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CESIFO WORKING PAPER NO. 5096
CATEGORY 8: TRADE POLICY
NOVEMBER 2014



CESifo
Center for Economic Studies & Ifo Institute

CESifo *Working Paper No. 5096*

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## Abstract

Unions are often stigmatized as being a source of inefficiency due to higher collective bargaining outcomes. This is in stark contrast with the descriptive evidence presented in this paper. Larger firms choose to export and are also more likely to adopt collective bargaining. We rationalize those stylized facts using a partial equilibrium model that allows us to evaluate firms' value functions under individual or collective bargaining. Exporting further decreases average production costs for large firms in the collective bargaining regime, allowing them to benefit from additional external economies of scale due to lower bargaining costs. Our findings suggest that the positive correlation between export status and collective bargaining can be explained through size. Including controls for firm-size destroys the estimated positive relationship between export status and collective bargaining. Using interaction terms between size and the export status, we find that larger exporters tend to do collective bargaining, whereas smaller exporters tend to refrain from collective agreements.

JEL-Code: F160, J510, E240, J300.

Keywords: trade, unions, exports, firm level data.

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November 14, 2014
We are grateful to Hartmut Egger, Price Fishback, David Friedman, Sebastian Galiani, Agnese Romiti and Luhang Wang as well as the participants of the 3rd Joint Workshop of Aarhus University and the IAB, The Second Annual Xiamen University International Workshop on Economic Analysis and Institutions for helpful comments and suggestions.

# 1 Introduction

Unions are often stigmatized as being a source of inefficiency, for instance due to higher collective bargaining outcomes. Nevertheless, many German exporters still belong to the collective bargaining regime. This is surprising as exporters have the reputation of being highly productive and as collective bargaining recognition is an employer's decision in Germany (e.g. Dustmann, Ludsteck, and Schönberg, 2009). Our paper contributes to this debate by analyzing the role of size and different kinds of bargaining costs for the performance of exporting firms.[1] While the relationship between firm productivity and export has been largely analyzed and explained both in the theoretical and empirical literature, our study focuses on the so far less explored link between firm productivity, export, and the choice of the bargaining regime. The empirical evidence presented in this paper shows a positive relationship between export status and the probability of collective bargaining. Furthermore, our results indicate that a large portion of the effect can be explained by firm size.

The theoretical argument we provide to explain the above findings is illustrated using a partial equilibrium framework with heterogeneous firms and wage bargaining. Ceteris paribus, we compare firms' value functions under different wage regimes. The comparison between union and individual bargaining outcomes can rationalize why larger firms may benefit from collective bargaining. Unions can be a source of efficiency for larger firms if bargaining involves additional negotiation costs. Instead of bargaining with each employee, larger firms are better off negotiating with one representative of the entire workforce. The larger the firm, the higher the efficiency gains relative to the costs of higher union wages. Hence, our model proposes an additional channel through which collective bargaining has the potential to enhance the gains from export.

Our paper is closely related to Carluccio, Fougere, and Gautier (2014) and Hirsch, Merkl, Mueller, and Schnabel (2014). The former provides an analysis of the link between firm-level exports and collective-bargaining outcomes. One of its main findings is that French exporters tend to negotiate firm-level contracts on top of the mandatory industry-agreements. Moreover, firm-level wage agreements can mitigate the negative effects of offshoring on the wages of blue-collar workers.[2] The latter paper

[1] The numerous works investigating the relationship between unionization and real economic variables (e.g. productivity, output and wages) seem to reach the overall conclusion that the effect of unions on real economic activity is minimal if not insignificant. Two prominent studies finding no effect of unions on productivity and wages for the US are DiNardo and Lee (2004) and Lee and Mas (2012). Furthermore, unionization has been recently used as a proxy for higher labor adjustment costs. Schmalz (2013) finds that more unionized firms increase their cash-flow balance sheet in order to insure themselves against the higher "human capital risk" brought about by the introduction of collective bargaining.

[2] Felbermayr, Hauptmann, and Schmerer (2014) find negative wage effects of firms' dependency on

studies the role of firm productivity for the endogenous choice between centralized and decentralized wage formation at the firm level. The authors show that more productive firms are more likely to choose centralized bargaining. Similarly to the present study, the authors argue that the observed pattern may be explained through external economies of scale. More productive firms are larger and better-off if they bargain wages with one representative. Our paper differs in many respects. Firstly, we analyze the role of size on the nexus between export and wage formation. Secondly, our focus is on exports and not firm-productivity. Firm productivity, size, and export status are highly correlated but the overlap between small exporters and large non-exporters is huge. Finally, both theoretically and empirically, our work tackles one important puzzle. How can the observed increase in exports co-exist with a decline in the collective bargaining share? If larger firms are more likely to engage in collective bargaining and also show a higher probability to export, one may expect a surge in union coverage. However, in Germany a decreasing union coverage goes hand in hand with soaring exports at the extensive and intensive firm margin. Including interactions between size and export status in our empirical models allows us to rationalize this puzzle, in so far as the effect of exports hinges on firm-size. Only the largest exporters tend to negotiate wages with unions, whereas smaller exporters tend to avoid collective bargaining. Thus, a simultaneous decline in union coverage and a rising export intensity are consistent with our results if rising exports are driven by the behavior of the smallest firms. At the theoretical level, we address this issue by simulating a trade liberalization experiment that replicates the observed increase of the share of exporters between 1996 and 2011. The model predicts that new exporters are smaller firms that are more likely to refrain from collective bargaining.[3]

Going beyond the scope of this paper, future research should endogenize the choice of collective bargaining in general equilibrium.[4] Our model rationalizes potential efficiency gains due to collective bargaining in larger firms by comparing firms' value functions under individual and collective bargaining. However, the model is silent on the determinants of the choice itself. Directed-search may provide a more intuitive micro-foundation. Suppose a model with heterogeneous firms and workers as in Helpman, Itskhoki, and Redding (2010): Exporting firms are more productive and assortatively match a work force with higher unobserved ability due to the greater effort they put into screening workers. Michelacci and Suarez (2006) develop a model with

foreign markets in the presence of collective bargaining.

[3] See Schnabel, Zagelmeyer, and Kohaut (2006) for evidence on the decline in union coverage and the determinants of collective bargaining in Germany.

[4] The model by Boeri and Burda (2009) provides an explanation for the endogenous choice of individual or centralized wage formation in a search and matching framework. Their model shows that better employment protection increases the probability that firms choose individual over centralized wage contracts.

directed search and firms' choice between wage bargaining and wage posting. They argue that bargaining has the advantage that firms can tailor contracts to workers' unobserved productivity. Employers should announce bargained wages in order to induce more able workers to apply for vacancies in their firms. Put differently, high-ability workers are an asset to the firm and wages should reflect the workers' ability. The findings of the above two papers, together with the mechanism highlighted in our model, can explain why exporting firms should bargain collectively in order to signal competitive working conditions.[5]

However, the same signals could be sent through signing competitive individual contracts. Individual contracts may be more efficient for smaller firms, which would gain higher flexibility by setting up contracts tailored to the worker's characteristics. In this case, in line with our empirics and theory, smaller firms may benefit from a non-involvement of the unions in the wage-setting process.

**First glance at the data.** Figure 1 presents the evolution of the share of German manufacturers subject to collective agreement, by firm-size categories. While a clear tendency towards de-unionization is evident in the first three size-groups, the share of collective agreement among firms with more than 500 employees declined only slightly over time and remained higher than 80 percent in 2011.

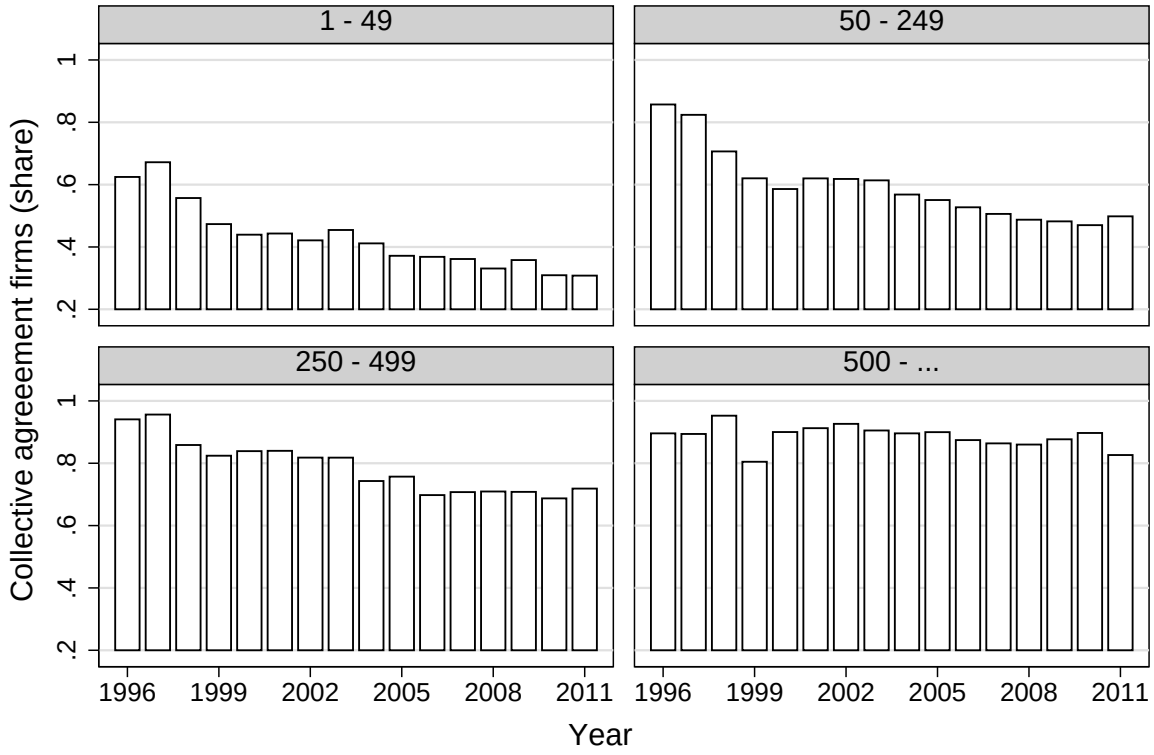
The remainder of this paper is organized as follows: the next section describes the data and the estimation strategy. Building on the results discussed in the last paragraph we will shed light on the role of exports and size for the choice of the wage setting mechanism in a firm. Section 3 introduces a partial equilibrium model that helps us to explain the empirical findings. Section 4 concludes.

# 2 Empirics

**Data and variables.** Our empirical analysis is based on the IAB Establishment panel, an annual representative sample of German plants with at least one employee, which the IAB has been carrying out since 1993 in West Germany and since 1996 in East Germany. In order to include both Eastern and Western German firms, we keep ob-

[5] This story is in line with anecdotic evidence discussed in Raff and Summer (1986). A tremendous increase in the average wage led to a sudden decline of turnover and lay off rates at Ford. Workers were more satisfied, which likely improved labor productivity and thus reduced layoffs. Moreover, workers are less likely to look out for outside options, which explains the large drop in the turnover rate.

Figure 1: Evolution of collective bargaining by size-categories




Notes: IAB establishment panel, manufacturing industries. Descriptive statistics weighted by using inverse probability weights.

servations from the year 1996 onwards. After restricting the sample to manufacturing firms we are left with a total sample size of 49,196 firms, observed within the 1996-2011 period. The establishment panel has the advantage of providing high-quality information on the main variables of interest for our analysis: number of employees,[6] firm export status and the type of bargaining regime in which the firm is involved.

We focus on the firm collective agreement status, that we construct as a dummy variable equal to 1 if the firm is involved in either plant- or industry-level collective bargaining and 0 otherwise. As for firm size, we use dummy variables for four size categories: less than 50 employees; 50-250 employees; 250-500 employees and size greater than 500. In the reduced form evidence presented later on we will include a larger set of variables. First of all, the skill composition of the workforce within each firm, which will be inserted as the share of workers performing apprentice, unqualified, qualified and working owner tasks. Moreover, we will additionally account for the age of the firm, by controlling for whether the firm was founded after 1995, and

[6] Two types of information on firm-size are included in the data: total number of employees and employees subject to social security contribution. Our main analysis is based on the former definition, but results of robustness checks based on the latter are qualitatively similar.

for a comprehensive set of year, regional and sector fixed effects.

Table 1: Collective agreement and firm-size

| | No CA | CA |
|---|---|---|
| | *1996* | |
| Less than 50 employees | 37.54 | 62.46 |
| Between 50 and 250 employees | 14.28 | 85.72 |
| Between 250 and 500 employees | 5.92 | 94.08 |
| More than 500 employees | 10.41 | 89.59 |
| Total | 35.62 | 64.38 |
| | *2000* | |
| Less than 50 employees | 56.05 | 43.95 |
| Between 50 and 250 employees | 41.41 | 58.59 |
| Between 250 and 500 employees | 16.11 | 83.89 |
| More than 500 employees | 9.98 | 90.02 |
| Total | 53.99 | 46.01 |
| | *2004* | |
| Less than 50 employees | 58.86 | 41.14 |
| Between 50 and 250 employees | 43.18 | 56.82 |
| Between 250 and 500 employees | 25.70 | 74.30 |
| More than 500 employees | 10.41 | 89.59 |
| Total | 56.76 | 43.24 |
| | *2008* | |
| Less than 50 employees | 66.91 | 33.09 |
| Between 50 and 250 employees | 51.26 | 48.74 |
| Between 250 and 500 employees | 29.07 | 70.93 |
| More than 500 employees | 14.00 | 86.00 |
| Total | 64.50 | 35.50 |
| | *2011* | |
| Less than 50 employees | 69.19 | 30.81 |
| Between 50 and 250 employees | 50.17 | 49.83 |
| Between 250 and 500 employees | 28.13 | 71.87 |
| More than 500 employees | 17.37 | 82.63 |
| Total | 66.11 | 33.89 |

Notes: IAB establishment panel, manufacturing industries. Descriptive statistics weighted by using inverse probability weights.

**Descriptive evidence.** This paragraph presents a descriptive picture of the relationship among our main variables of interest, i.e. collective agreement, firm size and export status. Table 1 links firm collective agreement status and size. As we have highlighted in the introduction, and as our further analysis will explain more clearly, the gains from performing collective bargaining may be higher than its costs for larger firms. The above intuition finds support in Table 1, which displays the percentage fre-

quencies of collective-agreement firms by size-categories for five years. Considering the latest year, i.e. 2011, the share of firms engaging in collective agreement increases monotonically with size, ranging from 30.81 percent among the smallest firms to 82.63 percent among the largest ones. Importantly, Table 1 also shows that the share of collective agreement firms has been decreasing over time, ranging from 64.4 percent in 1996 to around 34 percent in 2011, which is in accordance with the well-documented tendency to the decentralization of the bargaining process in recent years (Hirsch and Schnabel, 2014).

Table 2: Export status and firm-size

| | Domestic firms | Exporting firms |
|---|---|---|
| | *1996* | |
| Less than 50 employees | 87.64 | 12.36 |
| Between 50 and 250 employees | 38.91 | 61.09 |
| Between 250 and 500 employees | 14.22 | 85.78 |
| More than 500 employees | 17.24 | 82.76 |
| Total | 83.47 | 16.53 |
| | *2000* | |
| Less than 50 employees | 85.71 | 14.29 |
| Between 50 and 250 employees | 40.22 | 61.09 |
| Between 250 and 500 employees | 17.48 | 82.52 |
| More than 500 employees | 11.31 | 88.69 |
| Total | 80.39 | 19.61 |
| | *2004* | |
| Less than 50 employees | 81.62 | 18.38 |
| Between 50 and 250 employees | 31.64 | 68.36 |
| Between 250 and 500 employees | 15.80 | 84.20 |
| More than 500 employees | 12.03 | 87.97 |
| Total | 76.01 | 23.99 |
| | *2008* | |
| Less than 50 employees | 79.33 | 20.67 |
| Between 50 and 250 employees | 30.82 | 69.18 |
| Between 250 and 500 employees | 17.84 | 82.16 |
| More than 500 employees | 11.23 | 88.77 |
| Total | 73.38 | 26.62 |
| | *2011* | |
| Less than 50 employees | 77.88 | 22.12 |
| Between 50 and 250 employees | 25.31 | 74.69 |
| Between 250 and 500 employees | 14.73 | 85.27 |
| More than 500 employees | 8.91 | 91.09 |
| Total | 70.77 | 29.23 |

Notes: IAB establishment panel, manufacturing industries. Descriptive statistics weighted by using inverse probability weights.

Table 3: Collective agreement and export status

| | No CA | CA |
|---|---|---|
| | *1996* | |
| Domestic firms | 36.61 | 63.39 |
| Exporting firms | 30.59 | 69.41 |
| Total | 35.62 | 64.38 |
| | *2000* | |
| Domestic firms | 53.74 | 46.26 |
| Exporting firms | 55.04 | 44.96 |
| Total | 53.99 | 46.01 |
| | *2004* | |
| Domestic firms | 56.00 | 44.00 |
| Exporting firms | 59.18 | 40.82 |
| Total | 56.76 | 43.24 |
| | *2008* | |
| Domestic firms | 63.90 | 36.10 |
| Exporting firms | 66.14 | 33.86 |
| Total | 64.50 | 35.50 |
| | *2011* | |
| Domestic firms | 65.39 | 34.61 |
| Exporting firms | 67.87 | 32.13 |
| Total | 66.11 | 33.89 |

Notes: IAB establishment panel, manufacturing industries. Descriptive statistics weighted by using inverse probability weights.

A more careful look at Table 1 reveals that such a tendency is driven by small and medium-sized firms. Indeed, the percentage of collective agreement firms in the first two size-categories (i.e. firms with less than 50 and with 50-250 employees) has been decreasing by more than 30 percentage points from 1996 to 2011, while it has only slightly declined among firms in the largest size category. Hence, the overall message delivered by this simple cross tabulation is that, while in early years most German firms were engaging in collective bargaining, since the early 2000s an increasing fraction of small and medium-sized firms started not to bargain collectively with their workers, whereas larger firms still continue to do so.

As a second exploratory look at the data we focus on the distribution of firms according to size-class and export status. As shown in Table 2, and as predicted by Meliz-type models, firms clearly sort into the exporting regime according to size. Interestingly, comparing Table 1 and Table 2 we can immediately realize that size drives both the export status and the adopted bargaining regime: indeed, in 2011 91.09 per-

cent of the largest firms produce for the foreign market, and 83 percent of them adopt collective agreements. We also observe that the share of exporting firms within almost all size categories has been increasing by at least 10 percentage points between 1996 and 2011.

Finally, in Table 3 we show the percentage frequencies of domestic and exporting firms with and without collective bargaining for several years. Given that larger firms tend to export more and also to choose the collective bargaining regime, we might in principle expect a larger share of collective agreement firms among exporters, driven by size. However, Table 3 does not confirm such an intuition, and uncovers instead an apparently puzzling phenomenon: not only the share of collective bargaining firms among exporters is not higher than among non-exporters, but it is even slightly lower than among domestic firms in the latest years. The patterns examined previously help us to offer some explanations: on the one hand, as we saw in Table 1 the share of collective agreement firms has declined sharply especially among the smallest ones, and on the other hand this group of firms has experienced an increase in their exporting share over time. The fall in collective agreements among the smallest firms has been sharper than among the largest ones, while the increase in the export share was almost the same between the two groups. Hence, a tabulation as in Table 3, which does not condition on size, reasonably reveals a decreasing share of collective agreement firms among exporters.

**Empirical model and results.** In order to test the relationships among export status, collective agreement and size, we perform simple probit regressions where the dependent variable is firm collective agreement status, and we focus on export status and firm size as the main variables of interest. Tables 4 and 5 report the marginal effects from this first set of regressions. The specification in Table 4 does not include any type of fixed effects, while the one in Table 5 we control for year, sector and regional dummies. In the first column of both tables we use the export status as the only explanatory variable. When fixed effects are not included (i.e. the first column of Table 4), the estimated marginal effect suggests that being an exporter increases the probability of engaging in collective agreements by 0.16. However - and not surprisingly - such an effect is greatly reduced as soon as we allow fixed effects to capture all those time, sectoral and regional factors that might influence export status. Though smaller, the effect of collective agreement on the probability of exporting remains positive if we do not add any other explanatory variable, and equal to 0.11.

The estimated positive correlation between export and collective agreement statuses is likely to be spurious in the above regressions because we are still excluding some

important firm characteristics that may influence export status and be correlated with collective agreement. If this is the case, the export dummy will capture also the effect of those omitted variables.

As we have discussed, one of the factors that appears to co-vary both with export status and collective agreement is firm size. Thus, in the second column of Tables 4 and 5 we additionally control for firm-size categories. Interestingly, the sign of the effect of the export status on the probability of engaging in collective agreements turns now negative: exporting firms seems to have a *ceteris paribus* lower probability of collective agreements. Indeed, the marginal effect of CA on export status changes from $-0.05$ to $-0.032$ depending on whether fixed effects are included or not in the specification. Firm size, on the contrary, has a considerable influence on the probability of collective agreements, which increases monotonically with firm size. Indeed, relative to firms with less than 50 employees (the base category) firms with more than 500 employees have between 0.60 and 0.50 higher probability of exporting (second column of Tables 4 and 5, respectively). The relative difference of the probability of exporting across the different categories remains stable even after the inclusion of fixed effects. The negative association between collective agreement and export status is robust to the inclusion of other possibly important firm characteristics, such as the age of the firm, and the presence of a works council, as it is shown in the last column of Tables 4 and 5. The negative sign of the export dummy can be rationalized with the help of the theoretical considerations that we will develop in the next section.

Indeed, if there exist large fixed costs of bargaining collectively, and if the ability to pay them is strongly linked to size, conditioning on size in the above regressions reasonably decreases the probability of collective agreement for exporters. Given the higher competition from abroad, firms will tend to choose the bargaining regime that entails the lowest cost.

As we have just seen, including important observable characteristics in the probit equation for collective agreement may help eliminate the initial bias of the effect of the export status. However, omitted variables is not likely to be the sole source of bias in the previous models. In fact, not only the export status is a choice the firm takes, but it may well also be the case that the results we find are just driven by unobservable firm characteristics that affect both export status and collective agreement. In order to address the above concern, we follow common practice in the literature dealing with binary response models with endogenous binary regressors (for a recent application in the trade literature see, for example, Egger, Larch, Staub, and Winkelmann, 2011), and we estimate a bivariate probit model for collective agreement and export status.

Table 4: Probit marginal effects

| *Dependent variable: Collective agreement* | | | |
|---|---|---|---|
| Export (dummy) | $0.162^{***}$ | $-0.049^{***}$ | $-0.095^{***}$ |
| | (0.009) | (0.010) | (0.009) |
| Between 50 and 250 employees | | $0.264^{***}$ | 0.002 |
| | | (0.012) | (0.013) |
| Between 250 and 500 employees | | $0.464^{***}$ | $0.101^{***}$ |
| | | (0.016) | (0.021) |
| More than 500 employees | | $0.594^{***}$ | $0.263^{***}$ |
| | | (0.012) | (0.022) |
| Founded after 1995 | | | $-0.124^{***}$ |
| | | | (0.012) |
| Works council (dummy) | | | $0.361^{***}$ |
| | | | (0.010) |
| Year-dummies | NO | NO | NO |
| Sector-dummies | NO | NO | NO |
| Region-dummies | NO | NO | NO |
| Observations | 49146 | 49146 | 49146 |

Standard errors clustered at the firm level in parentheses. *significant at 10%, ** significant at 5%, *** significant at 1%. In Column (III) we additionally control for the share of workers with different qualification levels in each firm. The sample includes both Eastern and Western German firms.

The intuition behind this approach is straightforward:[7] we specify a two-equation model, one for the probability of performing collective bargaining, and the other one for the probability of exporting. The export status dummy will appear as an explanatory variable in the former equation, and as the dependent variable in the latter. The key issue is that the error terms of the two equations are allowed to be correlated, and the correlation between the error terms will be one of the estimated parameters of the model. In this way we explicitly take into account the potential source of endogeneity we mentioned above (i.e. correlation in unobservables) and we are able to get unbiased estimates of the marginal effect of export status on collective bargaining. Testing the endogeneity of the export status dummy is going to be very simple in this context: we will be able to conclude that the variable is endogenous if the estimated correlation coefficient between the error terms of the two equations is statistically different from zero. As we show in Appendix B , the endogeneity of the export dummy variable is only weakly supported by the data, given the low level of the Wald-test statistic for the estimated correlation coefficient. Hence, we proceed our analysis without taking the potential endogeneity issue any longer into account.

[7] See Appendix B for further technical details on the model and its estimation results.

Table 5: Probit marginal effects

| *Dependent variable: Collective agreement* | | | |
|---|---|---|---|
| Export (dummy) | 0.108*** | −0.033*** | −0.068*** |
| | (0.009) | (0.009) | (0.009) |
| Between 50 and 250 employees | | 0.212*** | −0.000 |
| | | (0.012) | (0.012) |
| Between 250 and 500 employees | | 0.378*** | 0.079*** |
| | | (0.017) | (0.019) |
| More than 500 employees | | 0.505*** | 0.208*** |
| | | (0.015) | (0.022) |
| Founded after 1995 | | | −0.079*** |
| | | | (0.011) |
| Works council (dummy) | | | 0.308*** |
| | | | (0.010) |
| Year-dummies | YES | YES | YES |
| Sector-dummies | YES | YES | YES |
| Region-dummies | YES | YES | YES |
| Observations | 49146 | 49146 | 49146 |

Standard errors clustered at the firm level in parentheses. *significant at 10%, ** significant at 5%, *** significant at 1%. In Column (III) we additionally control for the share of workers with different qualification levels in each firm. The sample includes both Eastern and Western German firms.

As a final investigation into the relationship between collective bargaining, size and export status, we address whether the largest exporters are also more likely to self-select into the collective bargaining regime. To this aim, we augment the above probit regressions with interaction terms between the export status and the size categories dummies. Table 8 in Appendix A shows the coefficients from this regression, while Table 6 shows the marginal effects of the size and export dummies on the probability of collective bargaining. Interestingly, we find that the probability of collective bargaining is almost 24 percentage points larger for the largest exporting firms with respect to the smallest exporting firms (Table 6). Importantly, the results of this last estimation hint that size drives the choice of the bargaining regime only for exporting firms, while it does not seem to be relevant for large non-exporting firms. The marginal effect of export status for the smallest firms is around -0.12. Such a negative effect decreases (although non-monotonically) with size and turns positive and marginally significant for the largest firms. This indicates that smaller exporting firms are on average less likely to choose collective bargaining, while switching to the export regime does not seem to be crucial for the choice of collective agreement for the largest firms (probably because those firms are already bargaining collectively with their workers, independently of their export status).

Table 6: Probit marginal effects of the model with interactions

| | |
|---|---|
| **1. Marginal effect of size for exporters** | |
| Between 50 and 250 employees | $0.046^{**}$ |
| | $(0.018)$ |
| Between 250 and 500 employees | $0.116^{***}$ |
| | $(0.024)$ |
| More than 500 employees | $0.243^{***}$ |
| | $(0.025)$ |
| **2. Marginal effects of size for non exporters** | |
| Between 50 and 250 employees | $-0.041^{***}$ |
| | $(0.016)$ |
| Between 250 and 500 employees | $0.076$ |
| | $(0.025)$ |
| More than 500 employees | $0.057$ |
| | $(0.038)$ |
| **3. Marginal effects of the export dummy for different firm-size categories** | |
| Less than 50 employees | $-0.122^{***}$ |
| | $(0.016)$ |
| Between 50 and 250 employees | $-0.035^{**}$ |
| | $(0.019)$ |
| Between 250 and 500 employees | $-0.082^{***}$ |
| | $(0.026)$ |
| More than 500 employees | $0.062^{*}$ |
| | $(0.036)$ |

Standard errors clustered at the firm level in parenthesis. *significant at 10%, ** significant at 5%, *** significant at 1%. The marginal effects of the size categories at points 1. and 2. are the discrete change of the predicted probability of doing collective agreement with respect to the base firm-size category (i.e. a firm with less than 50 employees). All marginal effects are computed for a firm in the sector "Building machines", in 2002, located in the Nordrhein-Westfalen region, with a worker council and founded after 1995. The other control variables are fixed at their average value in the estimation sample.

# 3 Theoretical considerations

Our empirical results reveal that the positive link between collective bargaining and export is driven by firm-size. Larger exporters tend to choose collective bargaining but smaller exporters tend to set wages without any unions involved. We argue that collective bargaining can yield efficiency gains to larger firms if we allow for firm heterogeneity and additional negotiation costs. We present a simple theoretical framework to illustrate the hypothesized link between firm size and wage bargaining regimes. The model is based largely on a partial-equilibrium version of Felbermayr, Prat, and Schmerer (2011). In contrast to the existing literature we assume that the bargaining process itself involves additional costs and resources. Firms may find themselves in one of two bargaining regimes. In the individual bargaining regime wages are agreed with each worker, whereas in the collective bargaining regime the firms deal with a single entity, i.e. the union. We do not specify the exact nature of bargaining costs but it seems reasonable to assume that bargaining with one entity entails economies of scale compared to spending time and resources on the negotiations with each single employee. However, for the sake of simplicity we neither endogenize the firms' choice of doing collective bargaining nor do we allow for any type of worker heterogeneity. This is clearly beyond the scope of this paper.

## 3.1 Setup

**Final output good.** The final output good is assembled according to a CES production function

$$Y = \left[ M^{-\frac{1}{\sigma}} \int_{\varphi \in \omega} q(\varphi)^{\frac{\sigma-1}{\sigma}} d\varphi \right]^{\sigma/(\sigma-1)}, \tag{1}$$

where $M$ is the mass of firms, $Y$ is the amount of the final output good produced by input of $q(\varphi)$ units of the differentiated intermediates, and $\varphi$ is firm productivity. The parameter $\sigma$ is the exogenous constant elasticity of substitution. The optimal input of intermediate $q$ from the CES production function reads

$$q(\zeta) = \frac{Y}{M} p(\varphi)^{-\sigma}. \tag{2}$$

**Intermediate inputs.** Firms produce by input of homogeneous labor according to

$$q(\varphi) = \varphi l(\varphi), \tag{3}$$

where $l(\varphi)$ denotes labor input and $\varphi$ indicates firm productivity drawn from a common distribution. As usual a firm can either serve the domestic market alone or it can export its products to $n$ symmetric countries, which involves iceberg transportation costs $\tau > 1$. If a firm serves both the domestic and the foreign markets, it distributes its total output in order to equalize marginal revenues across markets. Therefore, total revenues read

$$R(l,\varphi) = \left[\frac{Y}{M}\right]^{1/\sigma} (1 + I(\varphi) n \tau^{1-\sigma})^{1/\sigma} (\varphi l(\varphi))^{\frac{\sigma-1}{\sigma}}. \tag{4}$$

Firms' revenue depend on productivity, size and the export status $I(\varphi)$. We treat the sorting of firms into export and non-export as exogenous in this partial-equilibrium setup. Instead, we analyze the outcome for the non-export ($I = 0$) and the export scenario ($I = 1$) in order to compare firm values under different bargaining regimes.

**Labor market.** The labor market setup is identical to the one discussed in Felbermayr, Prat, and Schmerer (2011) and characterized by standard search and matching frictions. The vacancy over unemployment ratio is denoted by $\theta$ and a linear homogeneous matching function is assumed. We also define the vacancy filling ratio by $m(\theta)$. Jobs are dissolved each period with probability $s$, either because the firm exits as a whole with probability $\delta$ or the job match is destroyed with probability $\chi$. Furthermore, we assume linear vacancy posting costs $c$.

**Wage regimes.** In contrast to the literature we assume two bargaining regimes with different bargaining costs. Wages are either bargained individually (indexed by $I$) or collectively (indexed by $C$). In the individual bargaining regime the firm negotiates with each and every worker and has to pay $\zeta_I$ for each bargain. Therefore, total bargaining costs in this regime amount to $\kappa_I = l_I(\varphi)\zeta_I$. If wages are bargained collectively, the firm negotiates with a union as one single entity. Therefore, given that total bargaining costs are independent of firm-size, they are treated as fixed from the firm's perspective. These costs are denoted by $\kappa_C$.

## 3.2 Individual bargaining firms

Firms in the individual bargaining regime face the following optimization problem

$$
\begin{aligned}
J_I\left(l_I,\varphi\right) = \max_{v_I} \frac{1}{1+r}\{ & R_I(l_I;\varphi) - w_I\left(l_I;\varphi\right) l_I - cv_I - \kappa\left(l_I;\varphi\right) \\
& - f_D - I(\varphi) n f_X + (1-\delta) J\left(l_I';\varphi\right)\}, \qquad (5) \\
s.t.\ (i)\ R_I(l_I,\varphi) = & \left[\frac{Y}{M}\right]^{1/\sigma} \left(1 + I(\varphi) n \tau^{1-\sigma}\right)^{1/\sigma} \left(\varphi l_I(\varphi)\right)^{\frac{\sigma-1}{\sigma}}\ , \\
(ii)\ l_I' = & (1-\chi) l_I + m\left(\theta\right) v_I\ , \\
(iii)\ \kappa\left(l_I,\varphi\right) = & l_I \zeta_I .
\end{aligned}
$$

Firms post vacancies $v_I$ in order to maximize total revenues minus total costs plus the value of the firm in the next period,[8] discounted by the interest rate $r$. Most of the costs are standard in this setup and include wage costs $\left(w_I\left(l_I;\varphi\right) l_I\right)$, vacancy posting costs $\left(cv_I\right)$, fixed costs of starting production $\left(f_D\right)$, and (if the firm exports) fixed costs of serving the foreign markets $\left(nf_X\right)$. Furthermore, the optimization problem now additionally considers the bargaining effort $\kappa\left(l_I;\varphi\right)$. Conditioned on optimal vacancy posting, wages are then determined by the Stole and Zwiebel (1996a,b) sharing rule.

Following the standard steps in the literature, one can show that the solution to the firm's problem together with the sharing rule yield a wage and a labor demand curve equal to

$$
WC_I\text{:}\quad w_I = rU + \left(\frac{\beta_I}{1-\beta_I}\right)\left(\frac{r+s}{1-\delta}\right)\frac{c}{m(\theta)}\ , \qquad (6)
$$

$$
LD_I\text{:}\quad w_I = \left(\frac{\sigma-1}{\sigma-\beta_I}\right)\frac{R_I}{l_I} - \left(\frac{r+s}{1-\delta}\right)\frac{c}{m\left(\theta\right)} - \zeta_I, \qquad (7)
$$

where $\beta_I$ denotes the bargaining weight of the worker and $U$ the value of being unemployed. The wage and labor demand curves pin down wages and labor demand for given aggregate values of the labor market tightness $\theta$ and the alternative income $U$.

[8] Values which refer to the next period are denoted with a prime.

## 3.3 Collective bargaining firms

For the determination of wages and firm size in the collective bargaining regime we follow the efficient bargaining approach of Felbermayr, Prat, and Schmerer (2011).[9] Wages and employment are determined together as the outcome of a Nash-bargaining process.[10] The union's objective function during the bargain is the expected rent of its members compared to the situation of being unemployed, whereas the firm aims to maximize its variable profits. The solution to this problem yields the wage and labor demand curves for this regime

$$WC_C: \quad w_C = rU + \frac{\beta_C}{\sigma}\frac{R_C}{l_C}, \tag{8}$$

$$LD_C: \quad w_I = \frac{\sigma - 1 + \beta}{\sigma}\frac{R_C}{l_C} - \left(\frac{r+s}{1-\delta}\right)\frac{c}{m(\theta)}, \tag{9}$$

where $\beta_C$ denotes the bargaining weight of the union accordingly.

## 3.4 Firm size and collective bargaining

The model helps us to understand the effects of size in the context of collective agreements. A profit maximizing firm will compare profits in both regimes and opt for the one with higher returns net of the associated costs. In our very stylized model individual bargaining costs depend on firm size, whereas collective bargaining costs are considered fixed. Clearly, this gives rise to economies of scale in the union wage regime as the one-time payment can be spread over a larger number of employees, thus reducing the bargaining cost per-employee. Generally, the firms in the collective agreement regime face a trade-off: On the one hand, they spare additional bargaining costs and pay instead the union membership fee once, but on the other hand wages are usually higher.

$$\pi_I(l_I, \varphi) = R_I(l_I; \varphi) - w_I(l_I; \varphi)\, l_I - cv_I - \kappa_I(l_I; \varphi) \tag{10}$$

$$\pi_C(l_C, \varphi) = R_C(l_C; \varphi) - w_C(l_C; \varphi)\, l_C - cv_C - \kappa_C \tag{11}$$

Fixed production costs are equal on the left- and the right-hand side and can be neglected in this simple comparison. We compare the value of firms with size $l(\varphi)$. $\kappa_c > \kappa(l_i; \varphi)$ holds for small $l$. If we neglect the integer problem $l$ may approach zero associated with the scenario that individual bargaining is more profitable than

[9] We have also considered different other bargaining models and objective functions which did not change our qualitative results.

[10] For the exact equations we refer to the original model.

collective bargaining. Revenues and fixed costs in both bargaining regimes would be identical but variable production, recruitment- and bargaining costs would be zero. Let $l$ go to infinity. Wages and bargaining costs in the individual bargaining regime go to infinity as well. Bargaining costs in the collective bargaining regime remain constant. Thus, there exists one cutoff-size for which collective bargaining becomes more profitable. Smaller firms tend to bargain wages individually and larger firms bargain collectively with their workers. This finding rationalizes the stylized facts discussed in the last section, where we found that larger firms tend to do collective bargaining. We can add the export decision through the indicator function $I$. Exporting always increases firm size through higher revenues due to export. Hence, those firms which export *and* bargain collectively always enjoy higher revenues stemming from a larger size coupled with lower average bargaining costs. As a consequence, we find that firms jointly decide to do collective bargaining and engage in exporting if possible. Moreover, because switching to the export regime is associated with a jump in firm-size and revenue, the collective bargaining and the exporter cutoffs likely coincide. We will show this interesting property of the model in the simulations below.

# 4 Calibration and simulation

The outcome of the model is ambiguous and highly depends on how we set the different parameters. Table 7 summarizes the benchmark parameter values and their sources.

The most important parameters are the productivity cutoffs. Without loss of generality we can set the lower cutoff to unity, $\varphi_D^* = 1$. We let firms draw their productivity from a pareto distribution with a shape parameter $k = 1.144$. The estimates for $k$ are taken from Felbermayr, Hauptmann, and Schmerer (2014). The Pareto and the weighted share of exporters in 1996 allow us to pin down the exporter productivity cutoff to 4.823. Wages are different under collective and individual bargaining. We set them according to the means obtained from the IAB establishment panel without setting the individual labor market parameters. In principle it is possible to recover those parameters using the wage and the labor demand curve but we don't need those estimates for our purposes.[11]

Crucial for our analysis are the variable and fixed bargaining costs. Those cost pa-

[11] Alternatively, the individual labor market parameters could also be set according to estimates for Germany. The matching function can be parametrized according to the results in Kohlbrecher, Merkl, and Nordmeier (2013). Moments for the German job separation rate are reported in Hobijn and Sahin (2009). The unobservable parameters as the outside option, the bargaining power of unions or firms, and vacancy posting costs would have to be set accordingly.

rameters are unobservable and have to be set in order catch some moments observed in the data. For the benchmark calibration we target a situation where all collective bargaining firms are also exporters. Although simple, this calibration captures our reduced form evidence: Exporters engage in collective bargaining.

Starting from this benchmark scenario we conduct our trade liberalization experiment. We will see that this scenario replicates some of the stylized facts discussed in the empirical section and we are also able to shed light on the puzzle discussed in the introduction. Scenarios where trade liberalization increases the share of exporters but decreases the collective bargaining coverage can be simulated through lower iceberg transportation costs.

Table 7: **Calibration-Parameter Values**

| *Parameter* | *Interpretation* | *Value* | *Source* |
|---|---|---|---|
| $\varphi_D^*$ | Survival productivity cutoff | 1 | Normalization |
| $\varphi_X^*$ | Export productivity cutoff | 4.82 | Export share 1996 of 0.16 |
| $w_C$ | Wage, collective bargaining | 59.27 | IAB data |
| $w_I$ | Wage, individual bargaining | 48.62 | IAB data |
| $\kappa_C$ | Union bargaining costs | 180 | Normalization |
| $\zeta_I$ | Individual bargaining costs | 15 | Normalization |
| $\sigma$ | Elasticity of substitution | 3.8 | Felbermayr et al. (2011) |
| $P$ | Aggregate price level | 1 | Normalization |
| $\tau$ | Variable trade costs | 1.3 | Ghironi and Melitz (2005) |
| $n$ | Number of trading countries | 1 | Normalization |
| $k$ | Shape parameter Pareto distribution | 1.144 | Felbermayr et al. (2014) |
| $Y/M$ | Market size | $10E6$ | Normalization |

## 4.1 Simulations results

Starting from the benchmark calibration based on the parameters summarized in Table 7 we study the link between size and the individual/collective bargaining trade-off. We simulate counter-factual profit functions for increasing values of firm productivity. We compute firms' quasi profits starting from the lower cutoff and going beyond the exporter cutoff up to $\varphi = 6$. The smallest non-exporting firm in our sample has exactly one employee. Thus, we associate the cutoff firm's size with the smallest firm observed in the sample, which has exactly one worker. Firms with productivity $\varphi > \varphi_X^*$ additionally serve the foreign market. Size and revenue change

accordingly. Figure 2 presents the resulting profit functions for two different years, 1996 and 2011. The only difference between the two plots is the share of exporters. At the extensive margin we find an increase of exports of around 13 percentage points. Thus, the exporter-cutoff declines from 4.823 to 2.93, which replicates the increase of the share of exporters from 16.53 percent to 29.23 percent.

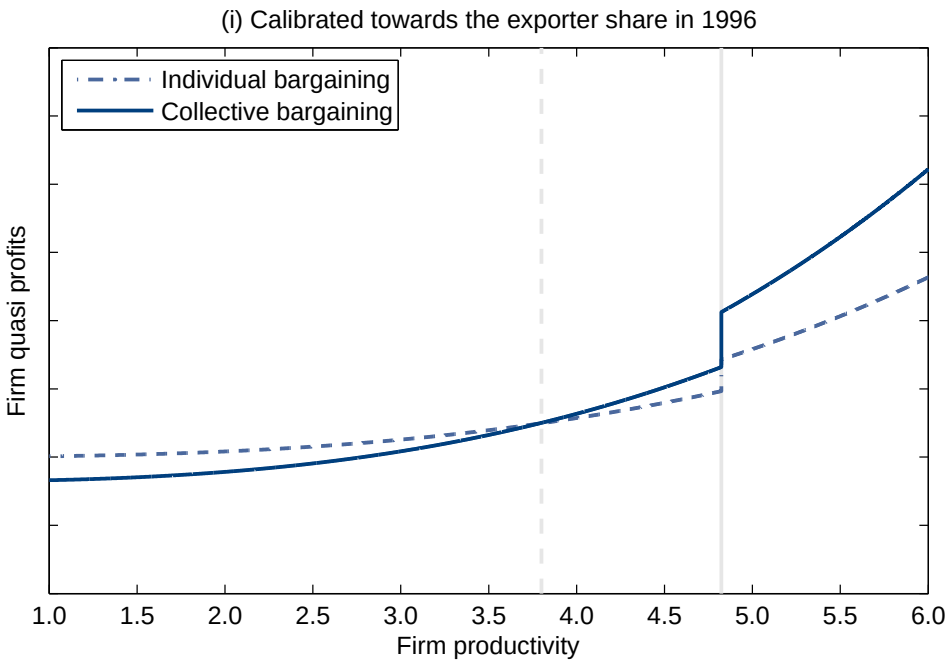
The dashed line represents revenue over bargaining costs in case of individual bargaining, the solid line represents revenue over bargaining costs if the firm chooses to pay the fixed union membership fee.

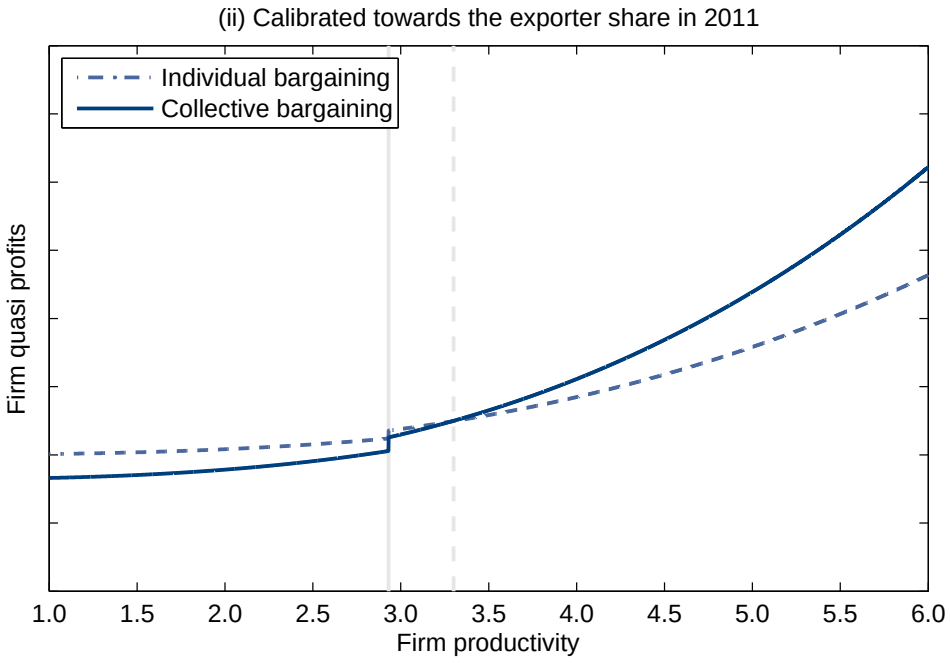
Both the individual and the collective bargaining outcome jump at the exporter-cutoff. However, the absolute value of this jump is lower under individual bargaining due to the discrete jump of variable bargaining costs, which is proportional over the whole range of firm-productivity as it is independent of size.

The simulation in the upper panel of Figure 2 shows that all exporting firms are large enough to exploit the additional scale effects. Moreover, only the small non-exporters would be better off choosing the individual wage formation mechanism. Albeit in line with the stylized facts discussed in the empirical section, the outcome is constructed through setting the right fixed and variable bargaining costs. The lower panel shows the situation in 2011 after the 13 percentage points increase in the share of exporters. Additional exporters are mainly smaller firms that now find it profitable to export, for instance due to lower transport costs. New exporters with productivity $3.55 < \varphi < \varphi^*_{X,1996}$ are still better off doing collective bargaining but the new exporters with productivity $\varphi^*_{X,2011} < \varphi < 3.55$ will start exporting without switching from individual to collective bargaining. The increase in revenues is not enough to compensate for the additional fixed costs.

Our simulation shows that falling collective bargaining coverage and rising exports at the extensive margin do not contradict the statement that exporters tend to do collective bargaining. In line with the results discussed in Table 6, we are able to show that firms that started to export are likely smaller firms that do not have to switch their preferred type of wage formation. Larger firms are more likely to do collective bargaining and those firms are mostly established exporters that already existed in 1996, when the collective bargaining share was still high.

Figure 2: A simple simulation exercise



# 5 Concluding remarks and outlook for future research

In this paper we have studied the relationship among firm productivity, the decision to export and the choice of the bargaining regime. Our analysis is inspired by interesting stylized facts suggesting that most productive, exporting firms are more likely to perform collective agreements, which seems to be in contrast not only with the common perception that unions are a source of firm inefficiency, but also, apparently, with existing studies addressing the impact of unionization on real economic variables. Our analysis contributes to the above debate by highlighting the importance of developing a theory addressing the endogenous decision of the bargaining regime in conjunction with the decision to export. Our model reveals two interesting channels through which collective agreements may positively affect firm productivity and export status. First of all, collective bargaining may decrease production costs for larger firms, in so far as bargaining is costly and firms with a large number of employees may find it more efficient to shift the bargaining process to the union level than to bargain individually with their entire workforce. Secondly, collective bargaining further enhances the gain in terms of external economies of scale that accrue to exporting firms: indeed, in the model, exporting further decreases average production costs for large firms that additionally do collective bargaining. Moreover, we calibrate the model towards the German economy and simulate the firm decision of the bargaining regime for different levels of firm productivity and size. We find that the higher firm productivity is, the more likely it is that it chooses to export *and* to perform collective bargaining. This result is driven by firm size: exporting increases firm size to such a point that it becomes more profitable for the firm to perform collective instead of individual bargaining.

Future research in this area should focus on the endogenous choice of collective bargaining determined by size and productivity. We have shown empirically that the positive correlation between export status and collective bargaining is driven by firm size. Moreover, we have proposed an easy model that can explain efficiency gains of collective bargaining if firms are large. Based on the discussion provided in the introduction, future research may provide a model that extends Michelacci and Suarez (2006) to international trade.

Another extension to the model could be to allow small firms to post wages instead of doing collective bargaining. One explanation for the small difference between collectively and non-collectively bargained wages may be that small firms mimic unionized firms by paying the same wages. Smaller firms should have an incentive to post wages instead of doing collective bargaining.

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# A Coefficients of the probit model with interactions

Table 8: Probit coefficients

| *Dependent variable: Collective agreement*<br>*Variable of interest: Export dummy* | |
|---|---|
| Export (dummy) | $-0.369^{***}$ |
| | (0.041) |
| Between 50 and 250 employees | $-0.133^{***}$ |
| | (0.050) |
| Between 250 and 500 employees | $0.293^{***}$ |
| | (0.105) |
| More than 500 employees | 0.213 |
| | (0.154) |
| Export (dummy)$\times$ | |
| Between 50 and 250 employees | $0.264^{***}$ |
| | (0.062) |
| Between 250 and 500 employees | 0.054 |
| | (0.115) |
| More than 500 employees | $0.673^{***}$ |
| | (0.161) |
| Founded after 1995 | $-0.276^{***}$ |
| | (0.039) |
| Works council (dummy | $1.091^{***}$ |
| | (0.040) |
| Year-dummies | YES |
| Sector-dummies | YES |
| Region-dummies | YES |
| Observations | 49146 |

Standard errors clustered at the firm-level in parentheses. *significant at 10%, ** significant at 5%, *** significant at 1%. We additionally control for the share of workers with different qualification levels in each firm. The sample includes both Eastern and Western German firms.

# B A bivariate probit model for collective agreement and export status

Formally, if the export status dummy is endogenous in the probit model for collective agreement, the model can be rewritten in the following way:

$$CA_j = 1[\mathbf{X_j'}\boldsymbol{\beta} + \gamma EXP_j + e_j] \tag{12}$$

$$EXP_j = 1[\mathbf{Z_j'}\boldsymbol{\delta} + \epsilon_j] \tag{13}$$

where $j$ indexes observations (i.e. firm-year) and the function $1[.]$ indicates that the outcome variable ($CA_j$ or $EXP_j$) is equal to 1 if the expression under square brackets (the "latent variable") is greater than 0. $\mathbf{X_j}$ and $\mathbf{Z_j}$ are vectors of explanatory variables, $\epsilon_j$ and $e_j$ are error terms, independent of $\mathbf{X_j}$ and $\mathbf{Z_j}$ and bivariate normally distributed with $\text{corr}(\epsilon_j, e_j) = \rho \neq 0$. Estimating model (12) without taking into account the correlation between the error terms of equations (13) and (12) would lead to inconsistent estimates of both $\boldsymbol{\beta}$ and $\gamma$. The likelihood function for the bivariate probit model is derived from the expressions for the probability of the four possible outcomes for $(CA_j, EXP_j)$. Namely,

$$P(CA_j = 1|EXP_j = 1) = \frac{1}{\Phi(\mathbf{Z_j'}\boldsymbol{\delta})} \int_{-z_j}^{\infty} \frac{\Phi[\mathbf{X_j'}\boldsymbol{\beta} + \gamma EXP_j + \rho e_j]}{(1-\rho^2)^{1/2}} \phi(e_j) de_j \tag{14}$$

$$P(CA_j = 1|EXP_j = 0) = \frac{1}{1 - \Phi(\mathbf{Z_j'}\boldsymbol{\delta})} \int_{-\infty}^{z_j} \frac{\Phi[\mathbf{X_j'}\boldsymbol{\beta} + \gamma EXP_j + \rho e_j]}{(1-\rho^2)^{1/2}} \phi(e_j) de_j \tag{15}$$

$$P(EXP_j = 0|CA_j = 1) = 1 - P(CA_j = 1|EXP_j = 1) \tag{16}$$

and finally,

$$P(CA_j = 0|EXP_j = 0) = 1 - P(CA_j = 1|EXP_j = 0) \tag{17}$$

Where $\Phi(.)$ and $\phi(.)$ indicate the standard normal cumulative and density functions respectively. The likelihood function combines expressions (14)-(17) together with the probit model for the endogenous variable $EXP_j$ (Wooldridge, 2002). Maximization of the so-derived likelihood function yields unbiased estimates of $\boldsymbol{\beta}$, $\gamma$, and the $\rho$ parameter, the statistical significance of which is tested through a simple Wald test.

**Identification.** Even if in principle exclusion restrictions are not necessary to achieve identification, it is advisable to have at least one variable in $\mathbf{Z_j}$ that is not included in $\mathbf{X_j}$. This helps make the model more robust to distributional misspecification, in this case to the normal distribution assumption (Monfardini and Radice, 2008). Following Hauptmann and Schmerer (2013) we use a dummy variable indicating whether the firm has undertaken investments in IT as exclusion restriction. As argued in Haupt-

mann and Schmerer (2013), this variable is very likely to be correlated with the export status, as long as exporting firms may invest in communication technology in order to ease their international activities. There are instead no obvious reasons why investments in IT may be correlated with collective agreement status. As an additional exclusion restriction, and in order to check the robustness of the above specification, we also use a measure of US openness at the industry level.[12] The rationale behind this choice lays on the importance of the US as a trade partner for German firms. Hence, we expect it to be correlated to German firms' export status, while there is no evident reason why openness in the US should influence the firm's decision of the bargaining regime.

**Results.** Table 9 reports the marginal effects of the estimated bivariate probit model, where we only use the investment in IT dummy as exclusion restriction. Column 1 shows the marginal effects on the unconditional probability of collective agreement, which are the ones that should be compared to those in Table 5 in the main text. The estimated marginal effect of the CA-dummy in column 1 has the usual interpretation of the average change in the probability of exporting when firms switch from no-collective bargaining to collective bargaining. As we can see, the effect of exporting on collective bargaining remains negative and significant. Exporters seem to be on average 14 percentage points less likely to bargain collectively with their workers. Columns 2 and 3 of the same table decompose the total marginal effect into two components: the contribution to the higher probability of doing collective agreement of those firms that export and the contribution of those firms that do not export. Intuitively, the results of table 5 for the marginal effect of the export dummy could be read as follows: *ceteris paribus*, doing collective agreement decreases the average probability of exporting by 14 percentage points. This is the result of two effects. On the one hand, those firms who already export have a 6.5 percentage points lower probability of collective agreement with respect to those who don't export. On the other hand, the domestic firms would lower their probability of collective agreement by 7.5 percentage points if they started to export. The marginal effects of the other covariates have the same sign and partly the same magnitude as the simple probit regressions in Table 5. As for the correlation coefficient between the error terms of the export status and the CA equation, we find that it is only significant at the 10% level in this specification. When we also add US export concentration in the equation for export status, as shown in Table 10, the estimated correlation turns out insignificant, while

[12] More specifically, we use the Herfindahl index of geographical concentration of exports, as reported in the OECD statistics on measuring globalization (micro-trade indicators). Since these figures are available up to 2009, the number of observations drops under this specification.

Table 9: Bivariate probit model (marginal effects)

| *Dependent variable: Collective agreement*<br>*Variable of interest: Export dummy*<br>*Exclusion restrictions: Investment in IT dummy* | | | |
|---|---|---|---|
| | I | II | III |
| | $\frac{\partial P(CA)}{\partial X}$ | $\frac{\partial P(CA=1,Exp=1)}{\partial X}$ | $\frac{\partial P(CA=1,Exp=0)}{\partial X}$ |
| Export (dummy) | $-0.141^{***}$ | $-0.066^{***}$ | $-0.075^{***}$ |
| | (0.043) | (0.020) | (0.023) |
| Between 50 and 250 employees | 0.022 | $0.125^{***}$ | $-0.102^{***}$ |
| | (0.018) | (0.011) | (0.011) |
| Between 250 and 500 employees | $0.106^{***}$ | $0.204^{***}$ | $-0.098^{***}$ |
| | (0.025) | (0.017) | (0.016) |
| More than 500 employees | $0.236^{***}$ | $0.311^{***}$ | $-0.074^{***}$ |
| | (0.027) | (0.021) | (0.017) |
| Founded after 1995 | $-0.076^{***}$ | $-0.025^{***}$ | $-0.051^{***}$ |
| | (0.011) | (0.008) | (0.008) |
| Works council (dummy | $0.313^{***}$ | $0.187^{***}$ | $0.127^{***}$ |
| | (0.010) | (0.007) | (0.007) |
| Year-dummies | YES | YES | YES |
| Sector-dummies | YES | YES | YES |
| Region-dummies | YES | YES | YES |
| Observations | 49051 | 49051 | 49051 |
| $\rho$ | 0.155 | | |
| | (0.090) | | |
| **Wald test $\rho = 0$** | | | |
| $\chi^2$ | $2.88^{*}$ | | |

Robust standard errors in parentheses. *significant at 10%, ** significant at 5%, *** significant at 1%. All specifications additionally control for the share of workers with different qualification levels in each firm. The sample includes both Eastern and Western German firms.

the estimated marginal effects change only slightly.[13] Hence, even if our concern for the endogeneity of the CA-dummy was reasonable, the data show weak support for the hypothesis of additional sources of bias of the export dummy coefficient besides the omitted variable one, which we have already addressed through the inclusion of an exhaustive set of explanatory variables in our empirical model.

[13] In both bivariate probit specifications the coefficients of the variables used as exclusion restrictions (i.e. investment in IT or US export concentration) are significant in the equation for the export status. The full regression output of the bivariate probit is available upon request.

Table 10: Bivariate probit model (marginal effects)

| *Dependent variable: Collective agreement*<br>*Variable of interest: Export dummy*<br>*Exclusion restrictions: Investment in IT dummy and US export concentration index* | | | |
|---|---|---|---|
| | I | II | III |
| | $\frac{\partial P(CA)}{\partial X}$ | $\frac{\partial P(CA=1,Exp=1)}{\partial X}$ | $\frac{\partial P(CA=1,Exp=0)}{\partial X}$ |
| Export (dummy) | $-0.125^{***}$ | $-0.057^{***}$ | $-0.068^{***}$ |
| | (0.044) | (0.020) | (0.024) |
| Between 50 and 250 employees | 0.018 | $0.127^{***}$ | $-0.110^{***}$ |
| | (0.018) | (0.011) | (0.012) |
| Between 250 and 500 employees | $0.103^{***}$ | $0.210^{***}$ | $-0.107^{***}$ |
| | (0.026) | (0.017) | (0.016) |
| More than 500 employees | $0.230^{***}$ | $0.315^{***}$ | $-0.085^{***}$ |
| | (0.027) | (0.021) | (0.018) |
| Founded after 1995 | $-0.077^{***}$ | $-0.027^{***}$ | $-0.050^{***}$ |
| | (0.011) | (0.008) | (0.009) |
| Works council (dummy)) | $0.309^{***}$ | $0.182^{***}$ | $0.127^{***}$ |
| | (0.010) | (0.007) | (0.008) |
| Year-dummies | YES | YES | YES |
| Sector-dummies | YES | YES | YES |
| Region-dummies | YES | YES | YES |
| Observations | 43070 | 43070 | 43070 |
| $\rho$ | 0.123 | | |
| | (0.091) | | |
| **Wald test $\rho = 0$** | | | |
| $\chi^2$ | 1.79 | | |

Robust standard errors in parentheses. *significant at 10%, ** significant at 5%, *** significant at 1%. All specifications additionally control for the share of workers with different qualification levels in each firm. The sample includes both Eastern and Western German firms.

# C Solution to the wage and job creation curve under individual bargaining

As in Felbermayr and Prat (2011) and Felbermayr, Prat, and Schmerer (2011) firms post vacancies until the increase of its value due an additional vacancy is zero so that

$$\frac{c}{m(\theta)} = (1-\delta)\frac{\partial J_i(l_i';\varphi)}{\partial l_i'} \tag{18}$$

which is used to solve the solution to the firm's problem with respect to employment. Moreover from $ii)$ we know that $\partial l'/\partial l = (1-\chi)$ so that

$$\frac{\partial J(l,\varphi)}{\partial l} = \frac{1}{1+r}\left[\frac{\partial R(l;\varphi)}{\partial l} - w(l,\varphi) - \frac{\partial w(l,\varphi)}{\partial l}l + \frac{c}{m(\theta)}(1-\chi) - \zeta_i\right]. \tag{19}$$

According to the envelope theorem we can ignore small changes and treat $l = l'$ in the long run so that

$$\frac{\partial R(l;\varphi)}{\partial l} = w(l,\varphi) + \frac{\partial w(l,\varphi)}{\partial l}l + \zeta_i + \frac{c}{m\left(\theta\right)}\left(\frac{r+s}{1-\delta}\right). \tag{20}$$

Firms bargain with each worker individually so that the following Nash bargaining condition is fulfilled:

$$(1-\beta)\left[E\left(l;\varphi\right) - U\right] = \beta\frac{\partial J\left(l;\varphi\right)}{\partial l}, \tag{21}$$

workers maximize their value of being employed in firm $\varphi$ over their outside option which depends on unemployment benefits and the expected payments when workers get matched to a new firm.

The shadow value of high-skill workers given by (19)

$$\frac{\partial J\left(l,\varphi\right)}{\partial l} = \left(\frac{1}{r+s}\right)\left[\frac{\partial R(l;\varphi)}{\partial l} - w\left(l,\varphi\right) - \frac{\partial w\left(l,\varphi\right)}{\partial l}l - \zeta_i\right].$$

and the value of being employed over being unemployed, given by $E\left(\varphi\right) - U = \left(w\left(l,\varphi\right) - rU\right)/\left(r+s\right)$, can be plugged into the Nash bargaining condition (21), which yields

$$w\left(l,\varphi\right) = \beta\frac{\partial R(l;\varphi)}{\partial l} + (1-\beta)rU - \beta\frac{\partial w\left(l,\varphi\right)}{\partial l}l - \beta\zeta_I \tag{22}$$

The differential equation (22) has

$$w\left(L,\varphi\right) = (1-\beta)rU + \beta\left(\frac{\sigma}{\sigma-\beta}\right)\frac{\partial R(l;\varphi)}{\partial l} - \beta\zeta_I \tag{23}$$

as a solution. The solution is obtained as in Felbermayr, Prat, and Schmerer (2011) Felbermayr and Prat (2011) and Larch and Lechthaler (2011). The difference being, that we have only one industry and symmetric countries so that the aggregate price level is equal to unity in both Home and Foreign. To solve for the Labor Demand curve we differentiate (23) with respect to $s$

$$\frac{\partial w\left(l,\varphi\right)}{\partial l}=\frac{1}{l}\left[\beta\left(\frac{-1}{\sigma}\right)\left(\frac{\sigma}{\sigma-\beta}\right)\frac{\partial R(l;\varphi)}{\partial l}\right]\ .$$

which can be used to substitute for $\left(\partial w\left(l,\varphi\right)/\partial l\right)l$ in the Labor Demand condition (20). Solving for the wage gives a solution that depends only on the equilibrium market tightness, exogenous parameters and the marginal product of labor

$$w\left(l,\varphi\right)=\left(\frac{\sigma}{\sigma-\beta}\right)\frac{\partial R(L;\varphi)}{\partial L}-\left(\frac{r+s}{1-\delta}\right)\frac{c}{m\left(\theta\right)}-\zeta\ . \tag{24}$$

This condition can be used to express the Wage Curve (23) as

$$w\left(l,\varphi\right)=rU+\left(\frac{\beta}{1-\beta}\right)\left(\frac{r+s}{1-\delta}\right)\frac{c}{m(\theta)}\ . \tag{25}$$

which depends on the outside option, the market tightness and other exogenous parameters but not on the newly introduced bargaining frictions. Given that all workers have the same outside option the wage curve states that firms all pay the same wages. The solution for the outside option of high skilled workers is pinned down by

$$rU(\theta)=b\bar{w}+\theta m(\theta)\left(\frac{w-rU}{r+s}\right)=bw+\frac{\beta}{1-\beta}\left(\frac{c\theta}{1-\delta}\right)\ ,$$

# D Solution to the collective bargaining problem

Objective function

$$\max_{w,l} \Omega(w,l) \equiv [U(w,l)]^{\beta} [F(w,l)]^{1-\beta}$$

or

$$\max_{w,l} \tilde{\Omega}(w,l) \equiv \beta \ln U(w,l) + (1-\beta) \ln F(w,l)$$

where

$$U(w,l) = (1-\delta) l \left[\frac{w - rU}{r+\delta}\right]$$

and

$$F(w,l) = \left(\frac{1-\delta}{r+\delta}\right) \left[R(l) - wl - \frac{c}{m(\theta)}\chi l\right] - \frac{c}{m(\theta)} l$$

The first order conditions are

$$\begin{aligned} \beta \frac{\partial U/\partial w}{U} + (1-\beta) \frac{\partial F/\partial w}{F} &= 0 \\ \beta \frac{\partial U/\partial l}{U} + (1-\beta) \frac{\partial F/\partial l}{F} &= 0 \end{aligned}$$

Combining the both conditions gives the contract curve

$$\frac{\partial U/\partial l}{\partial U/\partial w} = \frac{\partial F/\partial l}{\partial F/\partial w}$$

Since

$$\begin{aligned} \partial U/\partial l &= (1-\delta) \left[\frac{w - rU}{r+\delta}\right] \\ \partial U/\partial w &= (1-\delta) l \left[\frac{1}{r+\delta}\right] \end{aligned}$$

and

$$\begin{aligned} \partial F/\partial l &= \left(\frac{1-\delta}{r+\delta}\right) \left[R'(l) - w - \frac{c}{m(\theta)}\chi\right] - \frac{c}{m(\theta)} \\ \partial F/\partial w &= -l \left(\frac{1-\delta}{r+\delta}\right) \end{aligned}$$

The contract curve becomes

$$\frac{\partial R}{\partial l} = rU + \left[\frac{r+s}{1-\delta}\right] \frac{c}{m(\theta)}$$

The first order condition for the wage rate can be written as

$$w = (1-\beta) rU + \beta \left[\frac{R(l)}{l} - \left(\frac{r+s}{1-\delta}\right) \frac{c}{m(\theta)}\right]$$

Combing both equations gives the wage curve[14]

$$w = rU + \frac{\beta}{\sigma}\frac{R(l)}{l}$$

Plugging this back into the contract curve gives the labor demand curve

$$w = \left[\frac{\sigma - 1 + \beta}{\sigma}\right]\frac{R(l)}{l} - \left[\frac{r+s}{1-\delta}\right]\frac{c}{m(\theta)}$$

[14] where we used $q = \frac{Y}{M}p^{-\sigma} \Leftrightarrow p = q^{-\frac{1}{\sigma}}\left(\frac{Y}{M}\right)^{\frac{1}{\sigma}} \Leftrightarrow R = q^{\frac{\sigma-1}{\sigma}}\left(\frac{Y}{M}\right)^{\frac{1}{\sigma}} \Rightarrow R'(l) = \frac{\sigma-1}{\sigma}\frac{R}{l}$

# E Robustness checks

Table 11: Robustness check: Probit Regressions on Western German firms only (marginal effects)

| *Dependent variable: Collective agreement*<br>*Variable of interest: Export dummy* | | | |
|---|---|---|---|
| | I | II | III |
| Export (dummy) | 0.103*** | −0.080*** | −0.116*** |
| | (0.012) | (0.013) | (0.012) |
| Between 50 and 250 employees | | 0.219*** | −0.023 |
| | | (0.016) | (0.017) |
| Between 250 and 500 employees | | 0.382*** | 0.069*** |
| | | (0.019) | (0.025) |
| More than 500 employees | | 0.482*** | 0.201*** |
| | | (0.014) | (0.023) |
| Founded after 1995 | | | −0.096*** |
| | | | (0.017) |
| Works council (dummy) | | | 0.324*** |
| | | | (0.014) |
| Year-dummies | NO | NO | NO |
| Sector-dummies | NO | NO | NO |
| Region-dummies | NO | NO | NO |
| Observations | 25921 | 25921 | 25921 |

Standard errors clustered at the firm level in parentheses. *significant at 10%, ** significant at 5%, *** significant at 1%. In column (III) we additionally control for the share of workers with different qualification levels in each firm. The sample includes only Western German firms.

Table 12: Robustness check: Probit Regressions on Western German firms only (marginal effects)

| *Dependent variable: Collective agreement*<br>*Variable of interest: Export dummy* | | | |
|---|---|---|---|
| | I | II | III |
| Export (dummy) | 0.107*** | −0.046*** | −0.075*** |
| | (0.013) | (0.013) | (0.012) |
| Between 50 and 250 employees | | 0.206*** | −0.016 |
| | | (0.016) | (0.017) |
| Between 250 and 500 employees | | 0.363*** | 0.073*** |
| | | (0.018) | (0.024) |
| More than 500 employees | | 0.463*** | 0.199*** |
| | | (0.015) | (0.022) |
| Founded after 1995 | | | −0.066*** |
| | | | (0.016) |
| Works council (dummy | | | 0.304*** |
| | | | (0.013) |
| Year-dummies | YES | YES | YES |
| Sector-dummies | YES | YES | YES |
| Region-dummies | YES | YES | YES |
| Observations | 25921 | 25921 | 25921 |

Standard errors clustered at the firm level in parentheses. *significant at 10%, ** significant at 5%, *** significant at 1%. In column (III) we additionally control for the share of workers with different qualification levels in each firm. The sample includes only Western German firms.

Table 13: Robustness check: Probit Regressions on Western German firms only (coefficients)

| *Dependent variable: Collective agreement*<br>*Variable of interest: Export dummy* | |
|---|---|
| Export (dummy) | $-0.394^{***}$ |
| | (0.058) |
| Between 50 and 250 employees | $-0.192^{***}$ |
| | (0.074) |
| Between 250 and 500 employees | 0.214 |
| | (0.153) |
| More than 500 employees | $0.337^{**}$ |
| | (0.158) |
| Export (dummy)× | |
| Between 50 and 250 employees | $0.256^{***}$ |
| | (0.086) |
| Between 250 and 500 employees | 0.114 |
| | (0.161) |
| More than 500 employees | $0.548^{***}$ |
| | (0.163) |
| Founded after 1995 | $-0.229^{***}$ |
| | (0.058) |
| Works council (dummy) | $1.083^{***}$ |
| | (0.054) |
| Year-dummies | YES |
| Sector-dummies | YES |
| Region-dummies | YES |
| Observations | 25921 |

Standard errors clustered at the firm-level in parentheses. *significant at 10%, ** significant at 5%, *** significant at 1%. We additionally control for the share of workers with different qualification levels in each firm. The sample includes only Western German firms.

Table 14: Robustness check: Probit Regressions on Western German firms only (marginal effects)

| | |
|---|---|
| **1. Marginal effect of size for exporters** | |
| Between 50 and 250 employees | 0.023 |
| | (0.024) |
| Between 250 and 500 employees | 0.109*** |
| | (0.029) |
| More than 500 employees | 0.238*** |
| | (0.031) |
| **2. Marginal effects of size for non exporters** | |
| Between 50 and 250 employees | −0.058** |
| | (0.023) |
| Between 250 and 500 employees | 0.055** |
| | (0.037) |
| More than 500 employees | 0.082** |
| | (0.035) |
| **3. Marginal effects of the export dummy for different firm-size categories** | |
| Less than 50 employees | −0.128*** |
| | (0.020) |
| Between 50 and 250 employees | −0.047** |
| | (0.023) |
| Between 250 and 500 employees | −0.074** |
| | (0.037) |
| More than 500 employees | 0.028 |
| | (0.030) |

Standard errors clustered at the firm level in parenthesis. *significant at 10%, ** significant at 5%, *** significant at 1%. The marginal effects for the size categories at points 1. and 2. are the discrete change of the predicted probability of doing collective agreement with respect to the base firm-size category (i.e. a firm with less than 50 employees). All marginal effects are computed for a firm in the sector "Building machines", in 2002, located in the Nordrhein-Westfalen region, with a worker council and founded after 1995. The other control variables are fixed at their average value in the estimation sample.