∆ of log. value added	0.007 (0.040)	0.064** (0.025)	0.172** (0.028)
Establishments start exporting (lagged, yes = 1)	0.015 (0.100)	-0.189* (0.082)	-0.136 (0.101)
Establishments stop exporting (lagged, yes = 1)	-0.139 (0.146)	-0.122* (0.049)	-0.085 (0.085)
∆ of share of part-time employees	0.219 (0.134)	0.091 (0.076)	0.030 (0.105)
∆ of share of fixed-term employees	1.035** (0.231)	-0.131 (0.139)	-0.055 (0.198)

Δ of share of employees subject to social insurance contributions	1.457** (0.279)	0.059 (0.239)	0.445* (0.218)
Δ of share of female employees	0.117 (0.199)	0.432** (0.130)	0.146 (0.183)
Δ in union coverage	0.035 (0.063)	-0.053* (0.027)	-0.058 (0.052)
Wald test χ^2(df.)	176.27** (22)	132.90** (22)	199.82** (22)
R^2	0.1518	0.1834	0.2243
Obs.	1,043	1,043	1,043

Source: IAB Establishment Panel 2000 - 2014.

Note: Bootstrapped standard errors in parentheses (1000 repetitions). ** and * denote significance at the .01 and .05 levels, respectively. The regressions contain the first differences of reported profitability (two dummies), of reported state of machinery (two) yearly dummies (four) and a constant as additional variables.

Second, although this outcome would support out hypotheses 2a and 2b, we cannot find similar results if the firms decide to stop export activities. All parameters for the export variables are insignificant. We can only speculate here, but either composition of the workforce is not reversible or firms stopping exporting may have adjusted their workforce over longer periods of time, so that we cannot detect any significant changes in the short-run. As stated earlier, we cannot test for this using a wider lag structure, as this would reduce the number of observations considerably. Finally, in order to test whether our matching procedure matters, we estimated unweighted regressions (see supplement) and did not find significant outcomes for medium- and high-skilled, while the parameter estimate for low-skilled was significant but indicated a much lower reduction in labor demand (cf. table S.3 in the supplement). This supports the assumption of self-selectivity into international trade.

As shown in Table 6, we find the effects of starting and stopping exporting in the service sector to differ from manufacturing. Here, we find significant negative effects of both starting and stopping exporting on labor demand for medium-skilled workers. As the firms' workforce mainly consist of medium-skilled workers (see Appendix Table A.4), this result is possibly due to different effects in both situations. If the firms start to export, they probably experience more competition and therefore need greater productivity and lower labor costs. When they decide to end their international activities, it possibly goes along with a shrinking process and therefore lower employment. Another reason for the differing results between manufacturing and services is probably due to non-tradeable goods. It is reasonable to assume that it is not possible to export some of the goods in the service sector, like personnel services, for example, nursing, schooling, etc. Unfortunately, we do not have direct information about the produced goods. Moreover, if we were to use some industries as instruments for non-tradeable goods, the results of the matching procedure would become worse and the number of observations would reduce significantly. Therefore, our analysis relies on the presented regression outcome. The results that exclude some industries with a low share of exporting firms are available from the authors.

Summing up, we can conclude that there is relatively strong support for the hypothesis of self-selection into export and some limited evidence for further skill upgrading, but only for firms in manufacturing that start their export activities.

6. Summary

The study at hand analyses export activities' influence on establishments' labor demand for different skill levels. The reviewed literature mainly discusses two topics: first, whether firms' productivity increased due to a learning effect after beginning to export, or whether higher productivity leads to a self-selection into international business. Second, some studies have assumed that starting export activities will induce a skill-biased effect on labor demand towards highly skilled workers. Following this, we derived two major hypotheses for the empirical investigations: 1) Firms self-select into and out of exports, and 2) Firms starting to export experience a skill upgrade in employment.

Our work adds to the previous literature in several ways. To our knowledge, we are the first to apply difference-in-difference models to this question, with treatment effects controlling for selectivity of firms into exporting. The treatment model contains changing observables. Moreover, the first difference estimates eliminate unobserved heterogeneity on the firm level. We used radius matching based on calculations of propensity scores to control for selectivity. In addition, we allowed for different effects of firms that start and stop exports and analyzed establishments in manufacturing and services separately.

We estimated separate regressions for changes in employment for low, medium, and high skill levels using data from the IAB Establishment Panel survey that covers the period from 2000 to 2014. The data is augmented with information about wage levels and the number of those employed for all skill levels from German social security data. The outcome of the empirical work confirms our initial hypotheses, though primarily for firms in manufacturing. Establishments in manufacturing that start exporting are larger in value added and already employed a larger share of highly skilled employees before starting to export. The outcome for firms that stop exporting is similar, with opposite signs. Comparing results with and without weights from the matching procedure, we found that estimates for the manufacturing sector changed, again supporting our first hypothesis. Moreover, our second hypothesis is also supported, but only for establishments starting to export. We found that employment for medium- and high-skilled workers increased significantly in the year following entry into international markets. At the same time, the number of low-skilled workers decreased significantly. We did not find significant results for firms that eventually stop exporting, indicating the effect is potentially not reversible or only over longer periods of time. The effects of export in the service sector imply completely different behavior in both sectors, so analyzing them separately is highly warranted and needs further research.

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Appendix

Table A.1: Relative Changes in Low Skilled Employment

	All establishments	Establishments that…			
		did not export	started exporting	always exported	finished exporting
t-3 to t-1 (obs.)	-0.059 (51344)	-0.053 (22866)	-0.029 (649)	-0.054 (9785)	-0.021 (550)
t-2 to t (obs.)	-0.061 (60716)	-0.055 (27592)	-0.041 (793)	-0.058 (11685)	-0.015 (728)
t-1 to t+1 (obs.)	-0.057 (74492)	-0.054 (34103)	-0.008 (1113)	-0.056 (14225)	-0.040 (936)
t to t+2 (obs.)	-0.057 (72403)	-0.055 (26545)	-0.013 (900)	-0.062 (11225)	-0.050 (775)
t+1 to t+3 (obs.)	-0.057 (74492)	-0.058 (21233)	-0.053 (736)	-0.070 (9065)	-0.030 (602)

IAB-Establishment Panel 1996 - 2014

Table A.2: Relative Changes in Medium Skilled Employment

	All establishments	Establishments that…			
		did not export	started exporting	always exported	finished exporting
t-3 to t-1 (obs.)	-0.031 (85105)	-0.023 (45125)	0.022 (945)	-0.001 (11852)	-0.006 (953)
t-2 to t (obs.)	-0.028 (100721)	-0.023 (54794)	0.018 (1176)	-0.003 (14236)	-0.012 (1231)
t-1 to t+1 (obs.)	-0.028 (122788)	-0.027 (67596)	-0.003 (1648)	-0.008 (17382)	-0.020 (1618)
t to t+2 (obs.)	-0.028 (119878)	-0.028 (53352)	-0.005 (1319)	-0.010 (13675)	-0.028 (1272)
t+1 to t+3 (obs.)	-0.028 (122788)	-0.032 (43187)	0.002 (1063)	-0.015 (11039)	-0.030 (1007)

IAB-Establishment Panel 1996 - 2014

Table A.3: Relative Changes in High Skilled Employment

	All establishments	Establishments that…			
		did not export	started exporting	always exported	finished exporting
t-3 to t-1 (obs.)	0.037 (49498)	0.031 (18804)	0.041 (680)	0.055 (10190)	0.032 (536)
t-2 to t (obs.)	0.038 (59042)	0.031 (23022)	0.059 (833)	0.056 (12263)	0.054 (718)
t-1 to t+1 (obs.)	0.038 (72833)	0.027 (28691)	0.053 (1190)	0.052 (14967)	0.031 (928)
t to t+2 (obs.)	0.038 (70843)	0.026 (22962)	0.054 (975)	0.052 (11840)	0.044 (755)
t+1 to t+3 (obs.)	0.038 (72833)	0.022 (18883)	0.066 (793)	0.047 (9648)	0.034 (602)

IAB-Establishment Panel 1996 - 2014

Table A.4: Descriptive Statistics

Variable	Manufacturing					Services				
	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max
Exporting firm (yes =1)	70.863	0.373	0.484	0	1	112.876	0.130	0.336	0	1
Firms start export vs. no export	26.054	0.037	0.189	0	1	51.145	0.017	0.128	0	1
Firms finish export vs. always export	14.071	0.054	0.226	0	1	6.231	0.158	0.364	0	1
Daily median wage	64.060	75.206	31.474	0.031	1098.886	113.375	75.890	35.181	0.500	1275.260
Daily median wage low skilled	31.507	73.521	25.555	0.299	292.940	44.317	67.511	29.883	0.179	394.848
Daily median wage medium skilled	63.154	74.009	27.863	0.031	469.020	108.349	73.227	29.747	0.011	583.418
Daily median wage high skilled	39.683	126.733	54.582	2.117	1098.886	63.037	112.416	50.721	0.844	1553.815
Number of employees	66.882	170.865	1072.564	0.5	59207	127.156	90.635	318.170	0.5	17310
Number of low skilled	66.882	17.414	84.953	0	4406	127.156	8.529	42.460	0	3296
Number of medium skilled	66.882	120.405	743.103	0	40070.5	127.156	56.796	202.204	0	10439
Number of high skilled	66.882	23.895	231.361	0	16969	127.156	16.051	81.963	0	2817

Table A.4 cont.

Log. of value-added	57.167	13.924	2.238	4.320	22.709	72.442	12.810	2.012	3.792	21.132
Log. of productivity	34.422	10.618	0.812	3.419	15.048	44.278	10.457	0.949	3.252	16.954
Share of low skilled	66.882	0.084	0.115	0	1	127.156	0.081	0.125	0	1
Share of high skilled	66.882	0.086	0.132	0	1	127.156	0.128	0.206	0	1
Share of part-time workers	72.557	0.112	0.170	0	1	139.213	0.288	0.281	0	1
Share of time limited workers	72.927	0.037	0.097	0	1	140.177	0.066	0.163	0	1
Share of workers subject to the social insurance	73.224	0.819	0.249	0	1	141.001	0.721	0.290	0	1
Share of female workers	73.160	0.257	0.230	0	1	140.875	0.518	0.313	0	1
Collective agreem. (yes = 1)	72.654	0.739	0.439	0	1	139.599	0.692	0.462	0	1
Union coverage (yes = 1)	72.576	0.768	0.422	0	1	139.342	0.712	0.453	0	1
Eastern Germ. (yes = 1)	73.225	0.534	0.499	0	1	141.001	0.657	0.475	0	1

Source: IAB Establishment Panel 2000 - 2014.

Table A.5: Quality of Propensity Score Estimates (Radius Matching, Caliper 0.001)

		Pseudo R^2	LR-Test χ^2	Mean of standardized Bias	Median of standardized Bias
Start Export	manufacturing	0.027	15.71	3.4	2.6
	services	0.056	14.92	3.7	3.1
End Export	manufacturing	0.018	7.23	2.7	2.5
	services	0.112	15.76	8.0	6.4

Note: ** and * denote significance at the .01 and .05 levels, respectively. The results are derived from STATA module "psmatch2" (cf. Leuven / Sianesi 2003).

Table A.6: Conditional Difference-in-Differences Regressions for Different Skill Levels in Manufacturing (First Differences between t and t-2, Unlagged Export Variable, Weighted)

	(a) Low skilled	(b) Medium skilled	(c) High skilled
Δ of log. wages of low skilled	-0.198** (0.043)	0.031 (0.017)	0.157** (0.026)
Δ of log. wages of medium skilled	0.162 (0.155)	-0.472** (0.101)	-0.371** (0.105)
Δ of log. wages of high skilled	0.082 (0.054)	0.016 (0.020)	-0.555** (0.051)
Δ of log. value added	0.012 (0.025)	0.084** (0.009)	0.086** (0.015)
Establishments start exporting (yes = 1)	0.064 (0.053)	0.007 (0.022)	-0.026 (0.035)
Establishments finish exporting (yes = 1)	-0.072 (0.075)	-0.006 (0.031)	0.077 (0.057)
Δ of share of part-time employees	0.098 (0.136)	0.155* (0.062)	-0.459** (0.122)
Δ of share of fixed-term employees	0.654** (0.167)	0.567** (0.074)	-0.171 (0.105)
Δ of share of employees subject to social insurance contributions	0.035 (0.330)	-0.694** (0.142)	-0.058 (0.210)
Δ of share of female employees	-0.232 (0.161)	-0.406** (0.064)	0.011 (0.111)
Δ in union coverage	-0.051 (0.038)	0.008 (0.012)	0.046* (0.023)
Wald test χ^2(df.)	232.32** (22)	735.16** (22)	428.29** (22)
R^2	0.0933	0.2797	0.2202
Obs.	2,744	2,744	2,744

Source: IAB Establishment Panel 2000 - 2014.

Note: Bootstrapped standard errors in parentheses (1000 repetitions). ** and * denote significance at the .01 and .05 levels, respectively. The regressions contain the first differences of reported profitability (two dummies), of reported state of machinery (two) yearly dummies (four) and a constant as additional variables.

Table A.7: Conditional Difference-in-Differences Regressions for Different Skill Levels in Services (First Differences between t and t-2, Unlagged Export Variable, Weighted)

	(a) Low skilled	(b) Medium skilled	(c) High skilled
∆ of log. wages of low skilled	-0.138** (0.040)	-0.061** (0.019)	-0.071** (0.026)
∆ of log. wages of medium skilled	0.162 (0.136)	-0.617** (0.124)	-0.141 (0.107)
∆ of log. wages of high skilled	-0.058 (0.072)	-0.074* (0.030)	-0.248** (0.067)
∆ of log. value added	-0.029 (0.038)	0.024 (0.020)	0.133** (0.028)
Establishments start exporting (yes = 1)	-0.062 (0.109)	-0.003 (0.042)	-0.050 (0.051)
Establishments finish exporting (yes = 1)	-0.002 (0.105)	-0.173** (0.061)	-0.148 (0.102)
∆ of share of part-time employees	0.286* (0.125)	0.104 (0.070)	0.133 (0.092)
∆ of share of fixed-term employees	1.009** (0.235)	-0.039 (0.125)	-0.148 (0.182)
∆ of share of employees subject to social insurance contributions	1.286** (0.252)	0.091 (0.212)	0.373 (0.201)
∆ of share of female employees	0.332 (0.176)	0.367** (0.107)	0.002 (0.153)
∆ in union coverage	0.015 (0.053)	-0.037 (0.026)	-0.047 (0.050)
Wald test χ^2(df.)	175.41** (22)	165.13** (22)	165.32** (22)
R^2	0.1433	0.1964	0.2096
Obs.	1,235	1,235	1,235

Source: IAB Establishment Panel 2000 - 2014.

Note: Bootstrapped standard errors in parentheses (1000 repetitions). ** and * denote significance at the .01 and .05 levels, respectively. The regressions contain the first differences of reported profitability (two dummies), of reported state of machinery (two) yearly dummies (four) and a constant as additional variables.

Supplement

Table S.1: Difference-in-Differences Regressions for Different Skill Levels in Manufacturing (First Differences between t and t-2, Unlagged Export Variable, Unweighted)

	(a) Low skilled	(b) Medium skilled	(c) High skilled
∆ of log. wages of low skilled	-0.201** (0.032)	-0.004 (0.011)	-0.007 (0.017)
∆ of log. wages of medium skilled	0.068 (0.078)	-0.339** (0.049)	0.200 (0.117)
∆ of log. wages of high skilled	0.057 (0.036)	0.017 (0.016)	-0.493** (0.037)
∆ of log. value added	0.054** (0.017)	0.083** (0.008)	0.071** (0.011)
Establishments start exporting (yes = 1)	0.087 (0.052)	-0.014 (0.025)	0.036 (0.036)
Establishments finish exporting (yes = 1)	-0.029 (0.052)	0.013 (0.024)	-0.024 (0.032)
∆ of share of part-time employees	0.013 (0.095)	0.164** (0.042)	0.170* (0.069)
∆ of share of fixed-term employees	0.262 (0.135)	0.320** (0.054)	0.134 (0.070)
∆ of share of employees subject to social insurance contributions	0.157 (0.163)	0.517** (0.065)	0.366** (0.106)
∆ of share of female employees	-0.207 (0.111)	-0.041 (0.055)	-0.005 (0.075)
∆ in union coverage	-0.024 (0.024)	0.021* (0.010)	-0.030 (0.017)
F-Test F(df1., df2.)	8.91** (22, 2308)	17.66** (22, 3601)	15.37** (22, 2309)
R^2	0.0447	0.0818	0.1176
Obs. (no. of establishments)	5,705 (2,309)	9,731 (3,602)	6,126 (2,310)

Source: IAB Establishment Panel 2000 - 2014.

Note: . Standard errors are adjusted for clustering on establishments and robust to heteroscedasticity and serial correlation. ** and * denote significance at the .01 and .05 levels, respectively. The regressions contain the first differences of reported profitability (two dummies), of reported state of machinery (two) yearly dummies (four) and a constant as additional variables.

Table S.2: Difference-in-Differences Regressions for Different Skill Levels in Services (First Differences between t and t-2, Unlagged Export Variable, Unweighted)

	(a) Low skilled	(b) Medium skilled	(c) High skilled
Δ of log. wages of low skilled	-0.155** (0.023)	0.008 (0.009)	0.006 (0.014)
Δ of log. wages of medium skilled	0.008 (0.059)	-0.307** (0.028)	-0.045 (0.047)
Δ of log. wages of high skilled	-0.036 (0.033)	-0.013 (0.017)	-0.332** (0.034)
Δ of log. value added	0.054** (0.017)	0.077** (0.008)	0.062** (0.012)
Establishments start exporting (yes = 1)	-0.100 (0.065)	-0.060 (0.038)	-0.050 (0.041)
Establishments finish exporting (yes = 1)	0.051 (0.067)	-0.020 (0.031)	-0.071 (0.047)
Δ of share of part-time employees	0.031 (0.057)	0.102** (0.026)	-0.055 (0.047)
Δ of share of fixed-term employees	0.201 (0.104)	0.147** (0.056)	0.136 (0.089)
Δ of share of employees subject to social insurance contributions	0.200* (0.100)	0.278** (0.048)	0.129 (0.084)
Δ of share of female employees	-0.020 (0.101)	0.004 (0.043)	0.029 (0.074)
Δ in union coverage	-0.052* (0.025)	0.006 (0.010)	0.035 (0.020)
F-Test F(df1., df2.)	5.29** (22, 2098)	15.73** (22, 3779)	9.47** (22, 2052)
R^2	0.0305	0.0766	0.0646
Obs. (no. of establishments)	4,648 (2,099)	9,206 (3,780)	4,761 (2,053)

Source: IAB Establishment Panel 2000 - 2014.

Note: Standard errors are adjusted for clustering on establishments and robust to heteroscedasticity and serial correlation. ** and * denote significance at the .01 and .05 levels, respectively. The regressions contain the first differences of reported profitability (two dummies), of reported state of machinery (two) yearly dummies (four) and a constant as additional variables.

Table S.3: Difference-in-Differences Regressions for Different Skill Levels in Manufacturing (First Differences between t and t-2, Lagged Export Variable, Unweighted)

	(a) Low skilled	(b) Medium skilled	(c) High skilled
∆ of log. wages of low skilled	-0.206** (0.036)	0.005 (0.014)	0.015 (0.021)
∆ of log. wages of medium skilled	0.077 (0.094)	-0.409** (0.057)	0.230 (0.151)
∆ of log. wages of high skilled	0.043 (0.041)	0.030 (0.018)	-0.500** (0.047)
∆ of log. value added	0.063** (0.019)	0.078** (0.009)	0.071** (0.012)
Establishments start exporting (lagged, yes = 2)	-0.091* (0.044)	-0.026 (0.032)	-0.010 (0.034)
Establishments finish exporting (lagged, yes = 2)	0.113 (0.063)	0.020 (0.020)	0.024 (0.049)
∆ of share of part-time employees	0.002 (0.105)	0.174** (0.046)	0.118 (0.085)
∆ of share of fixed-term employees	0.296* (0.140)	0.265** (0.060)	0.198* (0.083)
∆ of share of employees subject to social insurance contributions	0.266 (0.192)	0.534** (0.076)	0.151 (0.124)
∆ of share of female employees	-0.124 (0.139)	-0.055 (0.065)	0.013 (0.091)
∆ in union coverage	-0.020 (0.027)	0.021 (0.012)	-0.039* (0.019)
F-Test F(df1., df2.)	8.62** (22, 1740)	15.01** (22, 2707)	10.60** (22, 1763)
R^2	0.0521	0.0768	0.1111
Obs. (no. of establishments)	4,222 (1,741)	7,128 (2,708)	4,619 (1,764)

Source: IAB Establishment Panel 2000 - 2014.

Note: . Standard errors are adjusted for clustering on establishments and robust to heteroscedasticity and serial correlation. ** and * denote significance at the .01 and .05 levels, respectively. The regressions contain the first differences of reported profitability (two dummies), of reported state of machinery (two) yearly dummies (four) and a constant as additional variables.

Table S.4: Difference-in-Differences Regressions for Different Skill Levels in Services (First Differences between t and t-2, Lagged Export Variable, Unweighted)

	(a) Low skilled	(b) Medium skilled	(c) High skilled
Δ of log. wages of low skilled	-0.140** (0.026)	0.009 (0.010)	0.005 (0.016)
Δ of log. wages of medium skilled	-0.021 (0.065)	-0.292** (0.031)	-0.084 (0.058)
Δ of log. wages of high skilled	-0.044 (0.039)	-0.015 (0.019)	-0.316** (0.040)
Δ of log. value added	0.063** (0.023)	0.075** (0.010)	0.069** (0.015)
Establishments start exporting (lagged, yes = 1)	-0.042 (0.065)	-0.025 (0.027)	0.066 (0.052)
Establishments finish exporting (lagged, yes = 1)	-0.094 (0.086)	-0.043 (0.033)	0.026 (0.053)
Δ of share of part-time employees	0.009 (0.069)	0.088** (0.030)	-0.117* (0.058)
Δ of share of fixed-term employees	0.303* (0.121)	0.171* (0.071)	0.157 (0.105)
Δ of share of employees subject to social insurance contributions	0.192 (0.123)	0.278** (0.058)	0.103 (0.095)
Δ of share of female employees	-0.070 (0.110)	0.030 (0.051)	0.013 (0.089)
Δ in union coverage	-0.048 (0.033)	0.003 (0.012)	0.026 (0.023)
F-Test F(df1., df2.)	3.28** (22, 1547)	10.39** (22, 2757)	6.91** (22, 1530)
R^2	0.0272	0.0744	0.0614
Obs. (no. of establishments)	3,415 (1,548)	6,775 (2,758)	3,582 (1,531)

Source: IAB Establishment Panel 2007 - 2014.

Note: Standard errors are adjusted for clustering on establishments and robust to heteroscedasticity and serial correlation. ** and * denote significance at the .01 and .05 levels, respectively. The regressions contain the first differences of reported profitability (two dummies), of reported state of machinery (two) yearly dummies (four) and a constant as additional variables.

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